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Fig. 1.

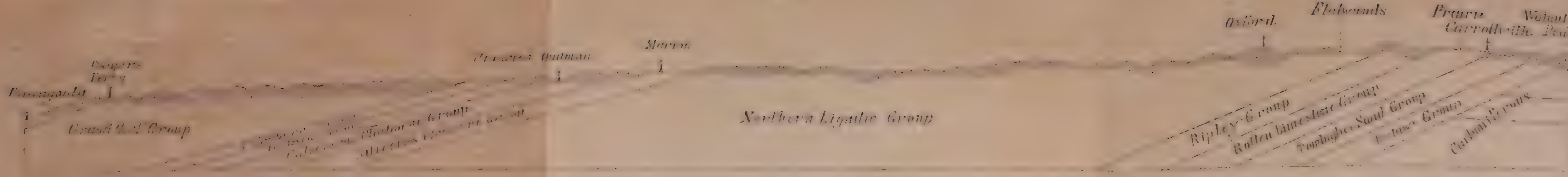

Fig. 1.—General Profile of the Formations of Mississippi, from Pascagoula, to Dwyer's Ferry, Quitman, Marion and Oxford, thence to the Alabama Line, near Walnut Peak P. O., Tishamingo Co.

(Note.—The great apparent thickness of the Northern Lignitic Group, as exhibited in this section, is owing to the change of direction of the line of section, which in part runs parallel to the *strike* of the strata of this group. The dotted space represents the Orange Sand.)

Diagram showing lines of General Profile, Fig. 1.

Fig. 2.

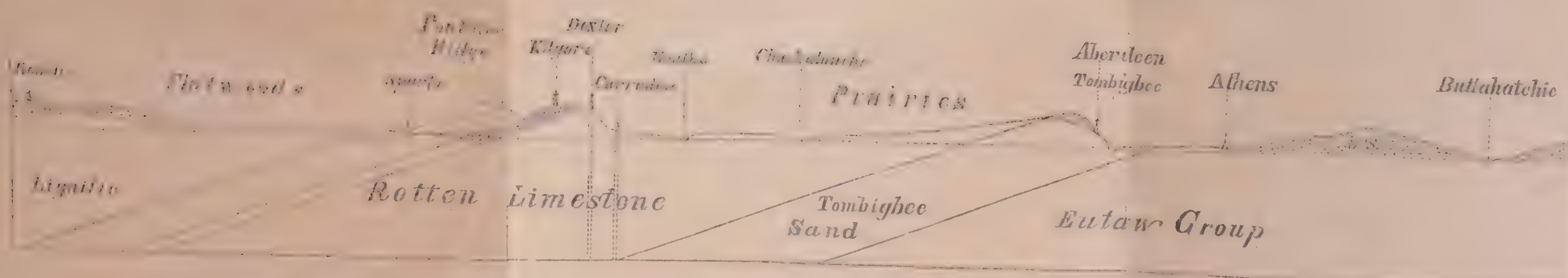

Fig. 2.—Profile of the surface and stratification of the Cretaceous Formation, from Benela to Sparta, Aberdeen, Athens, Buttahatchie, and State Line.

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W. L. Nicholson Esq
with the regards of
the Author -

REPORT

ON THE

GEOLOGY AND AGRICULTURE

OF THE

STATE OF MISSISSIPPI:

BY

EUG. W. HILGARD, PH. D.,
STATE GEOLOGIST.

PRINTED BY ORDER OF THE LEGISLATURE.

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PREFACE.

The Report on the Geology and Agriculture of Mississippi herewith presented to the public, and more especially, to the people of Mississippi, is intended to embrace the observations and results heretofore obtained in connection with the Geological and Agricultural Survey of the State, so far as they are complete in themselves, or calculated to impart useful information, either practical or scientific, as to the natural character and resources of the State.

There exists a great diversity of opinion, both among professional men and the public generally, as to what ought to be the character and extent of the investigations connected with State Surveys of this kind; nor can this be surprising in view of the fact, that the execution of such works under the auspices of State governments, has only been inaugurated at quite a recent date,- since the rapid progress of industrial pursuits by the aid of science, has rendered the claim of those depending more immediately upon the natural resources of the land, to similar assistance, too clear and pressing to be longer disregarded. At first, these Surveys contemplated mainly the development of the mineral resources of the countries to be examined; but the obvious importance of a simultaneous observation of the prospects offered to other pursuits, has gradually so expanded the sphere of investigation, that its limits, as well as the principal and primary subjects of investigation are now generally determined chiefly by the pecuniary means provided for the purpose, in connection with the natural conditions and first necessities of the regions to be explored.

It follows as a necessary consequence, that the objects of these Surveys, as well as the manner of their execution, will differ, more or less, in each State; and that the method of investigation pursued in one may be altogther unsuited to the conditions obtaining in another.

The Survey of Mississippi, according to the act creating it, was to be of the most comprehensive character—nothing less, in fact, than a complete Natural History Survey, embracing scientific as well as practical detail—similarly with that of New York. The limited means provided by law, however, have rendered it unadvisable to attempt to prosecute simultaneously such a multitude of subjects, since the development of the most practically important results would thus be unduly delayed; and for some years past, the more immediate objects of a Geological and Agricultural Survey have been chiefly kept in view, the other departments of natural science receiving such consideration only as their intimate connection with the chief objects necessarily required. In the present Report, therefore, the geological and agricultural features of the State of Mississippi, as far as observed, and the investigations made in relation to them, are chiefly considered.

As to the method pursued in the investigations themselves, and the direction of the latter, the Report will speak for itself. The main object in a practical point of view being, in Mississippi, the promotion of the interests of Agriculture and of kindred pursuits, (in the absence of metallic minerals to any useful extent) and the agricultural features being so closely dependent upon the geological, as to render the subdivisions based upon the latter almost equivalent to those which represent the former; since, moreover, the materials of the geological formations are important, not only as imparting their character to the soils, but also as furnishing natural manures of the highest value; the study of the geological phenomena is obviously the first step towards a full understanding of the agricultural resources, both present and future; which cannot be intelligently discussed without continual reference to the former. This study being absolutely essential, we must bring to bear on it all the means that science affords, even though these should, *at first sight*, seem to have no bearing on the practical questions to be decided—an objection not unfrequently urged against the detailed study of fossil shells, for instance. Yet this apparently unprofitable knowledge of the shells found in the several strata, is hardly less essential in the study of the geology of Mississippi, than the knowledge of the several letters of the alphabet is to him who would learn to read. And thus it is with many other subjects of scientific research mentioned in the present volume, which to those not accustomed to studies of this kind might seem of no interest whatsoever.

As regards the study of the agricultural features proper, both the methods I have pursued, and the objects I have kept in view, are more specially, and more fittingly, explained in the General Part of the Agricultural Report, than could be done in this place; and will be found amply exemplified in the Special Part, page 254, ff.

If the method to be pursued in investigations of this kind, is subject to differences of opinion (sufficiently great to have caused the American Association for the Advancement of Science, at one of its late sessions, to appoint a committee composed of some of the first men of science to examine the question), such is no less the case with reference to the manner of presenting the results to the public. It would seem that this point also must be considered as being, in a great measure, subject to variation according to the necessities of each case; and such being my conviction, it has been my aim throughout *to answer*, as far as I could, *the questions bearing upon the subjects in hand, which experience had taught me were afloat, and being agitated, among the people*, whether of a single neighborhood or district, or of the whole State; in such connection, and, as much as possible, in such language as I knew would make it understood at the points for which it was intended, even though the expressions employed might not in all cases be deducible from any authentic philological source. I am aware that in so doing, I have laid myself open to some criticism in a literary point of view; but I hope that the practical consideration just referred to may serve, in some measure, as an extenuation of the fault.

It is more especially with reference to the introduction of the somewhat lengthy chapter treating of the general principles of Rational Agriculture, that I feel it necessary to enter the plea of special fitness, since on general grounds, it might not be considered as being in its place in a special Report. It was originally suggested by my personal experience, among the agricultural population of the State, of the desire for information of this character;

and the probability that without it, the results of the Agricultural Survey could not readily be made available to a very large part of those for whose special benefit the work is intended. Yet I might not have thought myself justified in making this feature so prominent, even to the exclusion of a certain amount of special information, but that it appeared to meet the particular approval of the gentlemen constituting the legislative committee, to whose examination the manuscript was submitted—thus confirming the impression dirived from my own observation, regarding the propriety of introducing it, as explanatory of the nature and object of such investigations, and of the results elicited. With this special object in view, I have attempted to present, to the agricultural reader, as briefly and concisely as possible, and with the least use of technical terms compatible with that conciseness, the well-established principles of Rational Agriculture, with special reference to such matters as have a particular bearing upon the conditions existing in this State. The treatise, therefore does not in any manner pretend to completeness, but simply touches in an explanatory manner, such subjects as appeared to me of immediate importance in connection with the results of the Survey; and I have endeavored by copious references throughout the special part, to establish that connection, and to enable the reader unacquainted with the subject, to see, and act intelligently with reference to the reasons why a certain course is recommended in certain cases.

It is with reference to the latter point particularly, that I have deviated from the course usually pursued in Reports communicating analyses of soils; it being mostly left to the agriculturist to interpret, as best he may, the columns of names and figures which he recieves from the hands of the chemist. That under such circumstances, little benefit should result from these analyses, is not wonderful. The chemist, not knowing the circumstances under which the soil he has analyzed, occurs in nature, cannot, if he would, advise intelligently as to the import of his results; yet, to draw the conclusions contained in the abstract result communicated by him to the agriculturist, almost always transcends the knowledge of the latter; for it presupposes in most cases, an acquaintance with chemistry and the kindred sciences not to be expected, unless of professional men. The agricultural chemist, therefore, ought not only to make the analyses, but also to interpret them to the agriculturist; but he cannot, in general, do so intelligently from the results obtained in his laboratory alone, from a few specimens desultorily collected by others, without reference to any rule, or system of investigation; which can be consistently carried out only upon the scale of a public work, by State aid.

While this, however, may justly be claimed at the hands of the scientific investigator, it is asking nothing short of an impossibility, when it is expected of him that he should communicate the scientific detail of his researches, in language intelligible to those not previously acquainted with the fundamentals of the science. It might as well be asked that he should teach a person to read, without giving him the trouble of learning the letters of the alphabet.

It is very commonly and cheaply charged upon professional men generally, and upon those cultivating the exact sciences in particular, that they have a perverse disposition to wrap up everything known in an unintelligible, technical jargon, or "big words", as they are currently termed. It is expected of them that they should develop *new ideas* (such as always result from the special study of any subject), but that they should use no *new terms* in expressing or communicating them; which is simply impossible. No one can expect to be *taught*, without *learning*; let him catch the *idea*, and it will matter little to him whether the word expressing the same be Greek, Latin, or Chinese; English terms, already possessing definite meaning, cannot be used to express new ideas. If he cannot take the time, or trouble, to learn the *idea*, he ought not to complain if he cannot understand the *term*.

In a practical point of view, it being undeniable that the frequent recurrence of technical terms not familiar to the general reader, will often deter the latter from attempting to read even that which he can understand, I have thought it best to separate, as much as possible, the purely scientific part from the purely practical, so as to enable each one to select at once what is suited to his taste and purpose. I have for this reason, separated the geological part from that descriptive of the agricultural features, connecting the two, however, by copious references, and even repeating in brief, at times, in the latter part, important points in the geology of the country, already given in the former part, and more fully discussed there. In the geological part itself, I have given under separate heads ("*Useful Materials*") the chief practical results embraced in the previous description of geological detail, which it would be impossible to render fully intelligible to readers not conversant with the science, without writing, at the same time, a Compend of Geology. The latter course has been to some extent pursued in many State Reports, and among others, in the two Reports published previous to the present one, in this State. I have so much the more felt justified in omitting this feature, and substituting for it a Compend of Agriculture, before noticed.

But it may be thought by some that under the circumstances, the geological, scientific detail might, for practical purposes, as well have been omitted altogether. But it is inadmissible, at the present day, to appear before the public with mere assertions, without presenting, as vouchers for the accuracy of the observations, the record of the latter; and the fact that that record cannot be made intelligible to all at the first glance, can form no legitimate objection to the propriety of giving those who *can* understand it the opportunity of judging and controlling, the correctness of the conclusions. The very separation of the practical from the scientific detail, has necessarily imparted to the latter an aspect even more abstruse than usual; but the unprofessional reader may skip what seems unintelligible to him, with the understanding that he loses nothing that *could* be explained, unless *he* were to go to the trouble of making himself acquainted with the rudiments at least of the science, which it is not the province of a State Report to teach. A great deal, however, of what might not be intelligible to the general reader, *by itself*, will become so to those desiring further information on the subject in hand, by looking up the paragraphs referred to in the text—to facilitate which, the paragraphs occurring on every page are given at the top, on the *inner* corner. The whole being written with a view to these references, to avoid incessant repetition, it will be quite essential to the casual reader to make use of them.

The discusssion of the agricultural features of a region involves, necessarily, two distinct classes of data, viz: 1st. The *general* description of the surface configuration, vegetation, soil, etc. 2nd, The discussion of the peculiarities of the several soils, if the observations made are such as to render such discussion useful.

While the former class of observations has been made, and is recorded here, with reference to the greater portion of the State, the latter is as yet very incomplete, in consequence of the chemical work of the Survey having unavoidably remained far behind the field work. Copious specimens of soils, marls, etc., from the regions examined are, however, in the collection of the Survey, and will be subjected to analysis, or such other examination as they may require, so soon as the limited means of the Survey—consisting, thus far, of my single-handed labor, with the occasional aid of kind friends—will permit; and the same is intended to be done with reference to the districts not yet sufficiently examined, as mentioned in the Special Report. The publication of preliminary Reports necessarily containing a great deal of crude and undigested matter, is not a pleasant necessity to the scientific investigator; but I shall consider the objects of the present Report to be amply attained, if the observations, results and suggestions it contains, shall succeed in awakening our agricultural population more generally to the importance and necessity of agricultural improvement, and of a rational system of Agriculture. It rests with them, in great degree, to render the Agricultural Survey that which it should be. It is upon them that the scientific investigator is dependent, in most cases, for knowledge of the faults and virtues of a soil, the cause and remedies of which he is to ascertain; it is they who must test in practice the correctness of his conclusions; and it is only by co-operation of this kind between the practical agriculturist and the scientific investigator, that the benefits of the aid of science to Agriculture, are capable of realization. Agricultural science is young; it cannot as yet answer at once all questions which may arise in regard to the mutual relations of soils and crops; but its fundamentals are well established, and it is upon investigations like these that its progress must be based.

It is obvious, moreover, that the knowledge thus obtained of the peculiarities of the State, is a most essential step towards the establishment of Agricultural Schools of a character truly practical, in which the young men of the State shall be taught, not only general principles, and what ought to be their mode of procedure in certain suppositious cases: but also what are, *in fact and practice,* the cases they will have to deal with *in their own State,* illustrated by actual specimens, having received a thorough examination.

In mentioning the vegetation of the several regions, I have throughout made use of the popular names, as far as such exist; when, however, characteristic plants requiring mention *possessed no English name*, I have given the systematical botanical term, which conveys the meaning to *some* persons at least. I must observe, however, that in reference to the popular names of the Oaks, there exists a great confusion in our State; those generally adopted in the United States, and which have already passed into systematic botany and text-books, having partially, in Mississippi, been transferred to *different species*. Thus the *Quercus falcata*, everywhere else called Spanish Oak, is generally designated as "*Red Oak*" in Mississippi: the *true* Red Oak (*Q. rubra*) of the Middle States, is either not distinguished here from the Black Oak (*Q. tinctoria*), or is by many thought to be a "kind" (variety) of the *Q. falcata* (the "*Red*" Oak of the Mississippians, or Spanish Oak proper.) On the other hand, the name of "Spanish Oak" is popularly applied, in Mississippi, to the *Q. coccinea*, the Scarlet Oak of other States. To use the other nomenclature by itself, would involve, either throwing the student of botany into inextricable confusion as to the trees of the State, or else a misunderstanding on the part of the agricultural population, which would be the more serious, as these several Oaks indicate very essential differences of soil. To avoid these inconveniences, I have throughout, in the text, used the names *as adopted in botanical text books*, but have introduced after them, in parenthesis, quotations, and *italic* type, the corresponding names as usually used in Mississippi. Thus, Spanish ("*Red*") Oak implies the *Quercus falcata*, commonly termed "*Red Oak*" in Mississippi. The "Poplar" (*Liriodendron tulipifera*—Tulip-tree of the text-books), also, I have placed in quotations, because the name properly belongs to the Lombardy Poplar and Cottonwood (*Populus*) tribe of trees.

To those familiar with the sciences, it is proper to state, that the methods I have pursued in the quantitative analyses of soils, etc., are essentially those described by Dr. R. Peter, in the third volume of the Kentucky Geological Report, which yield results very uniformly satisfactory with a great variety of materials. The time during which the soils were digested with acid of uniform strength, was in most cases, as uniformly as possible, *five days*. Want of time and proper arrangements have hitherto compelled me to omit the separate determination of sand, and the extraction of the soil with carbonic acid water (both intended to be performed hereafter). I have substituted for the determination of moisture contained in the air-dried soil (varying greatly within brief periods), that of the moisture absorbed by the same at a fixed temperature if possible, in an atmospere at the point of saturation, with aqueous vapor; which renders the determinations directly comparable, and seems to offer a very important element in the determination of the treatment of soils. Not having had a space of a perfectly uniform temperature at my command, the temperatures at which the saturation took place, have varied somewhat, as will be seen by reference to the analyses; but it is my intention to determine, at the earliest possible moment, the law of variation in this respect, so as to render the results strictly comparable. I hope that the imperfections of the work in a scientific as well as in many other points of view, may meet with lenient judgment at the hands of those at least, who have experienced the difficulties besetting an observer who has to rely almost entirely upon his single-handed labor, in the numerous departments of science involved in a work of this kind.

It may be noticed by those possessing the Report of my immediate predecessor (L. Harper), that many facts and localities mentioned there, are referred to and described in the present one also. As stated at first, it has been my aim to communicate as completely as possible, all reliable observations and results heretofore obtained in connection with the Survey; and wherever I have availed myself of the observations, either of my predecessors, or of other scientific observers, I have given due credit. With reference to Harper's Report, therefore, I have simply to say, that nine-tenths of all the data given there in relation to the northwestern portion of the State, are extracts, sometimes literal, from my field notes, made in the capacity of Assistant in 1856; the observations then made being here presented in the light in which they appear to me, and with the conclusions to which, in my judgment, they legitimately lead. Owing to the want of his field notes, as well as those of his predecessors, I have been compelled to rely chiefly upon my own recollection with reference to the observations jointly made in the southern portion of the State, in 1855, so far as I have not since re-examined the region personally.

I have to regret that the inadequacy of the appropriation made for printing the present Report, has compelled me to curtail its contents in several important particulars, and among others has necessitated the omission of the tables of elevations, as ascertained by the railroad surveys ; which are, therefore, reserved for a future Report ; and has likewise rendered necessary a partial reduction of the size of the type. Notwithstanding these curtailments (as far as compatible with the objects of the Report), the cost of publication has, under the circumstances, seriously exceeded the amount provided.

Of the accurate observations contained in Prof. Wailes' First Report (which has become somewhat scarce), I have availed myself, so far as they come within the purpose of the present Report ; giving due credit therefor.

To Dr. William Spillman, of Columbus, Mississippi, I am indebted for the catalogue of fossils given in the Appendix, as well as for other favors.

To Leo Lesquereux, Esq., of Columbus, Ohio, I am indebted for determinations of fossil plants from the Lignitic strata of North Mississippi.

My most especial acknowledgments are due to Prof. W. D. Moore, of the University of Mississippi, for voluntary assistance not merely occasional, but of the most comprehensive kind and in part, of the most toilsome character ; he having for months together devoted all his leisure time, even at nights when necessary, and oftentimes at great inconvenience to himself, to the furtherance especially of those portions of the work which otherwise, in the multifarious duties devolving upon me, could hardly have been touched as yet. I owe to his patient labor the systematic arrangement and labeling of the Survey collections at Oxford. Without his assistance in the determination and comparison of fossils, the geological features of the State would even now, in a great measure, have been but imperfectly determined, unless many other practically important investigations had been omitted instead ; and the compilation of the catalogues of fossils is almost entirely the fruit of his labor. Of fieldwork I owe to him the re-examination and more accurate tracing out of the deposits of hydraulic limestone in Tishomingo, the result of which is given in the Appendix. And finally, he has rendered me most essential aid in the arrangement and revision of the manuscript; and in seeing through the press its latter portion, at considerable inconvenience to himself.

I cannot close this, already somewhat lengthy preface, without expressing my obligations to the numerous gentlemen throughout the State, by whose kindness and intelligent assistance my labors in the field have been essentially lightened, and the work of the Survey materially promoted.

EUG. W. HILGARD.

OXFORD, August, 1860.

TABLE OF CONTENTS.

PART II.

AGRICULTURAL REPORT.

In the absence of Dr. Hilgard I am compelled to state, by way of appology, to him and to the readers of the Report, that lack of space has obliged me to substitute for an exhaustive index, alphabetically arranged, a Table of Contents: I have labored to make this as minute and full as possible, and hope that the careful reader by its aid will be able to turn rapidly and readily, to whatever he may desire to find in the text. The few errata deemed of sufficient importance to correct, are here subjoined:

On p. 3—"Marine Animal" should be opposite "Ripley Group" and the three lines just below brought up accordingly.
" " 240—immediately preceding ¶482, for "Retoration" read—Restoration.
" " 301—in the heading, for "Alterations", read—Alternations.
" " 304—in the sixth line of ¶650, for "properly" substitute popularly.

Two blanks involving the number of acres embraced in the Sea-Island Cotton Plantations, and the amount of cotton per acre produced on these, I have been unable to fill, the only information relative to these subjects, in the U. S. Census, being the return of 70 bales from Hancock County. W. D. MOORE.

JACKSON, Sept. 14, 1860.

PART I.

GEOLOGICAL REPORT.

1. *Configuration of the Surface.*—There are, probably, few States in the Union, concerning the aspect of whose surface erroneous impressions are more generally prevalent, than is the case with Mississippi. The reputed character of a comparatively small portion of its territory—the Mississippi Bottom—is very commonly referred to the greater portion, or to the whole of the State, among whose features, swamps, marshes and mosquitoes are thought to hold a prominent place. It may not be superfluous, therefore, to premise, that outside of the Mississippi Bottom, sand hills, with Pine, Black Jack and Post Oak, are a very conspicuous feature in the landscape ; the surface being generally hilly, though nowhere mountainous. Few of the ridges probably rise as high as 400 feet above the drainage of the country, the usual elevations of the hills above the minor watercourses being from 30 to 120 feet ; and none probably are above 800 feet in absolute elevation. All the inequalities of surface at present existing in Mississippi, are due to denudation—formed by the action of water. There are no hills or chains of upheaval properly speaking ; for, although many are composed chiefly of strata possessing a sensible dip, they are elevated above the rest of the country only because these have to a great extent been washed away, without being, at the present time, replaced by other deposits.

2. The dips are mostly very slight, so as to be rarely perceptible in one and the same locality, and often difficult to demonstrate

without actual surface levelings. The dips of the cretaceous strata has been best proven, and its amount approximately ascertained, by the artesian bores which have been numerously made in the region they underlie. In Lowndes and Noxubee counties, according to data collected by Dr. William Spillman, the dip is from 25 to 30 feet per mile, towards the S. W. Further N. the direction of the dip changes to the westward, and near the Tennessee line is nearly due W.; while in middle Alabama, according to Tuomey, the dip is nearly due S. In other words, the strata incline *away from* the great upheavals of the Alleghany range, the cretaceous belt skirting what may be considered the last spurs radiating from the mountains. [See Paragraph 78.] The strata of the Tertiary also possess a slight dip, as is shown by the rise of the water obtained in boring wells, in the southern portion of the State; and by the gradual sinking below the waters edge, as we advance southward, of the strata exhibited in the banks of the streams which, like Chickasawhay and Pearl Rivers, follow in general a southward course. The dip of the tertiary therefore coincides, in the main, with that of the cretaceous formation.

3. In view of these facts, we should expect to find the highest elevations in the north-eastern portion of the State. With respect to the *average level* of the country, this undoubtedly holds true, as is shown by the course of the larger rivers; but the rule is very much modified, as regards the highest *relative* elevations, above the general level of the drainage. For after we recede 70 to 90 miles from the sea-coast, the average level ascends but slowly, and we find *relative* elevations at least, equal to those in the N. E. portion of the State; and thence northward, no inference as to the hilliness, or the relative elevations of a region, can be drawn *a priori* from its position, either in longitude or latitude. In the latter direction, there is perhaps a little more regularity than exists in the former; the highest relative, as well as absolute, elevations being, on the whole, E. of a line drawn N. and S., through the center of the State. A notable exception to this rule, however, occurs in the extreme S. W., where the Mississippi river is skirted by ridges, some of which are elevated probably more than 400 feet above its level. Some of the highest ridges in the State are said to exist on the heads of Pearl River, in Newton, Neshoba, and E. Attala—a region with which I am not personally

acquainted; while the highest ridges in N. Mississippi of which I have any knowledge exist in the waters of the Hatchie, in E. Tippah, and in the hilly region dividing the waters of the Hatchie, Tallahatchie and Tombigbee. A table of such determinations of elevation as I have been able to obtain, will be found in the Appendix, at the end of the present volume.

4. *Geological Structure.*—The general geological features of the State are simple, and will be readily understood, in connection with the foregoing remarks, by reference to the geological map; the subjoined table of the formations occurring in the State, their several stages, principal materials, and character of fossils; and the general section, Fig. I, Table 1, in which, for the sake of a fairer representation than could otherwise be given, a *curved* line of projection (as indicated on the little map subjoined) has been adopted.

TABLE OF THE FORMATIONS OF MISSISSIPPI.

NAME OF FORMATION.	NAME OF GROUP.	PRINCIPAL MATERIALS.	FOSSILS FOUND.
Quaternary.	ALLUVIUM	Soils, sand-bars, etc.,	Living plants and animals.
	SECOND BOTTOM	"Hommocks,"	?
	YELLOW LOAM	Brown and yellow brick-clays,	?
	BLUFF FORMATION	Calcareous silt,	Terrestrial, part extinct.
	ORANGE SAND	Sands, pebbles, clays,	Those of underlying formations.
Tertiary.	COAST PLIOCENE?	Black fetid clays,	Living marine shells, living trees
	GRAND GULF GROUP	Light colored clays; white sandstones.	Plants partly extinct? Lignite.
	VICKSBURG GROUP	Marls and limestones,	Marine animals.
	LIGNITIC	Black clays,	Plants Lignite.
	JACKSON GROUP	Marls and soft limestones,	Marine animals.
	LIGNITIC	Black clays,	Plants, Lignite.
	CLAIBORNE GROUP	Marls and limestones,	Marine animals.
		Siliceous sandstones,	Marine animals.
	NORTHERN LIGNITIC	Black and grey clays; yellow sands,	Plants partly extinct; Lignite.
Cretaceous.	RIPLEY GROUP	Marls and limestones, sandy,	
	ROTTEN LIMESTONE	Soft chalky limestones, clayey,	Marine animals.
	TOMBIGBEE SAND	Greenish micaceous sands,	Marine animals.
	EUTAW GROUP	Dark colored clays, sand,	Marine animals.
			Plants, extinct; Lignite.
Carboniferous.	LIMESTONE	Fetid, crystalline limestone,	Marine animals.
	SANDSTONE	Siliceous sandstone and chert,	Marine animals.
	BLACK SLATE	Hydraulic limestone,	?

It will be perceived that *four* only of the principal geological periods are represented, viz: the *Carboniferous*, *Cretaceous*, *Tertiary* and *Quaternary*. In each of these, several stages, or minor subdivisions require to be distinguished. But before entering upon a special discription of these, it is necessary to premise, that with the exception of the territory occupied by the alluvium of the Mississippi Bottom, and by the Bluff formation of the Southern River Counties, the formations laid down on the map do not, as a general thing, occupy the surface to any considerable extent, nor even do they in most cases, immediately underlie the *arable stratum* of their region of occurrence. The latter, in most of the better class of upland soils, is formed by a yellow or brown loam, of an age more modern than the Bluff formation (which it frequently overlies), and from two to ten feet in thickness. But the formation which gives character to the surface conformation of the State—whose presence is the rule, and whose absence the exception requiring special mention; which forms the main body of most ridges, and to a very great extent, their surface also—is that which has been very appropriately designated by Prof. Safford, the State Geologist of Tennessee, as the Orange Sand formation.

5. It may appear surprising at first sight, in view of these facts that this important formation should not have been laid down, or even mentioned, on the geological map; but the very universality of its occurrence has made this a matter of necessity, unless the other formations were to be concealed by it on the *map*, in the same manner in which they are in *nature*: so much so, that this very formation is among the most serious obstacles in the examination of the more ancient formations of Mississippi, and that a proper understanding of its peculiarities is the first necessity in the study of the geology of the State. And since even a description of the other formations involves, of necessity, a continual reference to these peculiarities, it may be best to give the special description of the Orange Sand formation, out of its proper order in the geological series, as a key and introduction to the geological structure of Mississippi.

THE ORANGE SAND FORMATION.

6. As has been stated above, the Orange Sand formation characterizes the greater part of the surface of the State of Mississippi. It is entirely wanting only in the alluvial bottom of the Mississippi River; and it occurs to a limited extent only in the following districts: 1st, In the territory of the Bluff formation, skirting the Mississippi River southward of Vicksburg, to the Louisiana line. Above Natchez, the Orange Sand formation usually runs out at a distance of 8 or 12 miles from the Mississippi River, where it appears *underlying* the calcareous silt of the Bluff formation, sometimes only a few inches in thickness, but increasing rapidly as we advance inland; below Natchez, however, we find it forming a high Bluff of considerable extent (the White Cliffs) on the Mississippi River itself; and at Fort Adams, on Loftus' Heights, it appears in a stratum about 90 feet in thickness, overlaid by a stratum 73 feet thick, of the materials of the Bluff formation. It probably appears on many intermediate points also.—2d, In the territory occupied by the Jackson Group of the eocene tertiary. It is absent from the prairies of this district, (whether of the gypseous or calcareous character), but usually forms the ridges skirting them; it is wanting also, in the "Hog-Wallow-Prairie" district of the same region, in N. E. Smith and N. W. Jasper counties, but nevertheless forms all the ridges bordering on the same.—3d, It is wanting in a large portion of the territory occupied by the Rotten Limestone Group of the cretaceous formation, viz: on the prairies, and the gently undulating oak uplands skirting them. And finally, it is absent, or but feebly represented, 4th, In the "Flatwoods" region, and particularly, in the "Flatwoods" proper. In remaining portion of the State, the ground is either occupied by the members of the Orange Sand formation, or else, when the more ancient strata form ridges by themselves, it is only in limited patches. Very frequently, the older deposits form the beds of the streams, where they crop out in bluffs; constituting also the lower portion of the hills, which are capped with Orange

Sand strata--overlaid very generally, by the Yellow Loam deposit previously referred to, which is one of the newest formations of Mississippi.

7. The *thickness* of the Orange Sand formation is extremely variable. As originally deposited, its strata appear to have been dependent, as to their thickness, on the degree of denudation which the strata of the more ancient formations had previously undergone; but at present, the extensive denudations which have taken place in the Orange Sand formation itself have added a complicating element; so that a most extraordinary capriciousness in this respect, characterizes these deposits. The greatest thickness observed with certainty, to my knowledge, was in a well dug at the University of Mississippi, to a depth somewhat more than two hundred feet; and a section of about the same thickness occurs, according to Prof. Wailes, at the White Cliffs, in Adams county. One hundred feet is no unusual thickness; but most commonly it varies between 40 and 60 feet. Even on different portions of one and the same acre of ground, great variations frequently occur. Thus, in the town of Brandon, wells N. of the R. R. cut reach water at 45 feet, passing through Orange Sand strata all the way; while S. of the cut, the gray clay of the Upper Lignitic formation is struck after passing through a few feet only of sand.

8. The existence of hills of more ancient formations within those of the Orange Sand, as exemplified in diagram No. 2, (¶39,) is shown in numerous profiles, all over the State; nor does the external shape of these ancient hills leave any doubt as to their having been, themselves, originally formed by denudation, and afterwards covered over by the Orange Sand deposits. In such cases, the lines of deposition of the Orange Sand usually exhibit, near to the line of contact, slight inflections, conformable to the curvature of the interior mass; but the *general* horizontality of the stratification lines is not thereby disturbed. Nor do I know any instance of the departure from horizontality, in the Orange Sand strata, which could be referred to an upheaval, either local or general. The water obtained within these deposits, never exhibits any tendency to rise.

9. It is not to be inferred, however, that the stratification of this formation is remarkable for regularity. On the contrary, it is often extremely difficult to trace out one and the same stratum, or

Plate II.

STRATIFICATION OF THE ORANGE SAND FORMATION.

FIG. 1.

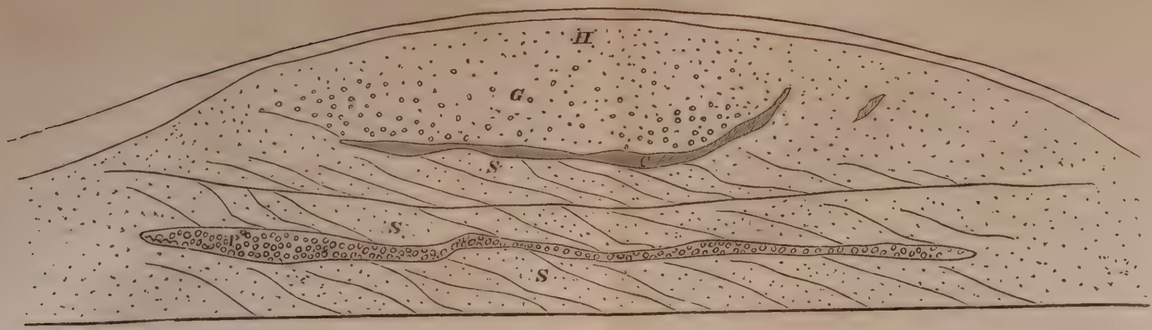


FIG. 2.

FIGS. 1 and 2.—Sections from cuts on the New Orleans, Jackson and Great Northern Railroad, near Summit, Pike Co.

FIG. 3.

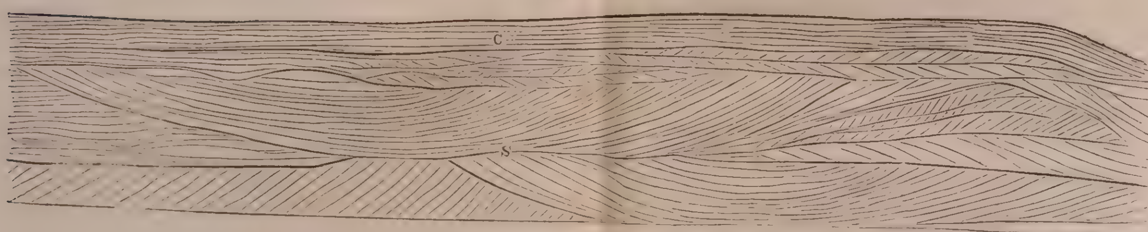


FIG. 3.—Section from a cut on the Mississippi Central Railroad, at Oxford, Lafayette Co.

S Stratified Sand. **C** Pipeclay. **H** Brownish Hardpan. **G** Small Gravel. **P** Pebbles.

stratification line, for any considerable distance. Not only does the material of which it is composed undergo entire changes within very limited areas, but the stratification lines themselves often exhibit the most fanciful irregularities, often coming square up against one another, and frequently exhibiting successive parallel lines of deposition forming a large angle with the lines of contact adjoining strata.

Fig.'s 1, 2, and 3, Pl. II representing profiles occurring in R. R. cuts in Lafayette and Pike counties, will illustrate this irregularity both with reference to stratifications and material; nor is it to be supposed, that instances of this kind are exceptional; they abound wherever the formation prevails in force. Even where horizontal lines of deposition can be traced for some distance, they are usually themselves wavy on a small scale. No one can fail to be struck by the similarity of the stratigraphical character of the Orange Sand, with that which may be studied to advantage on the banks of the Mississippi river at low stages of water, in the alluvial deposits. And there can be little doubt that the Orange Sand has been deposited in a similar manner, by flowing water; especially when the evidence afforded by the character of the material (*rounded* grains of sand and pebbles; see below) is taken into account; the grains of which, in all cases which have come under my observation, are more or less rounded, and without sharp angles or edges; which explains the common observation, that these sands are a very poor material for scouring purposes.

10. *Character of Materials.*—As the name indicates, the prevalent material composing this formation, are siliceous sands. They are usually colored, more or less, with hydrated peroxide of iron, or orange-yellow ochre. The color thus imparted is sometimes very deep and glaring; as on the Pontotoc Ridge, in eastern Itawamba county, and many other localities; more frequently, it is a dull rust color. In the southern Pine region (as in Smith, Marion, and Pike counties), it is often of a delicate rose hue; bright yellow tints are frequently found, and deposits of *white* sand are not uncommon. An endless variety of tints intermediate between the above, of course exist; and locally, crimson, purple, and almost blue tints, fancifully co-ordinated, may be observed.

11. Whenever the amount of iron contained in these sands is somewhat considerable, they exhibit a tendency to conglomerate;

and thus ferruginous sandstones are formed, of all degrees, from a friable mass to a solid rock of considerable hardness, and well suited to building purposes. when stones of the proper dimensions can be obtained. The several varieties of this rock play a prominent part in the topography of the State, and some of them claim our attention on account of their practical usefulness. I do not know of any instance in which a notable stratum of this ferruginous sandstone is found much below the present surface of the locality of occurrence. These ledges (of a few inches at most) are sometimes found at some depth, where a seam of denser material (*e. g.* clay) has arrested the further progress of a ferruginous solution, which otherwise would have imparted only a slight general cohesion to the whole mass of the sand. But commonly, the several varieties of this sandstone are found on or near the surface, capping the summits of hills and ridges ; and in truth, it is difficult to find an Orange Sand ridge of any importance where little slaty fragments, at least, of this rock, are not scattered about on the summit. Wherever an unusually elevated knoll is seen on these ridges, it is certain to be found capped with a deposit of this rock, partly remaining in place, on the summit, partly strewn adown the hillside. And even as we find these rocky knolls perched, as it were, on top of the ridges, so in level, or gently undulating tracts, elevated but little above the drainage of the country, we often see short ridges, or isolated hillocks of a truncated-cone shape, rising abruptly out of the plain, to the height of 70 to 150 feet and usually crowned with a clump of pines—a tree not seen for miles around perhaps, in the level country, and whose roots can with difficulty gain a foothold in the shallow soil, and crevices of the level ledge of dark colored sandstone which forms the summit. Cases in point are of frequent occurrence in North Mississippi ; the counties of Tippah, Marshall, Lafayette, Carroll and Yallabusha furnish abundant examples ; especially the gently undulating, fertile yellow-loam region of the latter county, where a number of these isolated pillars, now forming prominent landmarks in the plain, are left standing to show, apparently, the original surface level of the country, after the subsidence of the flood which spread over the older formations, the immense masses of sand which now cover the greater portion of the State. And it is to these rocky caps, no doubt, that these elevations owe their escape from the denuding action which has removed the rest of the stratum.

12. It is comparatively but rarely the case, however, that *solid* ledges of any considerable thickness are found on these summits. Solid ledges of 4 feet are not common, and but two cases are known to me in which their thickness amounts to ten or more feet. Most usually they consist of connected masses of fantastical shape, such as concretionary bodies are wont to assume; the interstices are filled with loose, or loosely cemented, sand. The latter, as might be supposed, is washed out in course of time, where the stratum is exposed to the weather; and when the remaining harder portions are broken asunder, it does not require a strong imagination to recognize in them the remnants of works of art; and nothing can convey a better idea of the prevalent forms, and character of the material, than the popular likening of such spots with the "ruins of a forge," or more properly, those of an iron foundry. There are angular plates, of several square feet, of plane surface, straight edges (the latter often provided with a regular rim,) and of uniform thickness; smaller plates, of a similar character, joined together at various angles, like fragments of boxes; others channeled, and variously curved, so as to form gutters and very frequently, *tubes* of considerable length and diameter, and remarkable regularity of shape. In some localities (as for instance, in S. E. Tippah, near the heads of Hatchie,) complete assortments of tubes may be seen strewn about on the hilltops—sometimes five feet in length, and of various bores from ¼ inch to four inches. The rough sandy surface, and even the color of these concretionary forms, renders them strikingly similar to newly made castings; and in districts where such forms are common, springs are not unfrequently provided with spouts and gutters from these natural warehouses. Sometimes these tubes may be found in place, ensconced in a mass of rock, so as to allow of blowing or even *seeing* through the latter. When thus in place, I have generally found them pointing in a N. E. and S. W. direction. Similar tubes and concretions of various shapes and sizes, are in many localities found *isolated*, in the interior of loose sandy strata; the hollows being, as in the case of those found on the hilltops, filled with loose ferruginous sand, or sometimes with yellow ochre. Round and oblong concretions of this kind, of small size, are very common in the neighborhood of Oxford; portions of them have been used as drinking cups.

13. This ferruginous sandrock is very commonly designated as "iron ore" among the people. It contains, however, much less iron than the aspect and weight of the material generally lead us to expect; average specimens yield from 60 to 80 per cent. of white sand. Iron ore of good quality, in the form of brown hematite, is occasionally found, partly in the form of small variously shaped nodules, statactitic in the interior (as in the S. W. corner of Tippah county), partly in thin sheets of pure fibrous ore, interstratified with sand, (as in Tishomingo county, and other localities near the Alabama line). I have nowhere, however, found it in quantities sufficient to justify the erection of a furnace, and where its occurrence in large masses has been reported, a dense variety of the ferruginons sandstone has commonly been mistaken for workable ore.

14. It is an interesting fact, that the formation of similar sandstones is still in progress, in numerous localities. In depressions, or in the heads of hollows, where forest leaves or other vegetable matter decays in contact with the ferruginous sand, the iron is dissolved as proto-carbonate, giving rise to chalybeate waters, which at times may be observed in almost every rill of Orange Sand formation. Such waters in percolating through the sand, deposit in it their iron; especially where they meet an impervious seam, of clay or other material. Thus the whole mass gradually indurates, and hard ledges are formed within it, producing precisely such shapes as we now find in the deposits on the hilltops. The cementation of the sand of the latter into ferruginous sandstone, also took place, most probably, long after the deposition of the stratum; and here too we find the ledges underlaid, generally, by an impervious layer of clay or clayey sand. As a general thing, the sands of the formation are less ferruginous, and ferruginous sandstone is less common, in the southern portion of the State, than in the northern; the sand also is generally finer, and more frequently micaceous. This is more especially true of the central belt, N. and S.; while as we approach the channels of the Mississippi and Tombigbee Rivers, this difference is less perceptible, and the materials quite coarse, down to a low latitude.

15. It has been mentioned, that *white* sands are occasionally found in the Orange Sand strata. Similarly, white, siliceous sandstone occasionally occupies the place of the ferruginous sand-

stone above described. This feature is, however, of comparatively rare occurrence, and confined to small areas, or patches. Usually. this siliceous sandstone, also, caps the hills; it is sometimes, however, found below the hilltops, and overlaid by Orange Sand with ferruginous sandstone. Sometimes (as at Rockyford, Pontotoc county,) it is rather soft and even friable, exhibiting the peculiar stratification of the Orange Sand; but most generally it is remarkable for its extreme hardness, which renders it very difficult to work. It was a block of this character, derived from a limited deposit in N. W. Tippah county, which was quarried for the purpose of furnishing a stone for the Washington Monument; but the stone-masons at Vicksburg, to whom it was submitted, to be put into shape, found it so intractable, that a block of the Vicksburg limestone, from a quarry on the Yazoo River, was substituted instead. Deposits of a similar character occur in N. Attala county; at Burkettsville, and on the ridges N. and N. E. of the place; also in Holmes county, between Durant and Rockport stations, where it is frequently exhibited in cuts on the Mississippi Central Railroad, usually underlaid, at no great depth, by the impervious gray clays of the Lignitic.

16. Its mode of formation is well illustrated by a very small deposit occuring five miles S. W. of Oxford, which consists of unconnected blocks, buried in whitish sand, and of rounded, *menilithic* forms, precisely such as are formed by the *wet* sand when water is poured upon a mass of dry sand. It appears as if a solution of silex had flowed over the sand in the locality mentioned, imbuing only portions of it, which afterwards solidified into rock. Similar shapes are commonly observed on the under surface, or edges, of continuous deposits. Other instances of silicification occurring in the Orange Sand, as well as the description of an apparently fossiliferous variety of this rock, will be given below.

17. *Pebble Beds.*—The material next in frequency of occurrence to the various kinds of sand above mentioned, is *pebbles* or shingle, either cemented into puddingstone or, more frequently, loose and commingled with sand or clay. The stratigraphical position of the main pebble stratum appears to be, most generally, below the *heavy* strata of Orange Sand proper; it is not unfrequently, however, underlaid by similar sand deposits, and minor deposits especially of *small* pebbles, occur occasionally in the upper strata of the Orange Sand formation. There are within the State, two distinct regions of occurrence, in which this material appears in force. One of these extends along the eastern edge of the

alluvium of the Mississippi River, occupying, in N. Mississippi, parts of the counties of De Soto, Panola, Yallobusha, Carroll, Holmes, and Yazoo, gradually diminishing as the territory of the fossiliferous eocene is approached, and giving out almost entirely in the greater portion of Warren county. Then, below Vicksburg, it extends inland in a S. E. direction, and is found in numerous cuts on the New Orleans, Jackson and Great Northern Railroad, down to the Louisiana line. It appears in greatest force W. of the dividing ridge, and is but thinly represented on Pearl River; on the waters of the Bogue Chitto, however, it advances eastward, appears at Holmesville, and to a limited extent, in Marion county, on Pearl River. Westward of the dividing ridge, it is frequently met with until we reach the territory of the Bluff formation, where it is generally covered by the materials of the latter; as it is elsewhere by the yellow surface loam.

18. The other region of occurrence of the pebble bed, begins at the N., on the Tennessee River, in E. Tishomingo, and extends along the waters of Big Bear Creek, to the eastern heads of the Tombigbee, reaching the latter stream by way of Hurricane and Bull Mountain Creeks, in Itawamba county. It then extends southward on the eastern side of the Tombigbee, and is continued into Alabama, meeting the great pebble beds of the Warrior, which bear the city of Tuscaloosa. It appears that the pebble beds, as well as the Orange Sand in great force, are found well developed in the northern counties of Alabama. Great masses of pebbles are being moved southward, from these beds, by the Warrior and Tombigbee Rivers, whose navigation they tend to obstruct; the materials of the more ancient beds, however, as well as of those now being formed by the rivers, become finer as we advance southward, and ultimately mingle, imperceptibly, with the sands of the Coast. (Tuomey.)

Whether or not the two great belts of pebble deposits are connected with one another, somewhere in W. Tennessee, I have not learned; but from the direction of their respective outlines, where they leave Mississippi, such a junction seems highly probable. Between the two belts mentioned, pebbles are either absent from the Orange Sand formation, or appear only casually, and of inferior size—as small gravel. Some of the latter, however, as well as, occasionally, a few larger pebbles, properly belong to the yellow surface loam, and usually differ, lithologically, from those of the Orange Sand.

19. As for the material of the pebbles themselves, it is almost exclusively

siliceous ; hard aluminous sandstone, or siliceous claystone, is occasionally found, but by far the prevalent material is the several kinds of amorphous quartz—Chert, Hornstone, and Jasper, with numerous varieties of the rarer rocks of the same class—Agate, Chalcedony, Cornelian, Sardonyx, Lydian Stone, etc., of which very beautiful specimens have been obtained in the State. Gray and yellowish Siliceous Sandstone is very common ; and pebbles of Rock Crystal, as well as of white, crystalline quartz rock or Quartzite, are common in some localities, and occasionally found throughout the pebble deposit. Porphyry, and trappean rocks, are of rare occurrence, though not entirely absent. There is a marked difference of character, however, between the pebbles of the eastern, and of the western pebble region. In the former (at least in the valley of the upper Tombigbee,) Chert and Hornstene, with siliceous and aluminous sandstone, and some quartzite, are almost exclusively present ; while in the western belt, along the Mississippi, a great variety of rocks, as above mentioned, is generally found. In both regions, however, fossils of the ancient, palæozoic formations are of frequent occurrence in the pebbles themselves. (See below ¶ 29 & ff.)

20. The size and form of these pebbles, as may be supposed, are extremely variable, from small gravel to the coarsest shingle, and from the perfect egg shape, ellipsoid and disc, to irregular fragments with rounded angles only. The quartzite, rock crystal, lydite, jasper and trappean pebbles are almost always much worn and of regular shapes, and usually small, while those of the fossiliferous chert, hornstone and sandstone are often large, very irregular, and comparatively little worn. I have found a *Cyathophyllum* forming a pebble by itself, in which projecting radii were still extant, though somewhat rounded ; and on the blocks of crinoidal columns, the characteristic figures may sometimes be seen almost unharmed.

21. The average size of the pebbles might be stated as being between that of a pigeons and a large hens, or turkeys egg. But the maximum size found is very considerable, and somewhat puzzling to account for, on the supposition of transportation by water alone. Besides, *angular blocks* of considerable size, have been known to occur, one of which, a white, perfectly rough block of quartzite weighing about 150 pounds, (found in N. Lafayette county, in a hickory valley on S. 24, T. 7, R. 3, W., by A. H. Pegues, Esq.,) is now in the collection at Oxford. Rounded blocks of ferruginous quartz, a hundred pounds and more in weight, have been found on the bluffs bordering on the lower Yazoo, (Harper.) I myself have found, in Tippah county, T. 5, R. 1, E., (where pebbles are not otherwise prevalent,) perfectly rounded pebbles of white quartzite, weighing up to twelve pounds, at least ; and similar pebbles, even of larger size, are said to be common in that region.

In Claiborne county, at Rocky Springs, I found a rounded block of yellowish siliceous sandstone of great hardness, weighing 64 pounds, and containing two links of a calamite ; the rock differs decidedly from any sandstone known to me in Mississippi. Scratches have not, however, in any instance been found on their surface.

22. Usually, the pebbles occur in loose beds, commingled with sand, clay, or clayey sand; and in its western belt, along the Mississippi River, it is only very locally that they are at times found cemented, to a certain extent, by a ferruginous sandy cement, where an impervious vein traverses the stratum. In eastern Tishomingo county, however, they are very commonly cemented into a pretty firm conglomerate or puddingstone, by a cement of brown hematite, with very little sand. This conglomerate forms some high hills and ridges, and precipitous cliffs, on the territory of the Carboniferous formation in the county mentioned; and it is occasionally seen, through eastern Itawamba, and Monroe counties, as far south as Buttahatchie Creek. A more detailed account of the peculiar features of the Orange Sand formation in eastern Tishomingo, will be given below. (¶ 30 & ff.)

23. A singular rock belonging to this formation, and much resembling a true puddingstone, is found in a few localities in W. Tippah and E. Lafayette counties, on the territory of the Lignitic Tertiary. (*e. g.* S. 1, T. 5, R. 2, E. Tippah county; S. 33, T. 9, R. 1, W., Lafayette county.) It consists of a ferruginous and somewhat sandy cement, in which are imbedded numerous rounded concretions of a pisolithic structure, formed of concentric layers of a siliceous material, more or less ferruginous, and in some almost white; the largest being about ¾ inch in diameter.

24. *Clay Deposits.*—Clay has been repeatedly mentioned as occurring within the Orange Sand formation; and although this material does not usually form heavy deposits, and cannot therefore vie with the others mentioned as to *quantity*, the great *frequency* of its occurrence, as well as its practical usefulness in numerous cases, renders it second in importance to none. The clay deposits of the Orange Sand are most common in (though by no means confined to) its lower stages; they rarely extend over large areas, save that at times, their layers, often incontinuous, intervening between adjacent strata of sand, may be traced, under favorable circumstances, with little change of either quality or quantity, for a mile or two. As a general thing, the larger masses of clays appear in basin-shaped, lenticular, or nodular masses, when occurring independently of other formations; the only notable exception to this rule, known to me, are the white and red clays of the carboniferous territory, in Tishomingo, which form strata extending over considerable areas, and of unusual thickness.

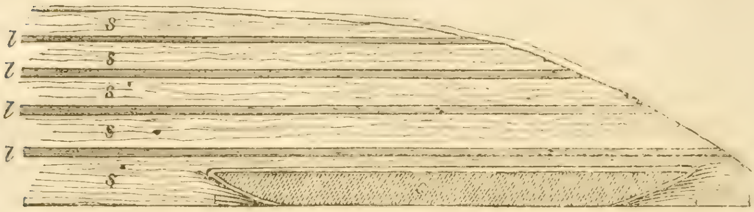
25. Very commonly, however, clay deposits occur near to the contacts of the Orange Sand with underlying clayey formations: and then the shape of the mass conforms, more or less, to the surface of the latter; though stratified horizontally. In these cases, the Orange Sand clay is oftentimes but little different from that of the more ancient formation from which it has obviously been derived, though redeposited in evident stratigraphical and lithological connection with the Orange Sand.

26. The general character of the clays *properly* belonging to this formation, is that of meagre pipeclays of great plasticity, requiring but little seasoning before they are worked; wherein they differ essentially from the fat, intractable clays of some of the underlying formations. Like all other materials of the Orange Sand, they are remarkably poor in lime and magnesia. As to their color, it is a singular fact that but few of them are strongly ferruginous. Grayish yellow, cream-color, white, and purple, are the usual tints; the latter rarely occurs throughout large masses, but very frequently in layers and stripes within masses of other colors; and its various shades, contrasted with the other hues mentioned and an occasional bright yellow, crimson, or blue stripe or dot, give rise to very unique and beautiful colorings. The red ochre tint of the red clay deposit found in Tishomingo, is rather unusual. A great variety of colors is sometimes met with in the small nodular masses which frequently occur in the southern part of the State, mostly associated with gravel deposits, and themselves apparently representing pebbles—since the stratification lines which they often exhibit, appear to be entirely independent of those of the Orange Sand deposits.

The clay which composes these nodules cannot, however, be identified with that of any of the older formations of the State, unless indeed, we imagine them to have been deprived of their carbonaceous coloring matter, and their protoxide of iron transformed into peroxide—a kind of metamorphosis which, as will be seen, appears to be common, with some others, in the Orange Sand formation. It is indeed, but very rarely that we find in this formation, under ordinary circum stances, anything that allows of farther oxidation by atmospheric influences. I know but one instance in which a very dark colored clay, containing a large amount of oxidizable matter occurs within the Orange Sand proper, though at a great depth below the surface; and even in this case, the oxidation has penetrated several inches into the mass, which is very dense.

27. The instance in question occurs in the deep cut on the Memphis and Charleston Railroad, about 4 miles east of Pocahontas Station, in Tennessee, but deserves description here on account of its importance in a geological point of view.

[No. 1.]



s s s. Loose yellow sand.
l l l. Indurate ledges (ferruginous sandstone.)
c. Mass of black clay

The cut in question (Diagram No. 1.) is ninety feet deep, through a ridge dividing the Tuscumbia river from one of its eastern confluents. The main body of the ridge consists of yellow and orange colored sands (with occasional layers of pipeclay) in which, fortunately for the permanence of the excavation, there are several successive indurate ledges, (*l l l,*) ferruginized, which serve as shelves to support the caving sand. On the western half of the cut, there lies imbedded in the sand, and surrounded by it as far as visible, a basin shaped mass of black, tenacious, fetid clay, (*c,*) with scarcely a trace of stratification, At the center of the basin, about 15 feet of this mass are visible above the road-bed ; its total thickness, as indicated by the visible part of the outline would be about twenty feet, with a maximum length of 75 yards. The clay contains, diffused throughout the mass, minute crystals of iron pyrites and a few very indistinct, carbonized remains of plants, apparently grasses, and perhaps, willows. On the outside and upper surface of the mass, however, there is a *shell* as it were, of cream colored clay, one to four inches in thickness ; evidently the same as the rest, and passing into it by a shaded band of transition. The same cream color is assumed by the black clay when it is burnt, and in the present case it is evidently the result of oxidation from the outside. [Similar cream colored clays are very common elsewhere in the Orange Sand formation.] The stratification lines of the surrounding sands, which elsewhere exhibit the usual wavy appearance, show a decided inflection downwards, and the layers thin out as they approach the mass, so as to conform, to a considerable extent, to its external shape.

Special descriptions of some of the more notable deposits of clays in the Orange Sands will be found under the head of the Useful Materials of this formation.

FOSSILS OF THE ORANGE SAND FORMATION ; ITS GEOLOGICAL AGE.

Extensive and minute examination, which I have bestowed on the various stages and facies of the Orange Sand formation of Mississippi have failed to satisfy me that it contains any fossils whatsoever characteristic of itself. *It usually contains the fossils, as well as the materials, more or less modified, of the underlying* formations ;* and although silicified wood is of very common occurrence in the Orange Sand strata generally, the circumstance of its occurrence with any degree of frequency being either confined to the territory of the lignitic formations, or to water-worn fragments, seems to indicate that this fossil, also, is derived from more ancient deposits, and owes its presence within the Orange Sand to the destruction of the former by denudation. It is true that the coarse sands which compose the main mass of the formation, are a material unfavorable to the preservation of fossils ; but the fine sands, as well as the impalpable clays which so frequently occur, could not but have preserved traces at least of the proper fossils of the Orange Sand period, had any such existed. The black clay deposit on the Memphis and Charleston Railroad, previously described, is the only instance in which, to my knowledge, there is strong evidence of fossils (leaves) being found within the Orange Sand in their original place. The shape of this mass renders it difficult to believe it anything else than a deposit formed *in loco* ; but we shall see that even thus, it might be supposed to belong to the underlying lignitic tertiary, and not properly to the Orange Sand.

29. *Devonian and Silurian fossils in the Orange Sand.*—Corals are the most commonly occurring among the pebbles of the western belt (¶ 17) ; *e. g. Lithostrothion basaltiforme, Calamopora, Astræa, Millepora, Catenipora, Chætetes, Cyathophyllum, Petraia.* Next to these, stems of *Cyathocrinus* and other Crinoidea are most abundant. I have also found an *Atrypa*, and a fragment of a *Trilobite.*

30. *Carboniferous fossils in the Orange Sand.*—The pebble beds on the territory of the carboniferous formation, in Tishomingo county, consist chiefly of chert, hornstone and sandstone, containing fossils identical with those of the underlying carboniferous strata —*Cyathophyllum, Fenestella, Gorgonia, Pentremites, Productus,*

*Not always of those underlying in the same locality ; but commonly, at least, at no great distance.

Spirifer, *Terebratula*—and the pebble strata themselves are frequently underlaid by a somewhat cellular breccia of angular fragments of the same materials, which intervene between the pebble strata and the unchanged carboniferous rocks.

This breccia, which is usually cemented by a ferruginous material, sometimes contains abundance of fossils; though the hornstone *in mass* is poor in these, and they are generally very poorly preserved; oftentimes, indeed, it appears as though the stratum had only been thoroughly shattered by some cause without removing the fragments much from their natural position, so that those belonging together have been re-cemented *in loco;* the ferruginous cement, at the same time, has penetrated the hornstone to the depth of 1-10 to 1-8 of an inch, so as to imbue completely the smaller fragments. This hornstone is exceedingly brittle, so as to fly to pieces readily whenever the surface even of a large block is broken by the hammer. From semi-transparent, flinty varieties, this rock sometimes passes through all gradations into an opaque and soft stone, and finally into white, pulverulent silex, which forms a stratum of about 10 feet thickness in the neighborhood of Eastport, Tishomingo county. The soft mass is at times traversed by harder layers, or bands of hornstone; both in the latter and in the pulverulent mass, carboniferous fossils are found, though sparingly.

31. On S. 16, T. 2 R. 10 E., near Scruggs' Bridge, in the same county, I observed in a well, overlying the carboniferous limestone, ledges of this hornstone, two to six inches in thickness, *alternating* with layers of about the same thickness, composed of *both pebbles* and *angular fragments* of hornstone, imbedded in a pale bluish clay.

It is difficult indeed, under these circumstances, to determine definitely to which formation the breccia and brittle hornstone strata properly belong. While in some respects they closely resemble the rocks of the siliceous stage of the Carboniferous, the intimate connection of a part of the hornstone at least, with the pebble strata, seems equally obvious; and the *cement* of the breccia at least is most probably of Orange Sand age. Here, as elsewhere, the pebbles are totally destitute of calcareous materials, which the Orange Sand appears to have in all cases metamorphosed, or rather pseudomorphosed, by means of siliceous or ferruginous solutions; but we find frequently in the pebbles, an oolitic structure which belongs to the carboniferous limestones of the region; the material being, however, entirely siliceous. Might not the same solution which effected this pseudomorphosis, have been instrumental in forming the brittle hornstone and breccia?

32. I ought to mention in this connection, the singular change, resembling decay, which purely siliceous pebbles of various kinds sometimes appear to have undergone in particular regions. The most striking example I have seen occurs in Simpson county, near Cokesville or Cokes School House, N. E. 1-4 T 10 R 17 W. Wells here are of great depth—100 feet—and a few feet beneath the surface, there appear beds of (generally small) pebbles mixed with yellow sand. The

pebble bed is of inconsiderable thickness, beneath it lie beds of yellow and pink sands, down to the water level.

The pebbles thrown out of wells and gravel pits in this region contain a great variety of rocks in the fresh state ; among these, hornstone of various tints, agate, chalcedony, lydite with white veins, rock crystal, and hard standstone ; in the former three, impressions of palaeozoic fossils, and chalcedonized corals, are common ; also oolitic pebbles of the same materials. Mixed with these fresh pebbles there are others consisting in the main of a white or yellowish, light, porous, siliceous mass, whose particles appear crystalline under the microscope ; which adheres to the tongue, is often readily broken by hand, yet bears most unequivocally the several characteristics of the rocks constituting the fresh pebbles, (except the rock crystal). The structure of the agates, with their crinoidal columns, the chalcedonized corals, the oolitic pebbles are there ; so are the veined lydite and hornstone, *with the substance of the vein usually unchanged* ; so that we sometimes find *vein skeletons* of such pebbles, from which the soft silica has been removed by water. Nor are the two extreme conditions alone found ; every degree of transition from fresh agate to the amorphous mass, may be traced ; some pebbles are changed outside, but fresh in the interior ; in others, an incipient dullness of the surface announces the commencement of the process. Whatsoever may be the nature of the latter, it is evident that one of its results must have been *the formation of a siliceous solution*, which percolated downwards. It appears therefore that in these pebbles, we see the product of the *beginning* of the process of which the silicified wood marks the *end*.

I have not ascertained what is the particular stratigraphical relation of these decayed pebbles to those in a fresh condition. The only peculiarity of the country which might have some bearing on these phenomana, is the great perviousness of the soil, in consequence of which, most of the hollows are without a water channel, and semi-cylindric in shape.—I have observed similar pebbles in other localities, though not often with equal frequency.

33. *Cretaceous Fossils in the Orange Sand.*—I have found well defined cretaceous fossils in three distinct localities ; in all of these they occur in ferruginous sandrock on the summits of high ridges ; the calcareous material of which the corresponding cretaceous strata consist, has been changed into a ferruginous sandstone not differing, apparently, from that ordinarily found, but in all cases of a conglomeratic character, and full of rosettes and irregular galls of yellow ochre and brown hematite.

One of the localities mentioned is near Harris' Cut, on the Memphis and Charleston Railroad, S. 3, T. 3, R. 9, E., Tishomingo county. (¶ 27.) Fossils are quite numerous, but badly preserved. Those identified are the following :

Cucullaea capax, Con.
Gervillia ensiformis, Con.
Dosinia densata, Con ?
Cardium Tippanum, Con !

Cardium sp., (allied to the former, and also found near Ripley.)

Trigonia n. sp. (probably identical with a species from Chunenugga Ridge in the collection of the Alabama Survey).

Inoceramus, sp.

Another locality is in the Hatchie hills, S. 20, T. 5, R. 5 E., S. E. Tippah county. Fossils few; those recognized are:

Ammonites placenta!

Trigonia thoracica!

A third locality is at Mr. Sidal's, S. 18, T. R. 5 E., Tippah county. Fossils few and indistinct; *Trigonia!* and a *Cardita?* were recognized.

It will be observed by a glance at the map, that all these localities lie to the *eastward* of the present region of occurrence of the group of fossils represented by the above, viz: the Ripley Group, or Upper Cretaceous.

34. *Tertiary Fossils in the Orange Sand.*—As yet I have not found any of the fossils of the marine tertiary in the strata of this formation. There cannot, however, be any doubt that a great part, if not all the silicified wood so commonly found in the Orange Sand strata, is derived from the several lignitic stages of the tertiary. Trunks of this wood may be found imbedded partly in the lignitic strata, partly in the adjacent Orange Sand. The most common place of occurrence of silicified wood, is at the planes of contact of the strata of the two formations, where we find not only entire trunks, but also layers consisting entirely of comminuted fragments. *Within* the lignitic strata themselves, the wood is commonly *lignitized*, *except* sometimes where these strata themselves are composed of sand. That portion of it which is buried in the lignite strata, is generally tinged black, in part at least, with carbon*; while that which projects into, or is found exclusively in the Orange Sand, is white or gray throughout, unless the trunk be a very large one.

35. The vegetable structure of the wood is generally very well preserved, and microscopic examination will, no doubt, enable us to determine the species (which are very numerous), and also to determine definitely whether or not the species found in the Orange Sand are peculiar, or identical with those of the underlying formations. Meanwhile, the only botanical evidence on the subject is this, that while no tree Palms have as yet been found in either the Lignitic, or Orange Sand strata of *North* Mississippi, they, as well as the remains o Endogens generally, are common in both the Upper Lignitic and the Orange Sand strata of *South* Mississippi. The remains of dicotyledonous trees, and especially of *Cupuliferæ*,† are common to both districts; coniferous wood,

*Cross sections of such partially blackened wood, possessing a round, jet black nucleus, have been claimed as being "Persimmon wood."

†Most of the woods found are popularly referred to Hickories, Oaks and Beeches, to the wood of which the majority of specimens bear a strong resemblance.

however, I have observed with frequency chiefly in the southern division, both in the Orange Sand and the underlying lignitic strata.

36. It has been stated before, that silicified wood occurs with greatest frequency near the planes of contact between the two formations, and is, therefore, most readily accessible in those districts, where the Lignitic formations form the base, and the Orange Sand the upper portion of the hills. I may add, that its frequency of occurrence in the Orange Sand is also dependent upon that of similar organic remains in the underlying lignitic strata. It is, therefore, most abundant where beds of lignite, and clays filled with lignitized trunks and leaves, are most common near the surface—*i. e.* in W. Tippah, E. Marshall, Lafayette, Calhoun, E. Yallobusha, Choctaw, Ocktibbeha, Winston and Neshoba counties. Whether or not the same is the case in Holmes and Yazoo counties, where lignite beds prevail, I have not learned ; to the southward of these, however, in Hinds, and Claiborne, southward of the lignite beds on the Big Black, silicified wood is very common. It is found more or less, however, in most districts where the Orange Sand prevails in force, and down even to the Sea Coast (Prof. Wailes collected specimens in Hancock county, and another, picked up on the beach at West Pascagoula, has been presented by Mrs. McRae). It is very uncommon, however, on the territory occupied by the cretaceous formation ; *except near the western border*, and *on the territory of the Lower Cretaceous or Eutaw Group*—the latter being also, a lignitic formation, though containing vegetable remains with far less frequency than does the lignitic tertiary. The only specimen found in Tishomingo county, where the Orange Sand is otherwise well developed, was picked up by myself, near Mr. Peden's Mill, on heads of Mackay's Creek, S. 9, T 5, R. 10, E., where outcrops of the lignitic cretaceous are abundant. Near Fulton, Itawamba county, silicified wood is also found. These, however, are the only localities in which I have met with this fossil E. of the Tombigbee, notwithstanding that, in Itawamba and Monroe counties, the Orange Sand formation is very largely developed, and one would look for its characteristic fossils *there* if anywhere.

37. It is true that although silicified wood occurs most frequently near to the surface of the lignitic formations, it is, nevertheless, sometimes found at a considerable elevation above the latter, on the Orange Sand ridges. If we seek for a reconciliation of this fact with the supposition of its derivation from the lignitic strata, we must ask the same question with reference to the cretaceous fossils mentioned above, which were found on hilltops, more than a hundred feet above any cretaceous strata at present existing ; and that too at a considerable distance from the region of occurrence of corresponding strata, now found to be composed of hard limestones and heavy clay marls. The same agency which was capable of performing this task of elevation and transportation, would have found little difficulty in doing likewise with semi-lignitized wood, of a much less specific gravity.

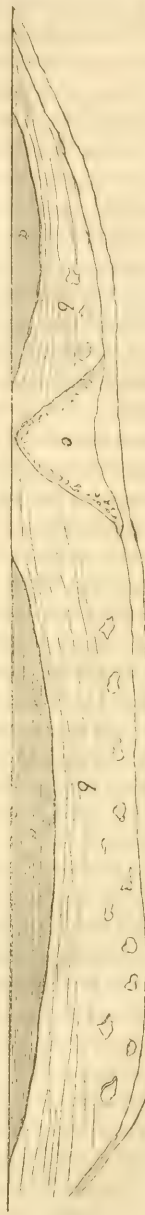
38. But we have more tangible proofs of the disposition of the Orange Sand to appropriate to itself the characteristics of other formations, in the insensible transitions which we frequently find between the materials of the Orange Sand

and those of underlying or adjacent formations ; which plainly prove that the current which first denuded the more ancient formations and then deposited the Orange Sand, sometimes re-deposited the materials first removed, without effecting any great change in their lithological character, or removing them to any great distance from their original place.

I have stated above (¶25), that where the Orange Sand is in contact with clayey strata of underlying formations, clays closely resembling those of the latter are often found unequivocally connected, by stratification, with the Orange Sand deposits. This is so commonly true, that in North Mississippi, where I have most closely observed the formation, the occurrence of these bluish clays is taken as a sign of the approach to the surface of the "black dirt," warning the well-digger not to proceed any further, for fear of spoiling the quality of his water by contact with the fetid bituminous clays of the Lignitic. Similarly, in Tishomingo county, it is often impossible to determine within many feet, the line between the greenish sands of the lower Middle Cretaceous, and the overlying Orange Sand ; and in several cuts on the Memphis and Charleston R. R., it is clearly shown that cretaceous sands, unchanged save in their stratification, have been redeposited on the previously denuded surface of older strata ; retaining in part at least, their lime, and also their characteristic fossils.

39. Diagram No. 2, representing a cut on Harris' contract, S. 3 T. 3 R. 9 E., will serve to exhibit these phenomena, which are repeated in many other cuts in the same region.

It will be observed that the undisturbed cretaceous material (a dark-colored, very compact sandy clay), which has evidently been subject to denudation, is overlaid by variegated sand (similar to that which, further W., forms the undisturbed strata of the Cretaceous), the stratification of which con-



[No. 2.]

a a, black sandy clay, horizontally stratified. *b b*, variegated sand with nodules containing cretaceous fossils. *c*, ancient ravine between the hills *b b*; brown sandy loam lined with fragments of ferruginous sandstone.

forms, in some measure, to the surface of the denuded mass. This sand is slightly calcareous, and contains cretaceous fossils, which are best preserved in the mass of the concretionary nodules appearing in the upper portions of the deposit —indurated by a cement partly ferruginous, partly calcareous. The ancient valley, the outline of which is marked by detrital fragments of slaty ferruginous sandstone, adds interest to this section. Immediately back of this cut rises a high Orange Sand ridge, on the summit of which cretaceous fossils are found in the ferruginous sand rock (¶11). In the case before us, as in numerous other instances seen in Tishomingo county, it becomes optional with the observer to which of the two adjacent formations he chooses to consider the material in question as belonging.

40. It is perhaps in an analogous manner, that the anomalous basin-shaped mass of black clay in the Orange Sand cut near Pocahontas (¶27) may meet its explanation. If originally existing in sands belonging to the lignitic tertiary (on whose territory we see similar phenomena), it might have resisted denudation by virtue of its extreme tenacity, while the adjacent sands might have been partially removed, and their place filled with Orange Sand deposits.

41. *Chemical effects on other formations.*—We have thus far noticed the changes which the materials of the more ancient formations undergo when removed by the denuding action which characterizes the Orange Sand period. But the *chemical* changes effected on the upper layers of these formations, even when remaining in place, are not less conspicuous at times. The effects produced are referrible, in general, to one or more of three agents, viz: *Lixiviation and Oxidation*, by the joint action of carbonic acid, oxygen and water; the action of *siliceous* solutions; and that of *ferruginous* solutions.

Instances of all of these effects within the Orange Sand formation have already been mentioned. The effects of oxidation may sometimes be noticed at the planes of contact of the Orange Sand with the black lignitic strata, which have been bleached on their surface; but more usually *this* influence has been accompanied or succeeded by one of the others, and most frequently, by the *ferruginizing* action which has already been cited as one of the prominent features, especially of the upper stages of the formation. Thus in N. Tippah county, and also occasionally in the more southerly portion of the northern Lignitic region, we find the uppermost layers of the latter formation (there composed chiefly of gray or black clays) transformed into red shales of considerable hardness—an excellent material for the preservation of organic remains, and in some instances very rich in fossil leaves. One of these localities (Hurley's Schoolhouse, at the heads of Ocklimita Creek (¶170), has furnished the best collection of fossil leaves which I have as yet obtained from the Northern Lignitic formation. Other instances of the occurrence of similar shales, will be found mentioned under the head of the latter formation.

42. A much more common effect of the contact of the Orange Sand with the Lignitic clays, is the appearance, on the line of contact, of variously shaped nodules of aluminous brown iron ore, of various degrees of purity not only in different localities, but within one and the same nodule. These nodules are so common in the eastern portion of the Northern Lignitic, from Tippah and E. Marshall to Lauderdale county, that they become the habitual surface indication of that formation, and are, therefore, very frequently found associated with silicified wood. Their usual shape is that of a flattened ellipsoid, and their size ranges from that of a marble to a diameter of 2½, and even three feet in one direction; when of large size, they are ordinarily very much flattened as well as lengthened. Being generally imbedded in clay, their outside is usually quite smooth; internally, they consist of concentric layers of different degrees of purity, which sometimes inclose a core of pure brown hematite, but more commonly a maze of cellular cavities, often resembling a honeycomb, either empty or filled with yellow ochre more or less pure. In the "Hills of the Flatwoods Region" (see Agricultural Report) they may frequently be seen on the hillsides, mingled with the common ferruginous sandstone (from the hilltops), from which, however, they are readily distinguished by their peculiar structure, and the fineness of their material. They serve as a very convenient mark of the level at which the impervious clays occur, and to which, therefore, the wells on the ridges will ordinarily require to be sunk.

43. Sometimes, though on the whole but rarely, we find brown hematite taking the place of silex in the petrification of wood; and fragments of wood thus ferruginized (of the same origin, no doubt, as the silicified wood) are occasionally imbedded in the ferruginous sandstone of the hilltops. The vegetable structure is in these cases but poorly preserved, so as to render it difficult, if not impossible, to identify the species.

44. The frequent occurrence of silicified wood, under the circumstances before discussed, as well as the hard siliceous sandstones previously mentioned (¶ 15), show that a liberal supply of soluble silex, has, in times past, been active in many portions of the formation. That the hard and flinty trunks now found were once in a soft or gelatinous condition, may be inferred from the fact that few large trunks have remained entire, or if so, are solid inside. Usually, we find them split up in billets, and when a round trunk occurs, a cross section generally shows numerous crevices running out radially from a hollow centre—such as would result from contraction in drying. The silicified mass itself exhibits all the several varieties of amorphous quartz, from semi-transparent

chalcedony (the usual material of silicified palm wood), through white hornstone to a soft fibrous mass resembling asbestos, which furnishes elegant objects for, the microscope with the least possible trouble—the cells being thus separated, though perfectly preserved. The asbestiform varieties are most frequent in S. Hinds county, near the Mississippi Springs; soft grayish hornstone is the common material elsewhere.

45. Not unfrequently, cavities occurring inside of silicified trunks, are found studded with small, but very perfect crystals of smoky quartz. Some beautiful specimens of this kind, from a large trunk, and with crystals of unusual size (1/8 to 1/2 inch in length) found on Lime Kiln Creek, have lately been presented by the Rev. Mr. E. Fontaine, of Battle Springs, Hinds county.

In this case, the external form of the trunk, as well as the outlines of its woody structure, are still distinctly recognizable on portions of the specimen, though crystallization has destroyed the detail. Crystals precisely similar to those just mentioned, but attached to a siliceous mass without any apparent structure, were found in S. Ocktibbeha county, a few miles S. of Whitefield, on S. 21, T. 17, R. 12 E., near Mr. Dodson's place; and the unusual character of, the specimens induced me to proceed to the spot for a special examination. The deposit is found on a low ridge, and has been traced for a mile and a half in a S. W. and S. direction, while (being confined to this single ridge) its width is inconsiderable—not more, perhaps, than twenty yards. It is a stratum 12 to 18 inches thick (lying 2 to 3 feet below the nearly level surface), of a white siliceous rock, both the upper and lower surface of which is studded with crystals of smoky quartz, 1/4 to 1/2 inch in length. The solid portions of the rock so closely resemble silicified wood, that an isolated fragment would be unhesitatingly referred to such origin; it forms, however, as has been said, a level stratum of some extent, and there is very little curvature of the layers to be traced, even in large blocks. In the interior of the mass, there are many irregular drusy cavities, lined with numerous successive bands of siliceous mass and also studded with radiating crystals; some of the solid portions themselves, in fact, are mere conglomerates of crystals, of a bluish tint. Their form is the hexagonal prism, in which both sets of planes are very evenly developed, while usually the terminal rhombohedrons are very *unequally* developed, so that one of them is often entirely suppressed.

The sand overlying this deposit bears all the characters of the Orange Sand formation; underlying it, however, there are sharp sands containing large scales of mica, such as are but rarely seen among the Orange Sand materials, and greatly resembling those accompanying the lignitic strata of the region. The nature of the deposit itself, however, can leave little doubt that it is nothing more than a bed of *lignite* which has undergone a process similar to that which has effected the silicification of the uncompressed trunks commonly occurring. Fragments of silicified wood are very common in the same neighborhood; and lignite beds are abundant in the adjoining portions of Ocktibbeha and Winston.

46. I ought to mention, in connection with the subject of silicification, the peculiar structure exhibited at times by certain cherty varieties of the hard

siliceous sandstone, which has been mentioned as taking the place, occasionally, of the ferruginous sandstone. Where thin ledges (6 to 8 inches) of this rock occur, the surfaces exposed to the weather sometimes show a great number of rounded holes, like gimlet-holes, penetrating the rock at right angles to the stratification line; which is also the direction in which it most readily cleaves. On breaking such blocks we find in the interior of the mass numerous crevices, which I cannot describe better than as resembling those left in burnt brick, when straw or chaff has been used in their manufacture. These crevices are almost always lined with some ferruginous matter, and whenever they reach the surface, the action of the atmosphere soon widens and rounds them. In some instances too I have met with blocks in which these crevices were singularly contorted, in such a manner as would result if green grass leaves were kneaded up with plastic clay, and then burnt out. Whether or not these crevices represent organic remains, it is difficult to decide; at times it may be thought that the entire form of a blade of grass has been traced, but when followed up, instead of terminating, it may open out into a wide, irregular space, lined also with ferruginous matter, and from which, perhaps, similar, but utterly irregular fisures radiate in several directions.—It is hardly less difficult to construe them into fucoids.

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47. The characteristics of the Orange Sand formation in Mississippi, as given above, leave little doubt as to the circumstances under which it has been formed. The character of the surface upon which it rests, its own irregular stratification, and the dependence, to a great extent, of the nature of its materials upon that of the underlying formations, proves beyond question that its deposition, preceded and accompanied by extensive denudations, has taken place in flowing water, the effect of whose waves, eddies and countercurrents is plainly recognizable in numerous profiles. Nor can there be any doubt that the general direction of the current was from north to south, although locally changed or directed by the pre-existing inequalities of the surface.

The arrangement of the pebble-beds into belts (running, in Mississippi, approximately N. and S.) proves that currents of greater velocity, capable of transporting these coarse materials, existed there, coincident in the main with the channels of the great rivers at present existing—the Mississippi and Tombigbee; the connection of the latter channel with the former, having, it appears, been subsequently closed by the induration into puddingstones, and consequent resistance to denudation, of the pebble-beds of N. E. Mississippi and N. W. Alabama, thus throwing northward the waters of the Hatchie, Tuscumbia, Big Bear, and other southern tributaries of the Tennessee River in Alabama. The Western Highland Rim of Tennessee (see map accompanying the Geological Reconnoissance of Tennessee, by M. Safford, 1856) appears to have prevented the irruption of this current, to any great extent, into the Tennessee Valley and the Central Basin of Tennessee; the pebble beds as well as (in N. W. Alabama) heavy deposits of Orange Sand extend along the western and southern border of the Carboniferous region, between the Tombigbee and Warrior rivers, and eastwards to the Coosa; meeting, perhaps, still further east, the deposits brought down on the E. side of the Alleghanies, on which the cities of Baltimore, Washington, Richmond and Petersburg, Va., and Columbia, S. C., are situated.*

48. While the pebbles were deposited chiefly in these channels, where the velocity was great, the intervening space, cut up into numerous minor channels by denudation, retained the smaller gravel and sand, and also, where some protecting ridge afforded a chance for quiet subsidence, received deposits of clayey materials, which naturally would be as limited as was the area of the "slack water" itself. It is easy to understand how under such circumstances, when the currents which caused the first denudations began to slacken, the materials of older formations might be removed and then re-deposited with little change, at no great distance from their original place, and subsequently covered over with fresh masses brought from a distance. At the *end* of the period, the violent currents having subsided, the pebble deposits themselves were in many cases covered over by sands similar to those which, in other regions, compose the entire formation. Still later, the processes of oxidation, lixiviation, silicification and ferrugination (all of which are probably still in progress) commenced, and subsequently still (apparently even later than the deposition of the Bluff formation), great denudations again ensued, partly contemporaneous with, partly subsequent to, the deposition of the yellow surface loam—one of the latest formations, apparently, preceding our present era.

49. However different may be the geological detail of the Orange Sand formation from that of the Northern Drift deposits, the evident anology of their lithological composition and general history would lead us to suppose the two formations to be genetically related. In both cases, immense volumes of water destitute, or nearly so, of organic life, rushed southward, bearing with

*See Second Report on the Geology of Alabama, by M. Tuomey, ed. J. W. Mallet. A few months prior to the death of the lamented Tuomey, during a visit at Tuscaloosa, I compared notes with him on the subject of this formation, the extensive and characteristic development of which in Mississippi and N. W. Alabama, was unknown to him at the time of writing the portion of his Report relating to the same. As far as comparable, the observations, and conclusions arrived at by each of us independently, tallied perfectly, except with refereuce to the occurrence of Mastodon bones IN the formation, as mentioned by him (p. 147 of the IId Report). He admitted, however, that the bones in question might well be referable to the Bluff formation, the existence of which on the Lower Tombigbee, he had but shortly before ascertained. His suggestion regarding the nature and origin of the waters which deposited the Orange Sand formation, (Ibid p. 146,) appear to be confirmed by all the additional observations subsequently made by myself.

them the fragments and detritus of the older formations. Both formations immediately underlie the Bluff or Loess formation.

Whether or not the Orange Sand deposits contain any materials *necessarily* derived from a high northern latitude, still remains to be determined, for thus far, the materials for comparison are imperfect on both sides. By far the greater mass of the pebbles occurring in Mississippi appear to be referable to sources lying S. of the Ohio river, on either side of the Mississippi, while the rocks most common in the drift of Illinois—granite, mica-schist and metamorphic sandstone, are either very rare or (like granite) entirely wanting. It will be interesting to inquire, whether or not the rocks composing the pebble-beds further north, in Tennessee, Kentucky, Arkansas and Missouri, are derived from localities correspondingly remote in that direction. It must be remembered, however, that the *present* outcrops of these formations may not *nearly* represent the localities of the *broken-down* strata which furnished the rocks, especially when the dips are slight, as is generally the case in the southern portion of the more immediate valley of the Mississippi.

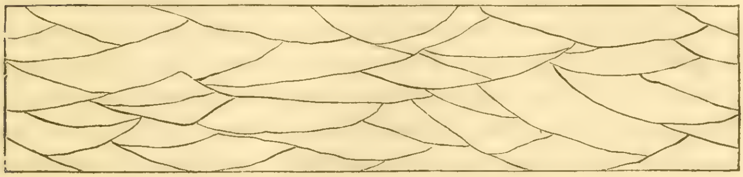
50. While therefore the materials composing the Orange Sand formation may be far from identical with those found in the Northern Drift, we may nevertheless suppose the two formations to have been nearly or quite contemporaneous, and caused by the same flood of ice-water, which in its course denuded the older strata, carrying their materials southward from their original place. Whether the large angular boulders, of which a few have been found in Mississippi, can be supposed to owe their transportation to some erratic ice-floe of unusual thickness, may be an open question, at least until the region intervening between the characteristic Orange Sand and Northern Drift (in Missouri for instance) shall have received a detailed examination.

Even at the present time, however, in severe winters, ice-floes are seen in the Mississippi River below Vicksburg, and there seems to be no valid objection to the supposition that the same might have happened during the drift period, even if the climate should have been warmer; since the enormous thickness of arctic ice-floes would readily carry them a few degrees further south than could be expected of the winter ice of the Mississippi River.

51. The relations mentioned by Tuomey (Second Report on the Geology of Alabama, p. 146) as existing between the shore of the tertiary sea and the region of occurrence of the southern drift on the Atlantic slope, are not so clearly recognizable in Mississippi and Alabama—owing perhaps to the slight development of the later marine tertiary, and the proximity to the great outlets of the continental waters. Not only do the deposits of the latter hide, to a great extent, those immediately preceding the drift period, but the latter may have been partially removed and destroyed by the denudations accompanying that epoch. Elevated ridges of deposits unequivocally belonging to the Orange Sand formation extend to within a few miles of the Gulf Coast in several instances; although more frequently, these ridges are subterranean at the present time, the valleys between them being filled with sands exhibiting the lines of

desposition usually observed in the sea beach formations; which now from the surface, so that the presence of the Orange Sand ridges is often demonstrated only by the phenomena observed in wells.

[No. 3.]



Stratification of sands in the Sea-Coast Counties.

The stratification exemplified in the section is exhibited not only in profiles of the sands overlying the impervious black clays on the "wet meadow" plains adjoining the coast, but also further inland, in the valleys; in that of the Pascagoula, for instance, as high up as Buckatunna Creek, Wayne county.—These valleys therefore originally formed inlets or fiords, which in the gradual upheaval of the continent were transformed into rivers, while the gradually retiring surf of the beach left behind everywhere the traces of its action, in the peculiar stratification of the sand.

52. I cannot see the validity of the objection urged by Tuomey himself (Second Report, p. 146 and 147) against his supposition, that the accumulation of the southern drift in belts parallel to the shores of the tertiary sea was caused by the checking of the velocity of the drift currents as they entered the sea. The very fact of currents conveying great volumes of ice-cold fresh water, coming from the land, would naturally cause all living creatures to retire seaward as early as convenient, and since the deposits themselves were formed by those currents *in their rear*, there appears to be nothing surprising in the fact that they do not contain any marine fossils. In a shallow sea, whose water would be very perceptibly freshened by such an enormous influx, even the influence of the differences of specific gravity might be reduced to a very small item by the balancing influence of differences of temperature, acting in the opposite direction; thus rendering unnecessary the assumption of a temporary redepression of the land as suggested by Tuomey. That the gradual upheaving process was continued up to a late date, and that currents more slow and deliberate than those which deposited the drift, covered the country for some time after the latter period, seems to be proved by the two superincumbent formations, the Bluff (327), and the Yellow Loam (332); since both the latter formations have availed themselves, in their deposition, of valleys previously excavated into the Orange Sand itself.

USEFUL MATERIALS OF THE ORANGE SAND FORMATION.

53. These consist of *Sands, Gravel, Building Stones and Clays* of various kinds.

SANDS.—In regard to these little need be added to what has been said in the general description of the formation. (See ¶ 10 ff.) They almost always contain more or less clay, which usually is what imparts to them their various colors; even when the color is white. In most cases (except those of ochreous tints, when the single grains are often covered with a hard crust of iron rust), washing will readily separate the mass into white quartzose sand and clay of a corresponding color; and hence the sand washed out of this formation by the streams, is generally white, and thus far well adapted to the purposes of the mason and plasterer; although, whenever the sand of other formations is accessible, it is commonly preferred to that of the Orange Sand formation, on account of the rounded shape and smoothness of the grains, which characterizes the latter, and is less favorable to the cohesion of the mortar in which it is used.

The sand deposits of the Orange Sand formation cannot usually be relied on much for continuity, their stratification, as has been stated, being extremely whimsical.

54. GRAVEL OR SHINGLE.– Its regions of occurrence have been sufficiently defined for practical purposes, in a previous paragraph (¶ 178 ff.) In a State where stones are scarce, a liberal supply of gravel for the improvement of streets and roads is likely to be appreciated. The deposits of the eastern border of the State do not as a general thing furnish gravel of equal purity with the beds bordering on the Mississippi, and are more frequently cemented so as to form loose puddingstones; which are rarely of sufficient coherence to serve for building purposes, while yet too hard to be broken up for gravel.

55. Gems of some value and of great beauty may sometimes be picked up among the pebbles of agate, cornelian, chalcedony, sard and jasper, which are most abundant in the S. W. portion of the State; commonly, however, the larger agates are cellular, with sharp incurrent and excurrent angles, so as to greatly reduce their available mass. They may often be recognized, among the mass of pebbles, by this irregularity of external form. The

cornelians are usually of a flattened shape; while the several varieties of jasper show less disposition to assume any particular form, though oblong, rounded forms are perhaps the most common. Several forms of silicified corals, most frequently *Astraea* and *Favosites* (alias "petrified honeycomb"), which are not uncommon in the pebble beds, also form handsome gems when polished.—According to Prof. Wailes, the gravel bars in the Mississippi River, between Vicksburg and the Louisiana line, afford a fine opportunity for collecting these stones.

Pebbles of limpid quartz or rock crystal are common in Wilkinson county, and are found more or less throughout the pebble-beds of the Mississippi valley. They are rarely above the size of a pigeons egg, and usually much worn and well rounded.

56. BUILDING STONES.—As has been mentioned, two kinds of rock occur in this formation. The most common is the dark brown ferruginous sandstone, often called "black rock," which caps the ridges of the Orange Sand formation—mostly in irregular and fanciful shapes, from which a gutter, or a spout for a spring may occasionally be selected; but sometimes also in solid ledges, of sufficient thickness to be valuable for building purposes.

This rock resists exposure to the weather very well; only the slaty varieties sometimes crumble in the course of time, while on massy blocks, no other effect is produced than that of whitening the sand-grains which project over the surface. It is not susceptible of polish, but well adapted to rough masonry; and stands well under water. It does not, however, resist fire well; the slaty varieties fly to pieces when heated; the massy rock, when heated slowly, can be made to stand, and in the "Pine Hills" is often used in fireplaces; ultimately, however, it also scales off and pulverizes. It resists sufficiently well when used in chimneys, where it is not exposed to a high temperature; and in Tippah, Tishomingo and Itawamba counties in particular, it has been extensively used for this purpose.

As may be supposed from its mode of occurrence, its deposits are usually quite limited in extent, occupying only the high knolls and ridges; so that the supplying of a single plantation with chimneys may often require the exploitation of several deposits. And as moreover, it is not at all difficult to discover these deposits, which form the prominent objects in the landscape where they do occur, I shall not attempt to specify many localities, but will only mention a few which are remarkable for being capable of furnishing large blocks of good quality, or regions in which the rock is unusually abundant.

57. On Tippah Creek, S. 7 T. 4 R. 2 E., Tippah county, near the crossing of the Hickory Flat and Salem road. Solid ledges 10 to 12 feet in thickness, and of considerable extent.—On the heads of Hatchie, Tallahatchie and Tombigbee, in T. 6 R. 4 E., Tippah county, on and near the Ripley and Fulton roads. In the sandy Pine Hills bordering on the E. Hatchie generally, the ferruginous sandstone is very abundant.—So also, on the high ridges in S. E. Itawamba, especially S. of Bull Mountain.—In S. E. Marshall and S. E. Lafayette counties —A heavy solid ledge occurs, on a level hilltop, a few miles W. of Water Valley, Yallabusha county.—Another, of considerable thickness and extent, on SS 29 and 30 T. 12 R. 2 W., Calhoun county, near Mr. Collins' place. The hills on the Otuckalofa, in N. Calhoun and N. E. Yallabusha, generally abound in this rock, so also do the high ridges of E. Carroll, N. Attala, and some portions of W. Choctaw.

Usually the rock is hard and requires to be worked with the hammer and chisel; in some instances, however, we find it sufficiently soft to be cut into shape with an axe without dulling the same. Several small deposits of this kind exist near the heads of Potlockney and Otuckalofa Creeks; one on S. 16 T. 10 R. 2 W., Lafayette county. The cement here is somewhat aluminous, and small particles of white clay, which cause white streaks on a cut surface, are imbedded with the sand grains. The rock stands the weather well, and chimneys have been built of it. It is of a pale brown color inside, but where lichens have grown on the outside, it is red, sometimes to the depth of ¼ of an inch.

58. The white siliceous sandstone of the Orange Sand formation (¶15) sometimes occurs in deposits sufficiently large to render it of importance. The chief localities of occurrence with which I am acqainted, are the following:

In Tippah county, on S. 35 and 36, T. 4, R. 1 E., there is a considerable deposit, where large blocks can be obtained (¶ 15); the rock is a very hard—a translucent chert rather than a sandstone, and from its resemblance to the Arkansas whetstone, it has been attempted to use it for the same purpose, which it answers tolerably well. A similar deposit, covering a few acres, exists on S. 19, T. 5, R. 2 E., near Mr. Milton Smith's; and another, quite small, on S. 1, T. 5, R. 1 E. Isolated blocks of it are frequently seen all over W. Tippah, and the adjoining portions of Marshall, Lafayette and Pontotoc. Near Rocky Ford, in the latter county, there is a large, continuous deposit of this rock, which strews the hillsides in large slabs, and blocks of considerable size—sometimes 10 feet in diameter. It is somewhat variable in its character—mostly hard, but workable; sometimes quite soft. It is found, N. of the Tallahatchie, between Catalfa and Tallaquamanola Creeks, for about 2 miles from the river; and southward of the same, around Rocky Ford, for about ½ mile. Large quantities of fine building stone could be readily obtained here, by simply prying the blocks out of the soil.

59. A small deposit occurs at Mr. Powell's place, 5 miles from Oxford, on the Water Valley road. Good sized blocks for foundations can be obtained here. Another locality, both of white and "black" sandstone exists, according to L. Harper, on S. 28, T. 8, R. 7 W., Panola county; and according to the same, a ledge of this rock, 4 feet in thickness and of great hardness, occurs in a hill on the Yockeney River, on S. 26, T. 10, R. 8 W. In Yallabusha county the white sandstone occurs in considerable force, at, and near Mr. Pearson's place, on SS. 3 and 4, T. 25, R. 6 E. Some of the rock here, also, is of excessive hardness, so as to be suitable only for rough masonry. Near Grenada this rock is found capping a hill. It is also found, in limited deposits, at several points in N. Calhoun; *e. g.* near Concord P. O.; and in considerable abundance, on S. 4, T. 25, R. 8 E.

N. Holmes and N. Attala are, probably, the region where the deposits of this rock are most abundant; on the ridges N. and N. E. of Burkettsville, they prevail more generally than the brown sandstone itself; here also, it is often excessively hard. Near Rockport, and between that place and Durant Station, the white cherty sandstone is frequently exhibited in the R. R. cuts; as in many other places, it occurs here in disjointed, irregularly shaped blocks, rather than in solid strata, and imbedded in the sand of the Orange Sand Group.

I do not know of any deposits of this rock, S. of Attala county.

60. CLAYS.—Numerous varieties of useful clays occur in the Orange Sand formation; among these the following deserve especial mention:

White Pipeclay.—It is widely distributed in the formation, but does not often occur in large masses ; usually in nodules or " galls," from the size of a pea to that of a fist, and sometimes larger. These galls are most commonly found in strongly ferruginous "hardpan" (a semi-indurate mixture of fine sand and clay) but indistinctly stratified ; and thus forms striking objects on the otherwise uniform, deeply colored surface. They occur chiefly in the eastern portion of the State, from the Tennessee line down to Hancock county—thus on the Pontotoc Ridge ; on the sandy ridges of Noxubee and Kemper, W. of the Flatwoods ; in N. W. Wayne county, on the ridges bordering on the Chickasawhay (in the latter region, it occurs in nodules of some size imbedded in white sand : the clay is very pure and is used as chalk and for whitewashing) ; and in Hancock county, where the Orange Sand hills border on the plains of the Sea-Coast. In all the localities mentioned, however, the quantity is too small to render the material of much practical importance.

61. A large deposit of white pipeclay of great purity, however, occurs in Tishomingo county, chiefly on the southern portion of the territory of the carboniferous formation, following very nearly its western outline. It there forms a regular stratum of considerable extent, which in one locality at least was found to be more than 30 feet in thickness. The bed attains its best development, so far as the quality of the material is concerned, in the northern portion of T. 5 and in T. 4, R. 11 E., where it is about 30 feet underground in the uplands, though at times appearing in limited outcrops on banks of the streams. North-eastward and south-westward from the region mentioned, the bed also occurs, but changed in character—at least near the surface—to a white gritty hardpan, or clays of various colors and much less purity. It forms the lowest visible portion of the Orange Sand formation, and is almost invariably overlaid by strata of pebbles or puddingstone, which in their turn are sometimes overlaid by the common orange-colored sand.

62. The most southerly exposure of these beds, known to me, occurs on a small branch of McDouglas' mill creek, on SS. 4 and 9, T. 6, R. 10 E., near Mr. Pannel's place. For more than a mile along this branch, there are exposures in which about 20 feet of a whitish mass, varying from a fine clayey sand to a white plastic clay, appears overlaid by thick beds (20–40 feet) of ferruginous pebble conglomerate ; the latter in its turn, being overlaid by the

common ferruginous sand and brown sandstone, on the hilltops.

Similar outcrops appear in the neighborhood of Mr. Aleck Peden's place, on SS. 34 and 27, T. 5, R. 10 E., N. E. of Pannel's. Here also, a white stratum of which only a few feet are exhibited, is overlaid by pebble conglomerate, and this by the common Orange Sand. The white mass varies from pure plastic clay, to fine grained aluminous sandstone ; its upper layers are sometimes composed of a singular conglomeratic mass, consisting of small, white quartz pebbles imbedded in pure white pipeclay. In both localities, copious springs of pure water are shed by the impervious clay strata ; at Mr. Peden's there is a fine, bold chalybeate spring, which seems, however, to derive its mineral ingredients (sulphates of iron and magnesia, and common salt) from the adjacent carboniferous strata rather than from those of the Orange Sand. In either of the localities mentioned, materials suitable for fine pottery, or queensware, might be obtained.

63. Thence northward, the stratum is not often found outcropping, but, as has been stated, 20 to 30 feet below the surface of the uplands; the country being but slightly undulating. At Mr. Clingscale's S. 8, T. 5, R. 11 E., the clay stratum was struck at the depth of about 30 feet, beneath sand and pebbles; it was dug into, without being passed through, for nearly 30 feet more, no water being obtained from below, but dripping in above from the base of the pervious strata. The whiteness and plasticity of the material seemed to increase with the depth. The best portions of what was dug out of the well in question, had already been removed at the time of my visit, having been used for various economical purposes, as "chalk," whitewash, and "Lily-white." The specimens examined were, therefore, rather below the average quality, and on long exposure to the air, their surface shows some yellowish spots. I found, nevertheless, that in baking at a high heat they yielded a biscuit of greater whiteness than their natural color when fresh ; and that fine splinters, exposed for ten minutes to the highest heat of the mouth blowpipe, retained its shape perfectly while reduced to a semi-transparent frit. A quantitative analysis of the clay from Clingscale's well gave the following result :

WHITE PIPECLAY FROM CLINGSCALE'S.

Insoluble Matter		90.877
Lime		0.140
Magnesia		trace
Peroxide of Iron		0.126
Alumina	2.214	
Water		6.930
		99.864

This analysis (which was made solely for the purpose of ascertaining the ingredients foreign to the clay proper) proves the singular fact that this clay, though occurring in a formation characterized by the large amount of iron it commonly bears, contains a remarkably small amount of that substance; which, together with the minute proportions of lime and magnesia, explains its infusibility.

On S. 7, adjoining Clingscale's, at Mr. Hutchins' place, there is an outcrop of cream-colored clay, which also becomes whiter in baking, and is very refractory.

64. At Mr. Lovress' place, S. 17, T. 4, R. 11 E., strata of white conglomerate, similar to that at Aleck Peden's, were struck in a well at 28 feet; minor layers of beautiful white clay were encountered above this. An outcrop of pure white clay occurs on Peniwinkle Creek, on S. 8, just N. of Mr. Lovress'; the soil of the bottom shows plainly the admixture of this material by its whitish tint.

On S. 18, at New Warrenton, the white clay has also been found. Thence in a N. W. direction, the white materials appear in cuts on the Memphis and Charleston Railroad, near Iuka, and at Mr. Null's, S. 22, T. 3, R. 10 E.; overlaid, in all cases, by pebbles or pebble conglomerate. In the localities mentioned, however, the quality is inferior so far as visible (a few feet only), being rather a fine clayey sand than a clay, and traversed occasionally by red streaks. It is possible that at some depth, the quality might improve, as in other cases. In the railroad cuts, the white material was said to contain at times large lumps of dark *red* clay, the latter being even found independently, in the valley of Clear Creek, underlying the pebbles.

65. In none of the localities heretofore mentioned, the geological position of the white strata, and their connection with the Orange Sand, could be decisively established. At Mr. Aker's grist-mill, on S. 21, T. 3, R. 10 E., the following

section occurs, which shows the unquestionable equivalents of the white clay underlaid by materials possessing all the characteristics of the Orange Sand formation :

(Section 1.)

SECTION AT AKER'S GRIST-MILL, TISHOMINGO COUNTY.

	FEET.	INCHES.	CHARACTER OF STRATA.	NO.
o o o o o o o o o o o o			Pebble conglomerate forming the hills	6
. . . .		10	Loose white sands	5
o o o o		14	Pebbles imbedded in clay	4
— — — — — — — — —	8		Reddish-white siliceous clay with streaks, indurate above	3
∘⌔ ∘⌔		6	Gravel conglomerate ; ferruginous	2
o o o o o o o o o o o o	6		Large pebbles imbedded in clay	1

There can be no doubt, therefore, that these white strata, like the pebbles, are only a peculiar local facies of the Orange Sand.

66. *Practical uses of these beds.*—The two most important practical purposes which the materials occurring in the deposits just described, will serve, are, the manufacture of fine queensware,* and that of fire-proof brick.

As for the former, the plasticity of the material leaves nothing to be desired ; and since the amount of siliceous matter varies greatly in different layers, there could be no difficulty about giving to the mass the precise degree of meagreness which may be found most advantageous, by mixing the several successive layers.

67. The same may be said with reference to the manufacture of fire-brick (to which these materials are admirably adapted); which would probably, at the present time, be the most feasible and profitable manner in which the beds could be made available. The

* Not porcelain. Kaolin or porcelain earth contains, besides the white clay, a certain amount of undecomposed *felspar*, which imparts to it its property of being semi-fused at the temperature of the porcelain kiln. The same property might be imparted to the white clay in question, by the artificial admixture of ground felspar ; but it could not thus compete with the natural kaolin of Alabama.

manufacture of fire-brick differs from that of ordinary brick only in this, that it requires more care, both in working the clay and in moulding the brick. Beyond their fire-proof quality, it is demanded of fire-brick *that their shape shall be perfect, their mass uniform, and without flaws in the interior ;* also, that they shall be liable to *the least possible shrinkage* in a high heat.

The latter quality is imparted to them by a considerable admixture of either sand, or ground fire-brick, to the fire-proof clay, which itself ought to be thoroughly seasoned beforehand, and then well worked up with such additions of the above materials as may be required. In judging of the amount of sand or ground brick to be added, it is to be observed as a rule to add as much as may be consistent with the proper firmness of the burnt brick, and with convenient moulding. The latter process ought to be performed as in the manufacture of pressed brick, whenever a first class article is aimed at ; for it is only thus that internal and external flaws are entirely avoided. In some localities materials may probably be found which require no further admixture—the strongly siliceous varieties of the clay ; but whenever sand or burnt clay is added to the mass, care should be had that it be free from *iron*, which would seriously impair the fire-proof qualities of the clay. None but white sand ought to be used.—For the rest, they may be burnt in kilns, like common brick.

Similar white clays are mentioned by Prof. Wailes as occurring at White Cliffs, Adams county, and near Woodville, Wilkinson county. Of the extent of these deposits, I am not informed.

68. *Cream colored, or yellowish, and gray pipeclays,* which assume a faint reddish or pink tint in burning, are perhaps the most common in the Orange Sand formation, especially in the northern part of the State, where it overlies the lignitic strata.

Most of the clays of the latter formation assume similar tints when burnt, though as a general thing they are less refractory—in consequence, probably, of their containing larger amounts of *lime* and *magnesia.* The latter substances are copiously contained in the waters issuing from the strata of the formation, last mentioned, while their quantity is extremely minute in those emanating from the Orange Sand strata ; which are themselves as remarkable for the almost entire absence of these ingredients, as for the universal prevalence of iron. It would seem that the processes of oxidation and lixiviation which have characterized the Orange Sand, would readily account for the transformation of the dark colored, carbonaceous and magnesian clays of the lignitic strata, into such pipeclays as we now so commonly find in the Orange Sand; and it may be frequently noticed, where clays occur in the latter formation immediately adjacent to similar ones belonging to the former (¶25, 28), that while their upper portion is of a cream color, the lower are bluish and not completely oxidized. Instances of this kind may be frequently observed in S. Lafayette, on the Yockeney-Patapha River, in Calhoun, and N. Yallabusha.

It is in this position, viz: on the contact between the Orange Sand, and the Lignitic clay formations, that the best clays for common potter's ware are usually found. The undisturbed clays of the latter formations generally require, not only the admixture of sand but also much more seasoning than those which have already been worked up, as it were, by their re-deposition within the strata of the Orange Sand.

69. Good *potter's clay* is most frequently found, therefore, in the flatwoods region and the hilly country to the westward of the same, *i. e.*, in W. Tippah, E. Marshall, W. Pontotoc, E. and S. Lafayette, E. Yallabusha, Calhoun, W. Chickasaw, and probably in E. Choctaw and Winston. So far as I know, however, two potteries only, up to the present time, are availing themselves of these deposits; one being at Holly Springs, the other (Mr. Brush's) in N. Tippah county, on S. 17, T. 2, R. 3 E. In both factories, stone-ware of excellent quality is produced.—A third, according to L. Harper, exists at Hartford, Calhoun county; what is the nature of the clay used there, I am not informed. A clay very similar to that employed at Mr. Brush's pottery, but rather superior to it both in color and plasticity, occurs on S. 7, T. 25, R. 7 E., Yallabusha county; it has been used for tobacco pipes by the whites and Indians both, and also in some cases for white-(or rather *gray*-) washing houses. It might require the admixture of some sand.

A deposit of cream-colored clay, sufficiently refractory for fire-brick, occurs about two miles N. of Oxford, Lafayette county, in a cut on the Mississippi Central R. R. I have for some time used this clay for small crucibles, which resist both a high temperature, and the action of fluxes, remarkably well. A similar deposit occurs on the Yockeney-Patapha River, near the bridge on the Oxford and Water Valley road.

On the territory of the Lower (lignitic clay) Cretaceous, also, good potter's clay is found in several localities, especially in S. E. Itawamba, where it has given rise to a pottery (B. Dorsey's) on S.

32, T. 10 R. 10, E. On the territories of the *calcareous* (Upper and Middle) stages of the cretaceous, as well as of the tertiary formation, clays suitable for pottery are very rare or entirely absent. The calcareous clay marls often greatly resemble potter's clay, but may be distinguished by their effervescence with vinegar. They are too fusible to serve any purpose of this kind in their natural condition, and they do not appear to have entered to any great extent into the materials of the Orange Sand; which, moreover, is but feebly developed in their region of occurrence.

70. On the territory of the Southern Lignitic Tertiary, or Grand Gulf Group, strata of plastic clay also intervene with frequency between the Orange Sand and the undisturbed clays of the lower formation, while considerable deposits of pipeclay entirely *within* the Orange Sand are on the whole less common than in N. Mississippi. Their layers and nodules (or "pebbles") of pink and purple clay are of very common occurrence in Wilkinson, Amite, Franklin, Pike, Lawrence, Covington, Marion and Perry, and occur more or less over the whole territory of the Southern Lignitic; but I am not acquainted with any extensive continuous deposits of this character; they are usually met with in wells just before water is struck, and when penetrated, the lignitic clays are commonly reached at no great distance.

The *pale pink* varieties often become of a lighter tint when burnt, and are very refractory; such is the case, for instance, with the variegated (pink and white) clay occurring at Mr. Wesley Gray's mill on Bouie Creek, near Mt. Carmel, Covington county, which would make good fire-brick. The darker colored varieties, however, become red when heated, and do not resist a high temperature. The intensity of their color is a good indication as to their fusibility.

At Mr. Bell's, S. 16, T. 7, R. 11 W., Harrison county, on the Bayou Bernard, there is an outcrop of white and cream colored pipeclay, which is highly refractory and apparently meagre enough to be worked into fire-brick without any further addition; the Bayou would afford a ready means of conveying it to market. Any admixture of the red and yellow materials occurring at the same place, ought to be avoided.

The *gray* potter's clays of this southern region will be mentioned in connection with the southern Lignitic formation.

Numerous specimens of clays from localities not specially mentioned here are in the collection of the Survey awaiting examination as to their practical value, and will be reported on hereafter. Potter's clays are mentioned by Harper as occurring in several localities along the Mississippi bluff; but no specialities concerning their kind and geological position are given by him.

71. Not unfrequently, there are found within the Orange Sand formation clays so highly colored as to become of more importance, as pigments or paints, than for any other purpose. In numerous localities, these colored clays have been used for painting houses or fences, in the same manner that the white clay of Tishomingo has been employed as a whitewash.

It has been mentioned (¶64) that on the Memphis & Charleston Railroad, near Iuka, masses of *red clay* were found imbedded in the white mass; and that red veins are frequently visible in other localities. A remarkable deposit of clay impregnated with peroxide of iron so strongly as to make it valuable as an ochre or paint, occurs further north, on S. 30, T. 2, R. 11 E., near Mr. Biggs' place. The stratum crops out, with a visible thickness of 15 feet, forming the bank of a small stream: it is overlaid like the white pipeclay, by strata of ferruginous pebble conglomerate. The color of the mass is a dull red, resembling that of Burnt Siena earth, with somewhat more of a reddish hue; it contains occasional small veins or lenticular masses of perfectly white clay, resembling the rest except in color. It is but indistinctly stratified, and cleaves into irregular, massy fragments, the cleavage-planes often being almost black; it is peculiarly smooth or "greasy" to the touch, and when handled assumes a polished appearance. It writes readily on wood or paper, making a brownish red mark, and might easily be cut into pencils. When moistened it exhales a strong clay odor, and on being kneaded forms a plastic mass, which no doubt might be worked on the lathe after due seasoning. On being crushed it forms, with either oil or water, a paste so perfectly uniform and smooth, that the eye is unable to detect any coarse particles on a white surface painted with it, even when nothing more than a wooden pestle has been used in the process of mixing. It is therefore a most eligible material for the manufacture of paint, since it requires so little mechanical preparation. The color, as has been stated, very nearly resembles that of Burnt Siena earth (a reddish brown, very extensively employed), and may be rendered undistinguishable from the latter by a very slight admixture of lamp black.—Burning does not change the hue of the paint, but alters the dull red of the raw material to a brick red, which would also, of course, be the color of vessels made of it. The mass does not fuse readily, but is quite refractory; a very high temperature deepens its color and finally blackens it, with the appearance of incipient fusion.

72. As for the manner in which this deposit was formed, the white spots mentioned, between which and the red mass there is a zone of gradual transition, seem to prove that the whole was originally white, and was subsequently impregnated with a ferruginous solution. Unlike the other white clay deposits mentioned, this material, notwithstanding its compactness, is found on close examination to contain numerous minute pores, which in the white portions are distinctly marked by the ferruginous lining of their walls, though equally existing, and open, in both the white and the red portions of the bed. Under the lens they appear distinctly angular, and the space has evidently at some time been occupied by crystals of the form of a square, or possibly rhombic, prism or plate—(probably the former; the length of the major axis being about 0.02, that of the minor 0.01 of an inch), the substance of which has in most cases almost entirely disappeared; although in a few instances I have found those in the white portions incrusted inside with (yellow) *hydrated* peroxide of iron; while that in the red mass is evidently anhydrous.

Whatsoever may have been the original substance of these crystals, it is manifest that the red color did not spread from *them* as centers (as might be supposed had they been iron pyrites), inasmuch as the latter is entirely independent of them in its outlines. Their substance was evidently removed by a lixiviating process before the coloring solution infiltrated the clay.—In the lignitic formations, we find clays in which minute crystals of iron pyrites are thus disseminated throughout the mass, and the circumstance that all the pores in the white mass possess an inner coating of iron rust, seems to confirm the supposition that their origin is to be sought in crystals of pyrites, the form of which may have been either that of distorted cubes, or more probably, of the rhombic prisms of magnetic pyrites.*

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*I may mention in connection with the metamorphis of iron pyrites, just quoted, another singularly complicated case, occurring at McDouglas' mill, Tishomingo county (¶87). In a loose bed of hornstone pebbles, overlying the lower cretaceous clay, and itself overlaid by Orange Sand, we find some pebbles, studded with little druses of brown iron ore, a few of which still exhibit the forms of a regular octahedron. Similar pebbles, studded with (mostly tetrahedral) crystals of pyrites, occur at Turner's mill (¶83); and there can be little doubt that here, the common transformation of pyrites into brown iron ore has occurred. But in the interstices between the pebbles, we find loose masses, also of brown

I have not personally ascertained the extent of this deposit, but it probably extends both northward and southward from the locality mentioned ; and is said to crop out near Mr. McMackin's, 6 miles S. of Eastport.

73. About 3 miles S. W. of Westville, Simpson county, near Mr. Wright's, there occurs a deposit of pipeclay tinged *yellow* with hydrated peroxide of iron—a color which is rather uncommon elsewhere. It has been successfully used in the neighborhood as yellow paint; the tint is not, however, sufficiently intense and uniform to render the deposit of any more than local importance.

Yellow ochre is of common occurrence in the Orange Sand formation throughout the State, but no case has come under my personal observation in which its quantity and quality both would justify its exploitation on the large scale. A considerable deposit, the material of which has already been put to use in times past, exists, according to Prof. Wailes, at White Cliffs, Adams county. Usually, it occurs in small veins or lenticular masses, and very commonly fills the cavities of the concretionary nodules so frequently found. I have often heard of "beds" of yellow ochre, in different portions of the State, but have thus far either found them to consist of yellow sand, or, that the existence of a small vein or nodule had been taken as an earnest of a larger deposit close at hand. It is quite likely, however, that such beds may still be found, as the formation is certainly rich enough in the ingredients required.

Red ochre, also, is found very extensively, but usually in small quantities. Like the yellow ochre, it has been locally used as a paint in numerous places, and its tints are sometimes extremely beautiful, such as crimson, scarlet and purple. With the exception, however, of the ochreous clay deposit in Tishomingo, above described, I have not thus far found any deposit of coloring matter of this kind, of more than local importance.

74[1]. *Iron ore.*—Aluminous brown iron ore, and brown hematite, as has been mentioned (¶13), are very extensively diffused throughout the Orange Sand formation, more especially in the northern

iron ore, but their surface studded with brilliant crystalline surfaces of the form and aggregation of Iron Spar, or carbonate of iron. The process which has taken place here, seems to offer some analogy to that just noticed in connection with the red clay (¶71).

portion of the State. But although in case of need, if cut off from other States, Mississippi might manufacture her own iron, the desultory mode of occurrence, and uncertain continuity of the deposits, thus far found, of the purer kinds of ore, would not justify their exploitation, so long as advantages so greatly superior are offered in adjoining States, where inexhaustible beds of iron ore and coal often occur in one and the same mine.

The purest ore I have seen from this formation (a fibrous hematite) is found in Mr. Null's neighborhood, N. of Iuka, Tishomingo county. It occurs there in sheets and layers ½ to 2 inches thick, imbedded in yellow sand, and has been commonly mistaken for copper ore. Average specimens yielded 55 per cent. of iron.

74². *Materials for glass.*—White sand has been mentioned as of frequent occurrence in the Orange Sand formation. It is rarely, however, free from clayey particles, and altho' applicable to the purpose, such sand would not, as a general thing, be eligible for making white glass, unless previously freed from them by washing; as is often done naturally by the streams traversing the sandy regions, and more especially, by Pearl River and its tributaries, whose drifts of white sand often vie in purity with those of St. Genevieve in Missouri, whence the Pittsburg glass works receive a large part of their supply.

75. Waters of the Orange Sand Formation.—It has been stated already that the waters percolating through the Orange Sand formation, at the present time, are remarkable for the small amount of the salts of lime and magnesia which they contain, and may therefore be uniformly characterized as freestone waters. Silica, and iron in the shape of proto-carbonate, are the ingredients which at times appear in quantities sufficiently large to render the water mineral. The former is rarely altogether absent; the latter is sometimes contained in large quantities, but is very inconstant; in wet seasons it often is more abundant than in dry ones, and at times, chalybeate waters may be seen oozing out of every little rill. Then again, springs which originally were chalybeate, cease to be so after the land on which they are situated is cleared; and others lose their mineral properties so soon as they are cleared of leaves and other decaying vegetable matter. In fine, they are obviously dependant to a great extent, for their mineral properties, on the accidental condition of the surface, and therefore unrelia-

ble. It must be recollected, however, that although a spring may run out of the Orange Sand materials, it may have its *origin* in different strata; such, in fact, is the case with most of the mineral springs of the State, and not unfrequently the freestone water of the Orange Sand is rendered mineral by merely running over the surface of another stratum.

76. While, however, the *quality* of the water obtained from the Orange Sand, whether in wells or springs, is generally excellent, its *quantity* and *availability* leave much to be desired. This is owing to the perviousness of the greater portion of the mass of the formation, and the want of continuity, or irregularity of the impervious strata which it does contain. Where the Orange Sand prevails in force, wells often require to be sunk to great depths, and very frequently through the entire thickness of the formation, to where it rests on older and less pervious strata, which shed the water. Yet sometimes, in the middle of such a district, a few wells in a particular locality may yield water at a moderate depth, by striking, accidentally, some lenticular mass of clay of inconsiderable extent, and no less perhaps, of inconsiderable thickness; so that after a while an incautious cleaning out, the falling of a a bucket, or a slight shock of an earthquake, would break through it and allow the water to sink. A further deepening may reach another impervious ledge, which itself may give way in time; and thus wells are frequently kept deepening until either the underlying impervious formation is reached, or the depth becomes inconvenient, as has been the case at the University of Mississippi. At Oxford, close by, water is reached at moderate depths; and in searching for the cause, we shall find outcropping in the ravines adown the hillsides, several successive ledges of cream colored pipeclay, which we look for in vain in the R. R. cut, midway between the town and the University. In the Orange Sand, therefore, wells of 80 to 100 feet and more, are of common occurrence.

77. It is thus that in the more elevated ridge lands of S. Simpson, and S. Smith counties, for instance, the regular, rounded hollows and valleys are often without even a channel for flowing water; some bunches of leaves floated up against trees or bushes, give the only evidence that at times, in heavy rains, all the water is not absorbed by the sand. Yet even the next day after a rain,

the thirsty traveller may follow these hollows downward for miles, without seeing even a puddle, or a drop of water, until at last, when the level of the water-shedding stratum is reached, not single springs, but entire creeks of beautifully clear water are found flowing out at the foot of the hills.

In the agricultural portion of the present Report, the condition of the several districts with reference to waters and wells will be more specially mentioned; and in connection with these, also, those regions in which the Orange Sand is so strongly developed as to conceal entirely the other formations, will be more particularly noticed.

THE CARBONIFEROUS FORMATION.

78. The territory on which this formation appears, in Mississippi, is so small (as will be perceived by a glance at the map) that its geological relations can hardly be satisfactorily studied within the limits of the State ; its outcrops are comparatively few, and of small extent, in consequence of its being thickly overlaid, in most places, by masses of pebbles, and other materials of the Orange Sand formation (¶ 18). It is the more difficult to ascertain the order of superposition of the several strata, because in different localities, they appear partly horizontal, partly at various inclinations to the horizon, in opposite directions. Thus in its extreme southern portion (at Grisholm's Factory or Bay Spring) the heavy ledges of siliceous sandstone show a slight southward dip ; at the Cypress Pond, on SS. 25 and 17, T. 5, R. 11 E., the dip of the sandstone, overlaid by limestone, is decidedly to the northward ; and again, at Eastport, we find a black calcareous slate, like that which, in Alabama and Tennessee, is at the base of the Carboniferous system, at the high points of the surface, without any appreciable dip, and overlaid by cherty strata which elsewhere seem to be overlaid by limestone, and are, probably, equivalent to the siliceous sandstone of Bay Spring. It would seem, therefore, as if some of the folds of the strata, caused by the upheavals in Tennessee and Alabama, extended, at this point, into Mississippi.

79. The fossils thus far collected, according to a general examination, kindly given them by Prof. W. D. Moore, of the University, distinctly place the greater portion of the outcrops within the limits of the Warsaw and Keokuk Limestones of the Iowa Report, as will be seen from those mentioned below ; but thus far, observations are insufficient to allow of separating those belonging to each of these groups. There are probably, also, a number of undescribed species ; and it seems likely that lower, and perhaps even higher groups of the subcarboniferous series may hereafter be found to be represented.

80. The chief materials of the formation have already been mentioned as consisting of limestone (of different degrees of purity), chert or hornstone, and siliceous sandstone. The several degrees of transition of these rocks into one another are also represented, besides which, we find underlying the sandstone in several localities, a black clay shale charged with iron pyrites—the representative, perhaps, of the hydraulic slate of Eastport.

81[1] *Localities of the Carboniferous Formation.*—At Red Sulphur Springs, in T. 1, R. 10 E. (in Tennessee), a spring of strong sulphur water comes up from beneath a ledge of gray, non-fossiliferous, slaty hydraulic limestone of a perfectly uniform, dense, texture; which characterizes the northern portion of the formation. It is here as elsewhere overlaid by a stratified hornstone formation, whose lower portion is very hard and solid, and fossiliferous (*Fenestella*, *Productus*); but further up it becomes very brittle and almost void of fossils, and is interstratified with layers of pebbles imbedded in clay, which have been described before (¶31). Very nearly the same condition of things obtains all along Yellow Creek, so far as its course lies through the territory of this formation; on the lower portion of its course, however (from the crossing of the Red Sulphur Springs and Eastport road, to its mouth), we find on the left bank, the gray slaty limestone overlaid by a variety of aluminous sandstones, which in their highest portion became merely a soft, gray, sandy shale, void of fossils. Judging from some apparent transitions, these sandstones (of which there are some 15 to 20 feet) are the equivalents of the hornstone. We see, however, on the right bank (*e. g.* at Billing's mill) the slaty limestone itself appearing at the same level at which, on the opposite side, we find the sandy rocks. The former here gives rise to bald rocky hilltops, on which little else than the Prickly Pear and Stone-crop can find sufficient nourishment; and similar hilltops (which are of some importance as furnishing an excellent hydraulic limestone) are said to occur with frequency in the hills bordering on the Tennessee River, in the State of Mississippi. At Eastport, it is seen on the slopes of the ridge towards the river; in the bed of Big Bear Creek, and in that of a small creek which empties into the latter, close to the town. Here, as elsewhere, it is totally destitute of fossils; it cleaves readily into lenticular plates, with it a rough surface, and contains not unfrequently, hard, flat, siliceous nodules, of a few inches diameter, in which we generally see a few golden yellow crystals of iron pyrites. Analyses of this rock, as well as of that occuring on hilltops near Billings' Mill, will be found below (¶92–93).

Impure gray limestones, at times deserving rather the name of calcareous chert, crop out frequently in the bed of Yellow Creek, from its mouth upwards. Near Scruggs' bridge, on S. 16, T. 2, R. 10 E., there is an extensive outcrop of rock resembling in every respect, that of Eastport.

81[2] The siliceous deposits which overlie this rock in the neighborhood of Eastport, have already been, in part, described (¶31). The large masses of detritus derived from the pebble strata, which here cover the hillsides, render it difficult to observe fully the series of the Carboniferous. The lowest stratum which I have observed overlying the calcareous slate, is the singular deposit of pulverulent silex (¶30) traversed by bands of hornstone in all stages of decay.

This deposit, in which I have seen but a few fragments of carboniferous fossils (columns of *Pentremites*) has been struck in a well at Eastport, and crops out in a valley one mile S. of Eastport. [The occurrence of bluffs of this material, under circumstances similar to those under which it is found in Mississippi, near Gravelly Spring P. O., Lauderdale county, Alabama (nearly due E. of Eastport), is mentioned by Prof. Tuomey (Second Report on the Geology of Alabama, p. 9)]. The hills enclosing this valley are high and steep; their upper portion is formed by ferruginous pebble conglomerate or puddingstone, in which fragments of geodes of crystallized quartz are sometimes found; the lower by the ferruginous hornstone breccia described before (¶30). Underlying it, with a visible thickness of about 8—10 feet, appears the white silica deposit. The greater portion of it is pulverulent, and feels gritty (like starch) between the fingers; it is traversed, however (not always horizontally), by layers of hornstone 2—6 inches in thickness, which are not solid, but appear as though shattered into fragments; were the ferruginous cement present, it would form a breccia like that which overlies. In these layers, all grades of transition from solid hornstone into pulverulent, starchy silica, may be traced with ease.

It seems difficult to account for the condition of these hornstone layers, except by the contraction, in drying, of a gelatinous mass. The adjoining fragments usually fit each other, though not always exactly, and the same is the case in the overlying breccia, which seems to represent the solid hornstone ledges occurring at other points. W. of Eastport, we find this breccia apparently alternating with layers of hornstone, of which, also, it sometimes contains large lenticular masses. Near to the planes of contact of the breccia and the pebble conglomerate of the Orange Sand (¶30), the ferruginous cement is usually, not brown, but brick red.

On the waters of Little Bear Creek, in the southern portion of T. 3, R. 11 E., we find (*e. g.* at Mr. Common's gin-house) the hornstone breccia overlying directly an impure, sandy limestone, which here contains great numbers of *Productus costatus* Sow., and a *Spirifer* (allied to *S. bimesialis* Hall).

82. At the point where the M. and C. R. R. crosses Big Bear Creek, limestone more thickly laminated, and purer than the gray slate at Eastport, crops out on the banks.

S. of the R. R., on SS. 10, 2 and 1, T. 4. R. 11 E., along the old District Road, we find outcrops where a soft calcareous shale, characterized by immense numbers of a *Chonetes* (allied to *C. sarcinulata*), but containing also *Terebratulæ*, *Productus costatus*, stems of *Pentremites*, *Stylopora Prouti*, and *Zaphrentis spinulifera*, overlies a sandy limestone containing abundance of *Pentremites conoideus*, Hall, *Spirifer pseudolineatus*, Hall, *Terebratula*, a very large elongated *Productus*, *Cyathophyllum*, and columns of *Archimedes*. This limestone stratum, which is of inconsiderable thickness (about 10 feet), is underlaid in several localities by sandstone, which above is calcareous, lower down, siliceous, and destitute of fossils

83. On S. 22, same T. and R., at Mr. Turner's mill, there occur in the bed of. Big Crippled Deer Creek, outcrops of whitish chert containing abundance of fossils, among which *Fenestella*, *Gorgonia*, *Cyathophyllum* (*Zaphrentis ?*), *Productus*, *Terebratula* and stems of *Pentremites* are conspicuous ; it contains also small druses of iron pyrites, altogether tetrahedral in form, which does not vitriolesce, but is undergoing transformation into brown iron ore (¶72) and contains between 2 and 3-10,000 of silver. A short distance northward, on S. 15, we find the hornstone, which crops out in gullies, gradually changing into siliceous sandstone destitute of fossils, and resembling that of Bay Spring.

Close by, at a level somewhat higher, we find outcrops of a limestone ledge, and above this still, on the hillsides, we see angular fragments of hornstone—from which, although none of the latter was seen decidedly *in situ*, it would appear that the limestone is here both over- and underlaid by hornstone.

84. No limestone seems to crop out on, or E. of the main channel of Bear Creek, where its course lies through TT. 5, 6 and 7, RR. 10 and 11 E., in S. E. Tishomingo county ; but outcrops of siliceous sandstone, of various degrees of hardness, and destitute of recognizable fossils, are of common occurrence. In traveling through the hilly and rocky region intervening in Alabama, between Rock Creek and Cedar Creek, E. of Big Bear, in TT. 4 and 5, R. 12 E., I have seen the limestone and sandstone alternating repeatedly, in such a manner as to indicate a northward dip. At one point, a stratum of limestone only 15 feet in thickness, is over-and underlaid by non-fossiliferous, siliceous sandstone. At Mann's mill, near the mouth of Cedar Creek, the S. bluff of the creek consists of laminated siliceous sandstone, so hard as to strike fire readily ; the layers being from ½ to 1½ inches thick. A short distance above, there are several small caves, about 3 yards wide by 1½ high, running down obliquely into the sandstone ; about 15 feet below the surface they terminate in pools of clear cold water, which is said to rise and fall with that of the creek—although to the observer they appear to be rather above the level of the latter.

85. Further above still, near Walnut Peak P. O. (Mr. Suddard's) there is on the left side of the creek a large slough, known as the "Cypress Pond," which, running around in horseshoe shape, incloses between itself and the main channel of the creek, the greater part of S. 17, T. 5, R. 11 E. On the tract thus inclosed the Orange Sand alone prevails ; but on the landward bluff, which is from 30 to 40 feet high, there are outcrops both of limestone and sandstone. At the N. extremity of the semi-circle, the sandstone (which here is soft, yellowish, and effervesces with acids) appears at the foot of the bluff, while higher up we have a solid, black or gray crystalline limestone of considerable purity, which occupies the upper portion of the bluff for some distance southward of the point mentioned. The sandstone, however, gradually rises and takes the place of the limestone, until at the S. end of the bluff, as well as at Mr. Suddard's house, nothing but the soft, laminated, effervescent sandstone, destitute of fossils, is to be seen.

86. Several branches empty into the "Pond," and among these, one, at the N. end, has excavated for itself a deep, almost square, and for some distance

subterranean channel in the limestone, so as to appear and disappear repeatedly. In exploring one of these channels (which is 18—24 inches wide by about 3 feet high) for about 20 yards, I found the rock to be solid on all sides, the roof being curiously worn into cornice work, as though by the dripping of water from above ; but there are no stalactites. The fetid bituminous odor of the limestone pervades the air of these caves, as well as the water itself, which is, in consequence, undrinkable, and very hard besides.

The upper strata of the limestone are of a light gray tint, crystalline, and abound in fossils, especially columns of *Pentremites*, which appear prominently on the weathered surfaces. Lower down, however, the rock assumes a black tint, is almost destitute of fossils, and contains numerous small oolithic grains of a somewhat ferruginous material. Both kinds of limestone, whose cleavage is here generally massy, are very fetid. An analysis of the rock of the upper (purer) stratum is given below (¶95).

87. Northward of this point, also, in the same T., limestone sometimes appears on the hillsides. To the southward of it, however, I know of only one locality at which limestone is found viz : McDouglas' mill on the waters of Mackay's Creek, S. 5, T. 6, R. 10 E. At this point we obtain, on the bluff of the mill creek, the following section :

(Sec. 2.)

SECTION ON McDOUGLAS' MILL CREEK.

	FEET.	CHARACTER OF STRATA.	NO.
	20	Orange Sand forming hilltops.	6
	to		
	40	Loose cherty pebbles, or ferruginous puddingstone.	5
	10	Gray laminated clay, of the Eutaw Group (cretaceous).	4
	30	Gray crystalline limestone, in ledges 1 to 8 inches thick, containing Ptylopora Prouti, Sprifer (allied to Sp. bimesialis), Pentremites (symmetricus ?) Fenestella, Terebratula, etc. ; also spires of Archimedes.	3
	9	Yellowish or reddish, hard, siliceous sandstone, in laminae ½–1½ inch thick, with indistinct fossils—apparently heads and columns of a very large Pentremites.	2
		Black, semi-indurate clay shale, charged with iron pyrites. Bed of creek.	1

The fossils of the limestone, No. 3 (which is in places quite soft) are often prominently exposed on weathered surfaces, and sometimes washed out of the mass altogether. The indistinct fossils of the sandstone, No. 2, stand out prominently on its cleavage planes. Whether or not the shale stratum (No. 1) is fossiliferous, I could not ascertain.

88. The outcrop at McDouglas' mill constitutes an isolated outlier of only a few acres, between which and the outcrops at Peden's, Gardner's, and Bay Spring, we find (see below) only the strata of the Orange Sand and Eutaw Group.

Between Suddard's Ford (Walnut Peak) and Scott's mill on Big Bear Creek, S. 12, T. 5, R. 11 E., high bluffs of siliceous sandstone frequently occur on that stream, forming some of the little rock scenery to be found in the State. It occurs usually in ledges, from a few inches to 3 feet in thickness, is less flinty than that at Mann's and McDouglas' mill, and well suited for grindstones and flagstones. Outcrops of this sandstone are common, also, in the country bordering on Big Bear Creek, in the S. portion of T. 5, and in T. 6, RR. 10 and 11 E. Near Mr. Gardner's, on S. 36, T. 5, R. 11 E., there is a narrow valley excavated altogether into the sandstone, whose ledges form vertical walls 20–25 feet high on both sides, the talus at their base being strewn with huge blocks which have fallen from above. The ledges, whose thickness varies from ⅛ of an inch to 3 feet and more, seem to lie horizontally; the rock is usually hard enough to be suitable for grindstones and flagstones, though in some points it may be crumbled between the fingers. On the cleaved surface we often see, besides the ripple marks, curved tracings as of Cololithes or Serpulæ; but no distinct fossils occur.

89. At Mr. Alex. Peden's place, S. 34, T. 5, R. 10 E., the same sandstone appears, overlaid here both by ferruginous pebble conglomerate, and the strata of the white pipeclay deposit (¶62 ff.).

At Bay Spring, we find outcropping on Mackay's Creek, for about 2 miles above, and ½ mile below the factory, the hard siliceous sandstone of the Carboniferous. At the latter place itself, heavy, solid ledges of hard sandstone form the banks, both of the main creek and of a tributary which empties into it at that point; they show a dip of 2 to 3 deg. southward. The same indistinct impressions on the surface of the slabs, mentioned at Gardner's, are seen here.

This is the most westerly outcrop of the Carboniferous formation in Mississippi. All along Rock Creek (of Mississippi) and its branches, E. of Bay Spring, the sandstone crops out—more or less variable in its hardness and the thickness of its layers, yet still essentially the same. At Mr. Jourdans, S. 30, T. 6, R. 11 E., and at Mr. Smith's mill, on S. 32—both localities on Rock Creek—the sandstone is underlaid by a black clay shale precisely similar to strat. No. 1 at McDouglas' mill (¶87, Sec. 2); into which, at Smith's mill, the sandstone shows a transition, by the appearance of clay "galls," and the gradual softening, and darkening of the tint, of its lower layers.—The last outcrop of the carboniferous sandstone on Rock Creek occurs a few miles above its mouth; it also crops out, though it does not form high bluffs, on Big Bear Creek, in TT. 6 and 7, RR. 1[illegible] and 11 E., and in the hilly country intervening between the two creeks—where, however, even deep wells frequently terminate in the gray laminated clay of the Eutaw group.

USEFUL MATERIALS OF THE CARBONIFEROUS FORMATION.

90. These consist of *Limestones*, both *common* and *hydraulic*, *Sandstones*, and *materials* for *Glass*. *Bituminous coal* is not to be looked for, since the strata appearing in Mississippi correspond to those *underlying* the Coal Measures in Alabama and elsewhere; so that by mining in them, we should *recede from*, instead of approaching to, the level at which the coal is always found. According to the geological map of Alabama, the rocks of the Coal Measures of the Warrior coal field approach nearest to (within 7 or 8 miles of) the Mississippi line, in Marion county, Ala.; but I am not aware whether the coal itself extends so far.

91. HYDRAULIC LIMESTONE.—The dark-colored (black or gray) slaty rock, which occurs near Eastport, and which may be looked for, more or less, all over that part of the region colored black on the map, which lies N. of the line between TT. 2 & 3, possesses strongly hydraulic properties; *i. e.* it does not slake after burning, like common limestone, but if pulverized and then wetted, will harden under water, like Portland or Roman Cement. This property is imparted to the limestone by the clayey impurities which it contains, and in imitation of this natural mixture, hydraulic cement is now sometimes prepared, either by treating in the same manner as the rock naturally occurring, an intimate mixture of clay and lime, artificially prepared, or by mixing with quicklime certain substances naturally occurring (such as the puzzolana of Italy) in a finely ground condition. These artificial cements, however, are rarely equal to those prepared from good natural hydraulic limestone.

The principal localities of occurrence of this rock thus far observed, have been mentioned above (¶81).

92. The rock which forms the bald hilltops on the right bank of Yellow Creek, at Billing's mill, S. —, T. 1, R. 10 E., (and which may probably be found in many similar positions in the hilly country lying between the Red Sulphur Springs and Eastport road, and the Tennessee River), I have found to be of very superior quality; the cement made of it sets almost as rapidly as plaster of

Paris, and becomes very hard. An analysis of a portion of the specimens showing these properties, which readily cleaves into thin lenticular plates, is black on the fresh fracture and gray or whitish on the weathered surfaces, gave the following result :

HYDRAULIC LIMESTONE FROM BILLING'S MILL.

Insoluble Matter	54.201
Potash	0.473
Lime	23.247
Magnesia	0.788
Peroxide of Iron	0.903
Alumina	1.064
Phosphoric Acid	trace
Carbonic Acid	15.572
Organic Matter, Water, and Loss	3.752
	100.000

From the aspect of the outcrop, the quality of this rock does not seem to vary for 18 or 20 feet at least. No rock is seen in the bed of Yellow Creek at the point in question ; but farther below, near its mouth, impure cherty limestone, in layers from one to several inches in thickness, appears near the water level. It is doubtful whether this rock would answer the purpose of hydraulic limestone, whose best quality always seems to be announced, in this region, by its splitting easily into thin plates. It is quite likely, however, that rock of equal quality with that on the hill-tops near Billing's mill, might be found at a lower level also, and nearer the creek.

The rock which near Scruggs' bridge, on SS. 16 and 9, T. 2, R. 10 E., crops out in several bluffs on Yellow Creek, with a thickness of some 30 feet, coincides most closely with that occurring at Eastport, and no doubt possesses a similar composition, and properties (see below). Many similar bluffs exist, no doubt, between Scruggs' bridge and Billing's mill.

93. At Eastport the rock is found, as has been stated (¶81), in the bed of the creek which empties into Big Bear just S. of the town; in the bed of the latter stream itself; and on the slope, towards the Tennessee River, of the hill on which the Female Academy is situated. An analysis of a specimen from the latter locality, little different in aspect from that at Billing's mill, gave the following result :

HYDRAULIC LIMESTONE FROM EASTPORT.

Insoluble Matter	35.281
Potash	0.348
Lime	32.603
Magnesia	0.630
Peroxide of Iron	1.581
Alumina	1.914
Carbonic Acid, Water, and Loss	27.643
	100.000

For want of a sufficient quantity of material, I have been unable to make reliable experiments on the comparative rapidity of "setting" of the cement burnt from this rock; it seems, however, to solidify somewhat less rapidly than that from Billing's mill.

94. While these analyses, as well as the experiments made, leave no doubt as to the adaptedness of these rocks to the manufacture of excellent hydraulic cements, it must be recollected, that for each variety of hydraulic limestone there exists a certain *degree* of burning, after receiving which, it hardens best, or most rapidly. If on the other hand, the burning exceeds, or falls short of, that particular degree, the hydraulic properties will be the more impaired, the farther the burning given varies from the proper degree. The latter can only be determined by experiments on the large scale, in kilns properly constructed; the general rule being, that hydraulic limestones require much less burning, than those yielding quicklime. On account of the inequality of temperature which always prevails in the common lime-kilns, where the process is interrupted in order to draw the charge, these are altogether unsuited to the burning of hydraulic cement; and since, moreover, the manufacture of the latter involves, of necessity, the establishment of a mill (for grinding the calcined rock), and therefore, pre-supposes the existence of a constant demand to be supplied by continuous manufacture, the "perpetual" kilns, in which the burning goes on without interruption, are alone adapted to this purpose.

In view of the lively demand for hydraulic cements which exists in this State; of the high tax imposed on the consumers of this article by the long transportation which it has to undergo at present, and of the convenient accessibility of these deposits by way of the Tennessee River, while distant only 7 or 8 miles, at their nearest points, from the M. & C. R. R. (to which access might also be had, at high stages of water, on Big Bear Creek) there is reason to hope that they will not long remain unused. It is quite likely that due S. of Eastport, and on Big Bear Creek, they may be found to approach the R. R. much nearer than is the case on Yellow Creek. The limestone I have seen on Little Bear Creek, however, at Mr. Commons' (¶81), as well as that cropping out on Big Bear Creek near the crossing of the R. R., though impure, is of a different character, and probably better adapted to burning lime for agricultural purposes, than for the manufacture of hydraulic cement.

95. Limestones, for quicklime.—Most of the limestones mentioned above (¶82 to 87) are suited to the manufacture of quicklime; the localities, however, where the limestone occurs in the greatest abundance and purity, are at the Cypress Pond (Walnut Peak P. O., ¶85,86), and at McDouglas' mill on Mackay's Creek waters (¶87). At the former place, as before observed, two varieties of limestone occur; one, the uppermost stratum, being gray, and rich in fossils, the lower, black and almost without shells. Both rocks indiscriminately have been used in the preparation of quicklime, the product being of excellent quality, and perfectly white. The upper stratum containing the shells is, nevertheless, the purer, and ought to be preferred when the lime is to be employed in plastering and whitewashing. An analysis of this upper, purer rock, yielded the following result:

GRAY LIMESTONE FROM THE CYPRESS POND.

Insoluble Matter	1.680
Lime	53.495
Magnesia	0.817
Peroxide of Iron and Alumina	0.580
Carbonic Acid	42.035
Carbonaceous Matter	1.340
	99.947

1 cwt. of the limestone will therefore yield 56½ lbs. of strong lime, containing not quite 3 lbs. of foreign matter. This limestone is, therefore, the purest found in the State, and will yield lime equally as good as the majority of the imported article.

The limestone at McDouglas' mill is somewhat variable in its different ledges; several of these are equally pure, if not purer, than that of the Cypress Pond. This is especially the case with those on whose fractured surfaces we see numerous smooth faces of a glossy lustre, which are formed by the broken heads of a fossil, of about the size and shape of an acorn of the Red Oak (Pentremites) consisting of pure crystallized carbonate of lime or calcareous spar. The lime burnt from these ledges would be pure enough for any purpose.

There is no lack of fuel in the regions where these rocks occur; and abundance of fireclay to serve for the construction of the inner lining of the permanant "perpetual" kilns.

96. Building Stones, Grindstones and Flagstones.—The sandstone which has been mentioned as cropping out on Big Bear Creek, where its course lies through Mississippi, as also in the southern portion of the territory of the Carboniferous generally, is a very durable rock in almost all cases where it can be obtained in blocks of suitable size. It is only some of the slaty and calcareous varieties, like those mentioned as occurring at the Cypress Pond (¶85), which are subject to a considerable degree, to weathering. Large uniform blocks can be obtained below Scott's mill on Big Bear Creek, for several miles (¶88); at Gardner's (¶88), at Bay Spring (¶89), and at several points on Rock Creek.

The locality first mentioned, viz: the long bluff extending, chiefly on the E. side of Big Bear Creek, for several miles below Scott's mill, is of interest in another point of view. The rock occurring here is a sharp sandstone, of the proper degree of hardness for grindstones, and of great uniformity throughout; moreover, the ledges cleave with facility and with very straight and smooth surface, into slabs of various thicknesses, from an inch to several feet; so that all the labor needed to transform them into grindstones, would consist in cutting them round; while the thinner ledges might serve for whetstones. Bear Creek, in times of high water, would afford a most convenient means of shipment, but for the disagreement existing between the States of Mississippi and Alabama as to its navigability—Alabama having declared it a navigable stream, whereas in Mississippi, numerous mill-dams have been built across it.

The rock near Gardner's, which is of a similar quality, but less uniform, might also furnish grindstones. That at Bay Spring is too hard for the purpose.

Flagstones of large size, and of various thicknesses, can, of course, be also obtained at these localities.

97. Materials for Glass.—The deposit of white pulverulent silica, which has been mentioned (¶30,81[2]), is of very superior quality for this purpose, and being in a fine state of division, it would be preferable to the sand commonly used, for rapidity of fusion. The largest beads which could be fused before the blowpipe, of a mixture of this material with soda, were perfectly colorless in either flame. There are portions of it which are tinged with iron, but by far the larger part is of great purity, and might be mined with ease, like coal, by means of horizontal galleries.

The outcrop examined by me is in a small valley opening on that of Big Bear Creek, about 1 mile S. of Eastport (¶81[2]). The same stratum has been struck in wells at the latter place, and the deposit is probably co-extensive, in Mississippi, with the hornstone breccia itself, which overlies it, and occupies all of T. 2, R. 11 E., the N. part of T. 3, and N. E. ½ of T. 2, R. 10 E.—The inhabitants designate both the white pipeclay and the silica as "chalk;" the latter may, however, be readily distinguished from the former by its not affording any permanent white streak on wood; it "does not write." It is important to observe this difference, for the white pipeclay would be utterly useless in glass-making.

Occurring, as this material does, close to the banks of the Tennessee river, easily mined, and preferable as it undoubtedly would be to the coarse sand so often employed in glass-making, and which itself is shipped to considerable distances, it would seem that the exportation to the Pittsburg glass works, at least, via Tennessee and Ohio rivers, could be made a profitable business. For the manufacture of the soluble glass, or silicate of soda, now coming into use so extensively, a more desirable material could scarcely be procured.

98. Waters of the Carboniferous Formation.—Most of those occurring on its territory are derived from the overlying pebble formation, and are remarkably pure—as also, of course, are those flowing from the siliceous sandstone. The chalybeate occurring at Peden's (¶62), is probably derived from the laminated clays of the Eutaw group.

The Red Sulphur Spring in Tennessee (T. 1, R. 10 E.) is the only prominent example I know, of a mineral water which is *certainly* derived from the rocks of this formation. It would seem that any spring or well reaching the black shale underlying the sandstone at McDouglas' mill (¶87, No. 1 of Sec. 2) and Jourdan's, would of necessity possess mineral properties. The small amount of sulphates and of magnesia, which the mineral waters at Iuka contain, seem to indicate that they are derived neither from this stratum, nor from those of the lower cretaceous; while the Orange Sand alone would not be likely to impart sulphuretted hydrogen to them.

THE CRETACEOUS FORMATION.

99[1]. The territory occupied in Mississippi by the several stages of the cretaceous formation may be briefly defined as comprising (with the exception of a few townships in E. Tishomingo, occupied by the carboniferous rocks) all that portion of the State lying east of the following approximate line: From the point where Muddy Creek crosses the Tennessee line, *via* Ruckersville to Ripley, Tippah county: thence S. W. nearly to the line between ranges 2 and 3 E.; thence undulating nearly due S. to Houston, Chickasaw county; thence S. S. E., with a slight curve towards S. W., to Scooba, Kemper county, and to the Alabama line. On the map this line is laid down more in detail, the cretaceous formation being represented by the several shades of green.

99[2]. The general dip of the strata is between W. and S. W., at the rate of from 20 to 30 feet per mile. In the absence of surface levelings in the direction of the dip; in consequence, also, of the limited extent of the outcrops in the same direction, and the variability of the strata themselves (both as to character and thickness), accurate determinations of the dip are extremely difficult. A number of observations in bored wells in Lowndes county, collected and discussed by Dr. William Spillman, of Columbus, Mississippi, gave the dip in that region between 25 and 30 feet S. W., which is also the amount currently assumed by the well-borers in Monroe, Chickasaw and Lowndes. In the counties of Pontotoc, Itawamba, Tishomingo and Tippah, however, the bored wells are so few, and the hilliness of the country renders estimates of comparative surface levels so uncertain; the strata moreover are so variable, that I have been unable to obtain satisfactory data with reference to dip. It appears on the whole, however, to be rather less than that observed in the more southerly portion, and more nearly due W.; probably, over the whole of the cretaceous belt, at right angles to its W. and S. boundary line, since in Alabama, where the latter runs nearly due E.,), it is mentioned by Tuomey as being due S.: in Tennessee, according to Safford's map, the outlines bear N. N. E. In general, therefore, the dip of the cretaceous strata may be briefly defined as diverging from the upheaval of the Cumberland Range, around whose western and southern spurs it forms a crescent shaped belt extending from Tennessee, through Mississippi and Alabama, to the Ocmulgee River; its average width being, however, much less than that given in Hitchcocks' and Lyell's maps, and not often exceeding fifty miles.

100. In the cretaceous strata of Mississippi, at least three well defined groups or stages may be distinguished, the middle one of which exhibits two distinct facies, themselves deserving, perhaps, the dignity of separate stages. In preference to designating these stages as the Upper, Middle, and Lower Cretaceous, which might give rise to misapprehensions in reference to their relations to the strata of other regions, I shall apply to them specific names, already recognized and understood to some extent. These groups I shall briefly characterize in general, before passing on to their special description, without, however, for the present. attempting to parallelize them to those of more distant regions; to do which intelligently, the study I have thus far been able to bestow on them, is hardly adequate.

I. *Lowest.* EUTAW GROUP.*—Bluish black, or reddish, laminated clays, often lignitic, alternating with, and usually overlaid by, non-effervescent sands, mostly, (though not always) poor in mica, and of a gray or yellow tint. Contains beds of lignite, very rarely other fossils. Those found (by Tuomey, in Alabama—none in Mississippi) are silicified, and the sand when indurate, shows a *siliceous* cement.

II. TOMBIGBEE SAND GROUP.—Sharp, strongly micaceous sands, of greenish hue, laminated when indurate, and cemented by *carbonate of lime.* Very unequally developed in different localities, and apparently subordinate to the Rotten Limestone, into which it shows many lithological transitions, and many of whose fossils it shares. It is remarkable for the large number of species and individuals of *Inoceramus* which it contains, and also for the occurence in it of the gigantic *Ammonites Mississippiensis*, SPILLM.

*I adopt this name in view of these beds having been first examined in detail, and recognized as being of cretaceous age, by Tuomey, near Eutaw, Alabama. where they are characteristically developed.

III. Rotten Limestone Group.—Soft, chalky, white limestones of great uniformity and thickness, passing into heavy calcareous, massy clays, or light colored clay marls. Fossils numerically abundant, but species few. Characteristic are: *Placuna scabra: Janira quinquecostata; Gryphæa convexa, mutabilis, Pitcheri: Ostrea falcata: Rudistae; Mosasaurus.*—Underlies the prairies.

IV. Ripley Group, Con.—Hard, crystalline, white limestones (generally somewhat sandy and often glauconitic), underlaid by black or blue micaceous marls, whose fossils are in an admirable state of preservation. Prominent among the latter are *Cardium Tippanum* and *Spillmani*, *Cucullæa capax* and *Tippana*, *Gervillia ensiformis*, *Siliquaria biplicata*, *Dosinia densata*, *Crassatella Ripleyana*, *Baculites Spillmani* and *Tippaensis*, *Scaphites Iris*—also *Scaphites Conradi*, *Ammonites placenta*, a large *Atletha?* with sharp revolving *costae*, and others. The fossils of the hard limestone differ in some respects from those of the marl. These strata form the Pontotoc Ridge in Mississippi, and Chunnenugga Ridge in S. E. Alabama; according to late researches by Conrad, they also exist at Eufaula, Ala.

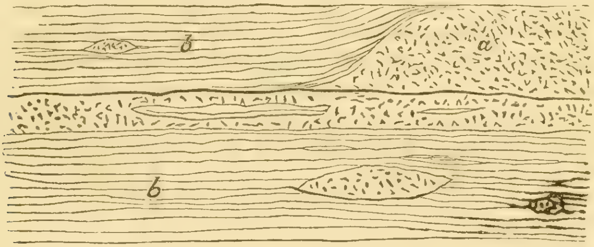
I. THE EUTAW GROUP.

("LOWER CRETACEOUS" OF TUOMEY.)

101. The territory indicated on the map (by the olive green tint) as being occupied by this formation, offers no strikingly charactistic features. By far the larger portion of its surface is thickly covered with the strata of the Orange Sand, from which the upper, sandy members of this group are often distinguished with great difficulty —it being some times, in fact, optional with the observer, as to which view of their age he may choose to take (¶38 39). It is even so, at times, with the laminated clays found in the region, which characterize the lower portion of the cretaceous deposits as well as those of the Orange Sand. Usually, the fat, compact, bluish laminæ of the cretaceous clay (popularly called "Soapstone"), are sufficiently distinct in their aspect and touch from the more sandy, and commonly micaceous, clay deposits of the Orange Sand; and in almost all cases there is one available mark of distinction: the ferruginous selvedges and stratification lines of the cretaceous clay, are *yellow* (hydrated peroxide) while those of the Orange sand are almost uniformly *red* (anhydrous peroxide.) These

clays form the water-shedding strata of the region; they are, therefore, frequently struck in wells, and numerous springs running off from their surface, have their basins dug into them by the inhabitants.

102. In Tishomingo county the cretaceous clay is most characteristically developed near the eastern edge of the region, and in many localities overlies the carboniferous rocks, on which we occasionally find its outliers for 8 to 10 miles eastward. The section at McDouglas' mill (¶87) shows the position of this clay with reference to the carboniferous formation; near Bay Spring (Grisholm's Factory) and in several localities N., E. and S. of the same, it overlies the carboniferous sandstone. Its laminae, in these localities, are usually separated by thin layers of sand, or, more rarely, of mica. The sandy ingredient increases as we advance westward (therefore towards higher strata) and northward from the line between TT. 4 and 3; and near to the line of the Tombigbee Sand Group, we more commonly find yellowish or gray sands with but here and there a lamina, streak or lenticular mass of dark colored clay. Diagram No. 4 is a specimen of the stratification usually exhibited in these cases, from an outcrop on the heads of Little Browns Creek, Tishomingo county.



Stratification of the Eutaw Group.

a, greenish-yellow sand.
b, blue and gray laminated clay.

These yellow and gray sands, which eventually become micaceous and calcareous, form the transition into the fossiliferous Tombigbee Sand; still, sands precisely similar are found interstratified with the characteristic Eutaw clays, so that the line between the two groups is necessarily somewhat arbitrary.

103. The point furthest N. at which clays distinctly bearing the character of this group have been found, is in wells near Honey's Mill on Yellow Creek, about S. 18, T. 3, R. 10 E.; further N. the Orange Sand strata either conceal the older formations, or the non-fossiliferous, yellowish sands are of so indefinite a character, that I have been unable to determine their age and position. Southward of this locality we find (besides those mentioned) characteristic outcrops of laminated clay at Mr. Hubbards, S. 27, T. 3, R. 10 E.; at Cartersville; at Peden's Mill, S. 9, T. 5, R. 10 E., Lindsay's Mill, S. 1, T. 6, R. 9 E., and Gurley's Bridge, S. 11, T. 6, R. 9 E., above Grisholm's Factory—all on Mackay's Creek; at Hutchins' place, S. 7, T. 5, R. 11 E. On the waters of Little Brown's Creek, on S. 9, T. 5, R. 9 E., and at Taylor's Mill, S. 10, T. 5, R. 9 E. Also, 1 mile E. of Marietta, Itawamba county.

At other points in Tishomingo, nearer to the line of the Tombigbee Sand, we find bluffs of non-calcareous, yellowish sands with only occasional bands of dark colored clay—thus at Haygood's place, S. 8, T. 5, R. 10 E.; at Tims' place S. 3, T. 5, R. 9 E., and at Moore's, S. 30, T. 6, R. 9 E. A few miles further W., on Big Brown's Creek, we strike the calcareous Tombigbee Sand. Yet even on the territory enclosed on all sides by clay outcrops, deep wells sometimes strike nothing but sand, similar to that at Tims' place, and bluffs show the same material. The blue or black laminated clays are found, as has been stated, in many localities in the southern portion of the carboniferous territory of Mississippi. It is very commonly struck in wells in TT. 5 and 6, RR. 10 and 11 E., at a depth of 20 to 30 feet.

104. Outcrops of laminated clays alternating with sand occur with frequency on Mackay's Creek, from Bay Spring down to its mouth, in Itawamba county. One of these, on a "caved" hillside, at Warren's mill, of which a section is given below, is of unusual interest on account of the fossil remains of trees which it contains, in the shape of lignitized trunks, obscure impressions of leaves, and lumps of fossil resin. The lignitized trunks being copiously incrusted with iron pyrites, induced a company of Georgians to commence mining operations on this spot, by driving a gallery into the lower, lignitic stratum; the work, however, was soon abandoned.

(Sec. 3.)

SECTION AT WARREN'S MILL, ITAWAMBA COUNTY.

FEET	CHARACTER OF STRATA.	NO.
40	Wooded hillside—Orange Sand on top.	7
4	Yellowish sand resembling that commonly overlying the laminated clays ; possibly in secondary place.	6
4	Sand similar to the above, filled with compressed lignitized trunks, often covered with pyrites.	5
⅔	Lignite & nodules of brown hematite, in ferruginous matrix	4
5	Dark colored, greenish, sandy clay, with an irregular, twisted or nodular stratification.	3
½–2	Yellowish-green sands, micaceous.	2
6	Thin layers of sandy, green, bluish, red or gray clay, interstratified with greenish sand. Lignitized trunks with pyrites imbedded in the mass.	1

The lignite found here is very much decomposed, so as to afford little hope of identifying the species of the trees. Not uncommonly there are found among the lignite rounded masses of fossil resin of a grayish yellow tint, with bands more or less translucent, resembling agate. It is very brittle, and when rubbed emits a faint aromatic odor. The latter, as well as the aspect of the material, strongly reminds one of hardened sweet gum or *Styrax liquida*. A portion of a disc-shaped mass of this substance, which originally was about four inches in diameter by 1½ in thickness, was presented by Mr. J. C. Reinhart.

The characteristic fat laminated clay does not occur in this section ; it appears, however, in the bed of the creek, lower down, and in bluffs on Big Brown's Creek, E. of Marietta. Thence southward, however, we find exhibited in many localities on the Tombigbee River, down nearly to the Monroe line, strata of the same character as those just described, viz : consisting of alternating layers of sand and clay of variable thickness, from 0.1 of an inch to 2 inches, and more. Such are the outcrops on the Tombigbee, near Fulton, from which numerous mineral springs flow, and also those at Van Buren ; at the latter place, there intervenes between the upper sandy portion and the more clayey beds below a thin ledge (1 to 2 inches) of fine grained, brownish aluminous sandstone.

105. I have not observed any outcrops in N. E. Itawamba except those mentioned on Mackay's Creek—Orange Sand strata occupy the surface altogether. Gray or black laminated clays, however, with occasional hard ledges, and iron pyrites, are struck in the wells at depths varying from 30 to 60 feet all over the region. On Bull Mountain Creek, however, there are numerous outcrops of the most characteristic kind, and on the dividing ridge between that creek and the Tombigbee, S. E. of Van Buren, the bluish-gray laminated clay is common both in outcrops and in wells.

While in S. E. Itawamba the formation is pretty well and characteristically developed, E. Monroe is almost entirely covered with Orange Sand strata ot great thickness, in which the lignitic clay strata of the Eutaw Group appear only in rare and small patches, while wells generally terminate in clays of the Orange Sand character. The only outcrops I am acquainted with in Monroe county, E. of the Tombigbee, lie between Weaver's Creek and the Little Sipsie. Outcrops of black, fetid, lignitic clay appear on hillsides, and even on a few hilltops, on SS. 23, 24, and 19, T. 12, R. 17 W., and are very generally struck in wells in the region mentioned. In one of these, dug about 1 mile W. of the Sipsie, in the last tier of sections of T. 12, a bed of lignite and iron pyrites was struck, rendering the water offensive—as is mostly the case where these clays come in contact with it.

Along the channel of the Tombigbee, however, we can trace the Eutaw Group in occasional outcrops, into Lowndes county, and thence, through the bored wells, into Alabama.

106. At Coulter's Ferry, on Old Town Creek (near its confluence with the Tombigbee), S. 34, T. 10, R. 7 E., Monroe county, there is a bluff about 120 feet high (from the water level), consisting of grayish-yellow, stratified, non-effervescent sand, which has "caved off" in terraces down to the waters edge. It is sharp, contains very little mica, but a great many black particles (tourmaline?), and is occasionally cemented a little, by a ferruginous cement. Not unfrequently, small lenticular masses and thin layers of gray laminated clay occur in this sand, which often impart to the latter a laminated structure discordant with the stratification lines. On the whole of this fine exposure, however, not a trace of fossil remains of any kind is to be seen.

Passing on westward from the ferry, for a mile, to Mr. Lisby's, S. 33, we find the continuation of the ridge which forms the Coulter's Ferry bluff, capped with the Rotten Limestone of the prairies ; and in the ravines of a branch tributary to Old Town Creek, we obtain the following section :

(Sec. 4.)

SECTION AT LISBY'S, SHOWING THE RELATIVE POSITION OF THE ROTTEN LIMESTONE AND EUTAW GROUP.

	FEET.	CHARACTER OF STRATA.	No.
	10	Rotten Limestone hilltops, with Exogyra costata, Janira 5-costata, Radiolites, etc. The lower ledges sandy and micaceous.	3
	30 to 40	Coulter's Ferry sands, non-effervescent. In the lower portion of the bed, large round concretions (3 to 4 feet in diameter) of calcareous, non-fossiliferous sandstone, usually very hard, sometimes soft.	2
	3	Dark colored, bluish, laminated clay.	1

The laminated clay appears at the same level at which, a short distance off, we see only sands ; showing that on the large scale as well as on the small, these deposits may be incontinuous, lenticular masses.

These outcrops are precisely analogous to those described by Tuomey (First Report, p. 118 ff.) as occurring at Finchs' Ferry, near Eutaw ; save in this, that here as elsewhere in Mississippi, these sands are non-fossiliferous.

A mile above Cotton Gin Port, at the ford, we find the Coulter's Ferry sands outcropping in the bed of the river. At the place itself, on the river bank, the laminated clay crops out two feet thick, overlaid by yellowish sand.

107. Thence down to Aberdeen, and so far as I know, from Aberdeen to Barton, on the Tombigbee, the Tombigbee Sand Group occupies the river bluffs. The sands and clays of the Eutaw Group are, however, struck in the bored wells at Aberdeen, and (at depths corresponding pretty accurately to a dip of 25 feet W. per mile) in those at Pikeville and Buena Vista, Chickasaw county. In some of the Aberdeen wells, a bed of white pebbles 8 feet in thickness has been found overlying a black, fetid, lignitic mass, at the depth of 217 to 220 feet ; pebbles are mentioned by Tuomey as forming part of these strata in Alabama, also. The lenticular or wedge-shaped laminæ of the clay are sometimes exceedingly troublesome in boring, as their smoothness imparts to them an uncontrollable tendency to slip sideways.

At Barton bluff, we find the following section :

(Sec. 5.)

SECTION OF CRETACEOUS STRATA AT BARTON, LOWNDES CO.

	FEET.	INCHES.	CHARACTER OF STRATA.	NO.
	15		Calcareous sand, micaceous, with oysters, Inoceramus, Janira quinquecostata, Placuna scabra, etc.	6
		6	Indurate ledge, with Inocerami.	5
	6		Calcareous sand, as above.	4
	1	6	Indurate ledge, a calcareous conglomerate of sand and shark's teeth and jaws, partly water-worn. Also, black concretionary pebbles.	3
	3		Calcareous sand, as above.	2
	4		Gray and reddish laminated clay, interstratified with greenish sand.	1

The prodigious number of shark's teeth and fragments of shark's jaws found in the lower indurate ledge (belonging to the Tombigbee Sand Group) is a remarkable feature of this outcrop. The *lowest* stratum is lithologically undistinguishable from the same at Warren's mill (¶104, Sec. 3), but contains only obscure traces of lignitic matter.

I am not aware that the Eutaw Group is exhibited in any outcrop S. of this, in Mississippi. At Columbus, it is struck after passing through about 100 feet of sands more or less micaceous and calcareous; the borings show the material to consist of layers of bluish or gray, and reddish clay, interstratified with sand.

II. THE TOMBIGBEE SAND GROUP.

108. The surface of the territory occupied by this group (indicated on the map by the dark green tint) is generally characterized by sandy hills, capped with the Orange Sand strata. We therefore perceive quite a sudden change in passing westward from it to the territory of the Rotten Limestone, with gently undulating

surface and heavy soils; while towards the territory of the Eutaw Group little difference is noticable, beyond that in the well waters.

The prevalent and characteristic material of this Group, as has been stated, is a fine-grained micaceous sand, more or less calcareous, usually of a greenish tint, but not unfrequently gray, bluish, black, yellowish and sometimes even orange red. Clays and non-calcareous (as also at times non-micaceous) sands are also found, although generally they are only subordinate to the characteristic greenish sand, which is the exclusive material in the southerly region of development, in S. Monroe, and Lowndes. In N. Tishomingo, there is a considerable variety of materials, among which bluish black clayey sands or sandy clays, and sands variegated with blue and yellow (frequently non-effervescent, but always strongly micaceous) are prominent. In S. Tishomingo, however, on the waters of Big Brown's Creek, the materials are undistinguishable from those prevailing in Lowndes county, like which they contain indurate ledges at short intervals.

Near to the edge of the Rotten Limestone, however, and particularly where they immediately underlie the latter, these sands are mostly loose and water-bearing, and light colored. In Itawamba, outcrops of their strata are scarce, their presence being recognized chiefly in wells; from Aberdeen down to several miles below Columbus, however, it forms the main mass of the river bluffs.

The greenish tint is imparted to these sands not by greensand grains, as is the case in the marls of the Ripley Group, but is caused by a greenish incrustation covering thinly a portion of the quartz grains. Whether or not this incrustation is of a glauconitic nature, I have thus far been unable to determine.

109. Beginning at the north, in T. 1, R. 9 E., Tishomingo county, we occasionally find in the (dug) wells a black, fetid, micaceous, non-effervescent clayey sand, while natural outcrops scarcely occur; the same is the case in T. 2, R. 9 E., and the adjoining portions of T. 2, R. 8 E.—a hilly, sandy region, thinly settled, except along the water courses; the surface of which is covered with Orange Sand strata, beneath which, at depths varying from 4 to 20 feet, the cretaceous strata are struck. It is in this region particularly that the denudation which the latter have experienced, previous to the deposition of the present surface materials, becomes very apparent, from the fact that the dark colored sands are struck at the same average depth on the *hilltops* as on the *hillsides.* This condition of things is abundantly illustrated in the R. R. cuts of the region, a section of one of which, on Harris' contract, S. 3, T. 3, R. 9 E., has been given in connection with the Orange Sand formation (¶39, Diagram No. 2).

The black, micaceous sandy clay forming the subterranean hills, is generally found overlaid by micaceous sands variegated with blue and yellow spots, which are sometimes stratified inconformably, as shown in the figure, and then pass imperceptibly into the overlying Orange Sand; at others they are obviously in their original place, conformably stratified, with an occasional ledge of dark colored clay, as illustrated in the section given below, from a hillside cut on Bell's contract, S. 33, T. 2, R. 9 E.

(Sec. 6.)

SECTION AT BELL'S CONTRACT, M. & C. R. R. TISHOMINGO CO.

	FEET.	INCHES.	CHARACTER OF STRATA.	NO.
	20		Blue sand with yellow streaks, horizontally stratified, containing large nodules composed of many ferruginous layers, with a nucleus of gray sandstone in the centre; often containing cretaceous fossils.	4
		10	Black, sandy, micaceous clay.	3
	25		Bluish and whitish sand with yellow streaks, with several ledges of ferruginous sandstone. Also ferruginous nodules similar to the above. Stratification horizontal.	2
			Black sandy micaceous clay. Bottom of cut.	1

The nodules mentioned above, and also occurring in the variegated sand of Diag. No. 2, are sometimes several feet in length by 12 to 18 inches diameter. The sandstone nucleus, which itself is generally filled with loose sand, is often quite insignificant compared with the numerous rinds of ferruginous cement which inclose it. The fossils it contains are poorly preserved; fragments of a *Callianassa*, an *Avicula ?* and *Gervillia* were recognized among them. The black micaceous mass is poor in fossils also; those occurring are generally pyritized nuclei, among them *Venilla Conradi*, and a *Siliquaria*. The laborers in the cuts were sometimes severely affected by the fetid exhalations of the "black dirt," while working in it.

110. Sands similar to those overlying the black strata here, are found in wells and outcrops on Yellow Creek waters, in T. 3, R. 8 and R. 9 E. On S. 29, T. 3, R. 9 E., a *silver mine* was said to have been discovered, not many years ago, in these sands, where they form the bed of a creek. It appears that the proprietor of the land, wishing to sell out, tried to enhance its value by shooting granulated silver, from coins, into the bank. The trick did not "take" well, however, and he fled the country shortly after. Frauds of a similar character have been repeatedly practiced by strolling miners, in E. Tishomingo; usually, however,

based upon the presence of iron pyrites. It was in the same formation, but mainly in the black micaceous sand, that several Georgia miners sunk a shaft near Mr. Odum's, S. E. of Jacinto, S. 29, T. 4, R. 9 E.; after finding a great deal of iron pyrites, at 60 feet they struck yellow sand (belonging, perhaps, to the Eutaw Group), and abandoned the "mine."

The following section, from a cut on Polk's contract, Mobile & Ohio R. R. (about S. 36, T. 2, R. 7 E., near the crossing of the Farmington and Danville road) furnishes an example of the variety of materials sometimes found in the strata of this group:

(Sec. 7.)

SECTION FROM POLK'S CONTRACT, ON MOBILE & OHIO R. R., TISHOMINGO COUNTY.

	FEET.	CHARACTER OF STRATA.	NO.
	3 to 4	White, stiff calcareous clay, with Exogyra, and Gryphæa mutabilis.	4
	8 to 12	Orange colored sand, with tubular concretions, resembling Orange Sand. No fossils found.	3
	3	Blue, clayey, micaceous sand, with Venilla, Cucullæa, etc.	2
	3	Bright green, fossiliferous sand. Bottom of cut.	1

The materials underlying No. 4, (the equivalent of the Rotten Limestone), are non-effervescent. The stratification in the cut is very irregular, from the great variations in the thickness of the strata. Numerous beautifully preserved nuclei (interior casts) of bivalve shells have been found in excavating this cut, but very few have come into my possession. Among those seen, *Venilla Conradi*, *Crassatella*, *Trigonia*, *Cardium* and *Cucullaea* were conspicuous. Sharks teeth, those of *Mosasaurus*, and an impression of a fish, have been found here, but in which stratum I was unable to ascertain.

111. At Jacinto, highly micaceous, black clayey sand is struck in most wells at depths varying from 10 to 15 feet, its thickness being 7 to 8 feet; then light colored sands with freestone water. In the public well, however, a ledge of indurate, limy sandstone was struck at 40 feet.—The same phenomena obtain, with little changes, all over T. 3, RR. 8 and 9 E.; N. E., and westward of Jacinto, the hilly surface is occupied by Orange Sand of greater or less thickness.

The same dark colored micaceous material, more or less calcareous, and with obscure casts, occurs on the M. & O. R. R., on King's Creek, S. 26, T. 4

R. 7 E., and in dug wells on S. 33, T. 4, R. 9 E., on the heads of Little Brown's Creek. Further S., however, as well in the middle of the belt, on Big Brown's Creek, the character of the material changes more and more to that of the common greenish micaceous sand, which further S. alone characterizes the group. It is thus at Boyer's mill (about S. 27, T. 5, R. 7 E.), where the material could hardly be distinguished from that of the Columbus bluff; and at Hare's mill on Big Brown's Creek, S. 10, T. 5, R. 8 E., where we obtain the following section:

(Sec. 8.)

SECTION AT HARE'S MILL, BIG BROWN'S CREEK, TISHOMINGO CO.

	FEET.	INCHES.	CHARACTER OF STRATA.	NO.
	14		Grayish-yellow, micaceous, loose, non-effervescent sand; fossils in the middle 5 feet.	4
	1		Greenish sandstone, with Exogyra and Inoceramus.	3
	15		Greenish, micaceous, coherent, effervescent sand, with Inoceramus, Placuna scabra, &c.	2
	1	1	Greenish sandstone, with Exogyra and Inoceramus.	1

Ledge No. 1 of this section forms the bed of the creek here, and for some distance around the same appears in the branches. On S. 30, T. 4, R. 9 E., about 4 miles N. E. of the locality just mentioned, on a very high ridge, we find a ledge 18 inches thick, of black micaceous clay, containing cretaceous fossils, underlaid by the non-effervescent sands of stratum No. 4 of the above section, overlaid by 6 feet of reddish sandy clay, and blue sand.—The sand in question forms the main mass of the ridge, and the section recalls to mind that given above from Bell's contract (¶109, Sec. 6).

Sections similar to that at Hare's mill, frequently occur on the waters of Big Brown's Creek, down to the Itawamba line, both in wells and on the bluffs of streams, which very commonly flow on the indurate ledges of greenish calcareous sand. On S. 8, T. 6, R. 8 E., a section of about 60 feet occurs on a washed hillside, where large blocks of the greenish micaceous sandstone are seen.

112. On Okalilly Creek near Carrollville, S. 22, T. 6, R. 6 E., there is a bluff 30 feet high, the lowest 20 of which exhibit the cretaceous strata, to-wit: 6 feet of blue and yellowish, non-effervescent, micaceous sand, forming the bed of the creek, overlaid by about 14 feet of whitish calcareous strata stocked with

oysters and other fossils of the Rotten Limestone; the material in the lower portion being rather sandy, but passing over by degrees into the Rotten Limestone above—none of which is seen E. of Carrollville.

113. The formations in N. W. Itawamba, I have but partially examined, and am not therefore certain of the line given there. The Rotten Limestone appears some distance E. of Guntown Station on the M. & O. R. R., and seems to touch 20 Mile Creek; at Guntown, nothing but the limestone is seen in either cuts or wells. E. of Richmond, on the Fulton road, on the waters of the Bogue Eucaby, and eastward of the same, strongly micaceous sands appear in the wells, which at first have limy water, but the less so as we approach the Tombigbee.

Near Borland P. O. (Squire Connel's, S. 18, T. 11, R. 8 E.), bluish micaceous sand, sometimes cemented into a soft sandstone, is found in wells and beds of creeks. A few miles westward, however, the heavy "beeswax hommock" soils of the Rotten Limestone appear on the higher ridges, and shortly after, the latter itself is struck in wells and outcrops. At Coulter's Ferry (¶106, Sec. 4), the Tombigbee Sands are sparingly represented by a few feet of micaceous material underlying the Rotten Limestone; and between this and Aberdeen, micaceous sand is struck in wells on the W. bank of the river, after passing through the Rotten Limestone.

Near Aberdeen, we find the stratum finely developed in a bluff on the Tombigbee river, on Dr. Tindall's land:

(Sec. 9.)

SECTION ON THE TOMBIGBEE, AT DR. TINDALL'S, NEAR ABERDEEN, MONROE COUNTY.

	FEET.	CHARACTER OF STRATA.	NO.
	15	Orange Sand—Hilltop.	4
	12	Non-effervescent varcigated sand, corresponding to No. 4, at Hare's mill and Bell's contract, Tishomingo.	3
	25	Greenish micaceous sand, becoming the more calcareous, the further downwards; with Exogyra, Placuna scabra, Ammon. Delawarensis (?), Baculites, Inoceramus. Fossils badly preserved.	2
	7 to 8	Non-effervescent, variegated sand, with tubular, anastomosing, ferruginous concretions, resembling cane roots; and small ledges of soft, non-effervescent sandstone, to waters edge.	1

At the Aberdeen Ferry, the micaceous sand crops out on both banks, up to 8 feet above low water. About 3 miles W. of Aberdeen, there is a change from the level prairie country further W., to sandy hills, with some pine.

114. On the road from Aberdeen to Columbus on the W. side of the Tombigbee, there is a change from the sands to the Rotten Limestone and back again, as indicated on the map; the aspect of the country varying accordingly. The section at Barton has been given above (¶107, Sec. 5); a section similar to it in most respects, is mentioned by E. Q. Thornton, Esq., of the Alabama Survey, as occurring near Colbert's Ferry, below Barton. At Plymouth Bluff, we find one of the best and most characteristic exposures of the Tombigbee Sand Group, of which a detailed section is given below. It was early visited and its fossils collected and studied, by Dr. William Spillman, of Columbus, who possesses a fine collection of its fossils; a number of these have been studied and named by Tuomey, and are mentioned in the catalogue appended to the second Report on the Geology of Alabama (¶258 ff.); most of the fossils marked "Columbus," "Lowndes county" and "Miss." are found at Plymouth Bluff.

A catalogue of the fossils from this interesting locality, kindly furnished me by Dr. Spillman, is given in another place.

(No. 10.)

SECTION ON THE TOMBIGBEE, AT PLYMOUTH BLUFF, LOWNDES COUNTY.

	FEET.	CHARACTER OF STRATA.	NO.
	3–4	Soil and disintegrated calcareous mass.	10
	12	Sandy calcareous clay, bluish, with Ostrea plumosa and Inoceramus barabeni ?—equivalent of Rotten Limestone.	9
	1–2	Hard calcareous sandstone.	8
	12	Greenish micaceous sand, with great numbers of Exogyra costata; also Placuna scabra.	7
	1–2	Calcareous sandstone, with "cane root" concretions.	6
	30	Greenish micaceous sand, slightly calcareous, poor in fossils.	5
	1–3	Seam of hard calcareous concretions, with Exogyra.	4
	12	Greenish micaceous sand, as above.	3
	1½	Hard calcareous sandstone with Inoceramus.	2
	10	Greenish micaceous sand. Bed of river.	1

The greenish micaceous sands form the main body of the hills on which the town of Columbus stands, and of those of this region generally; the Orange Sand strata proper being rarely more than 10 to 15 feet in thickness on the ridges, and often entirely absent. Frequently, however, the oxidizing action of the atmosphere has tansformed the upper strata of the greenish sands into reddish or yellow, which, however, may generally be distinguished by their sharpness, and the casts of fossils they contain, though sometimes very sparingly and poorly preserved. Casts of Baculites are perhaps those most commonly occurring, but the tubular anastomising concretions mentioned in the section at Dr. Tindall's bluff (¶ 113, Sec. 9), are still more common, and are frequently met with on the road from Columbus to Aberdeen. The bluff at Columbus, the highest portions of which are between 150 and 160 feet above low water level, consists entirely of these micaceous sands, more or less fossiliferous, of various shades of color, and with some indurate ledges. Sand precisely similar forms the bluff at Waverley; an analysis of the same is given below (¶ 140).

115. Fossils of the Tombigbee Sand Group.—The list of fossils in Dr. Spillman's collection, given below, will furnish a better view of the fauna of this group, than I could have derived from my own observations. So far as I am able to judge from the limited amount of attention I have thus far been able to bestow on the palæontology of the cretaceous formation, Dr. Spillman's collection represents correctly the fauna of the peculiar and prevalent facies of the green micaceous sands, from Lowndes county to Big Brown's Creek in Tishomingo. The subordinate facies of the black sands, however, which we find in N. Tishomingo, presents some differences of character, which may be observed for instance, in the rare occurrence of Cephalopods, and of the prevalent characteristic fossil of the cretaceous--*Exogyra costata*; while on the other hand, the bivalve genera *Venilla*, *Cardium*, *Isocardia ?*, *Crassatella !*, *Solen*, *Gervillia !*, and others, which are wanting at Plymouth Bluff, are prevalent. There seems to exist a close stratigraphical and lithological connection, however, between these black micaceous clays and the *unquestionable* Tombigbee Sands; otherwise the former might be suspected as representing the fauna of the Eutaw Group. Perhaps an opportunity might occur in Alabama of comparing the fauna of the Eutaw beds, with that of the black sands of Tishomingo. As it stands, the latter appears to offer more analogy to the fossils of the Ripley Group, than to those of the Rotten Limestone; to which otherwise, the fauna of the Tombigbee sands bear a close relation.

As regards the occurrence of the Tombigbee Sand Group in Alabama, the sections on the Alabama River given by Mr. Thornton (Second Report, Appendix 2, A) seem to demonstrate its existence there, although these strata do not appear to have been identified by Tuomey with those of Plymouth Bluff.

[For the catalogue of Dr. Spillman's collection of fossils from the strata of this group, which was not completed in time for insertion into the text, see Appendix No. I.]

III. THE ROTTEN LIMESTONE GROUP.

116. The general character of this formation in Mississippi varies little from that given by Tuomey and others to the same strata in Alabama. The surface of its territory is generally level or but slightly undulating; when high ridges do occur, their main mass is the limestone itself, on which the Orange Sand formation is wanting, or present only to an inconsiderable thickness, or in patches; the surface formation being mostly stiff clays, which underlie the prairies. Hence a great dearth of naturally available water during the dry season, characterizes the region in an economical point of view. The material of the formation itself is of great uniformity—a soft, chalky rock, of a white or pale bluish tint, with very little sand; consisting of variable proportions of fat, tenacious clay, and white carbonate of lime in crystals extremely minute, and with some shells of infusoria. The stratum is of great thickness and uniformity of character on its southwestern border, borings of 700 to 1000 feet being no uncommon occurrence in S. Chickasaw, E. Octibbeha, Noxubee and N. E. Kemper. In consequence of its dip, the stratum *here* thins out *northeastward* further N., *eastward;* but besides, there is a *general* thinning out to the northward, so that in S. E. Tippah, the maximum thickness is only about 350 feet, at Blackland, in Tishomingo county, 150, and on the Tennessee line, from 70 to 100 feet—perhaps much less. At the same time, in this northern portion of its territory, its materials lose their uniformity, consisting at times of white or bluish, tenacious, calcareous clay—called by the inhabitants, from its massy cleavage, "joint clay"—alternating with strata of the common "Rotten Limestone," and sometimes—though rarely—with layers more or less sandy.

Its lowest portions, where it adjoins the Tombigbee sand strata, are generally white clayey sands—as at the outcrop on Okalilly Creek (¶112), and stratum No. 10 at Plymouth Bluff, (¶114, Sec. 10). Among its fossils, those rarely wanting in any of its outcrops, are *Exogyra costata*, *Gryphaea mutabilis*, *convexa*, *incurva*, *Pitcheri*, *Placuna scabra*, *Janira quinquecostata*. The occurrence of the *Gryphaeae*, of *Ostrea falcata*, of *Radiolites*, *Ichthyosarculites*, and *Belemnitella mucronata*, which appear to be wanting in the Tombigbee sands, form prominent and convenient palaeontological marks of distinction from the latter group; [the *Gryphaeae do*, however, occur in the Ripley group also.] The species of the genus *Inoceramus* (numerous in both) also afford convenient landmarks, altho' I have not thus far determined them specifically.

117. Where the Rotten Limestone appears on the surface, or is covered by pervious strata, it appears white or yellowish-white, and generally preserves the same tint to some depth, varying with the perviousness of the mass, from 2 to 18 feet. Below this there is often a very marked change of color into bluish gray, which when wet looks quite dark and is therefore very commonly distinguished as "blue rock" from the "white prairie rock" on or near the surface. The rock is the same, however, both in composition and fossils, the difference of color being caused merely by the oxidation of a trace of carbonaceous matter, or protoxide of iron, or at times both. This circumstance causes great difficulty in the study of the strata, where the records of well-borings have to be relied on for information, since both the Rotten Limestone and the dark colored clayey sands of the Tombigbee Sand Group are often indiscriminately styled "blue" or "black rock" or "dirt," by the well-borers and inhabitants, rendering their accounts extremely perplexing and apparently incompatible with any regular stratification. Fortunately, notwithstanding the general levelness of the surface, outcrops are quite common in the Rotten Limestone region; the channels of the creeks are often cut into the rock itself, and from its resistance to denudation, it has not formed so many rounded subterranean hills, but comes to the surface where a stratum ends, through the surface materials forming "bald prairies" and "bald hilltops"—in which the limestone is too the surface to allow of the growth of trees or other deep rooted plants, and not unfrequently forms white areas many acres in extent, strewn with fossils (especially oysters) washed out of the mass, and only here and there a patch of *Verbena*, or *Cassia* (*C. obtusifolia, occidentalis, marilandica*).

118. *Localities of the Rotten Limestone group.*—At Breuton's contract on the Memphis & Charleston R. R., near Chawalla Station, a cut exhibits about 17 feet of yellowish white calcareous clay, overlying a blue, micaceous, compact, clayey, slightly effervescent sand; near the surface of the latter, the calcareous clay contains abundance of *Ostrea falcata*; above, some *Exogyrae* and *Gryphaeae* are found, but chiefly *Inocerami*, *Mytilus*, *Tellina*, &c. This whitish, calcareous, "joint" clay occurs in numerous cuts between Chawalla and Corinth, and also E. of the latter place; the cretaceous strata being from 3 to 20 feet beneath the surface over the whole region, while N. of Corinth, in Tennessee, bald prairies strewn with shells are said to exist. At Farmington, the "blue rock" is passed through, into loose water-bearing sand, at 40 to 50 feet; at Corinth, at 70; while at Mr. Tate's, S. 7, T. 1, R. 7 E., in Tennessee, N. of Chawalla, a bore of 356 feet did not strike any loose sand, but seemed to continue in the unchanged "blue rock." Due S. of this, also, near Bone Yard and Kossuth, and on the E. half of R. 6 E. down to T. 5 generally, wells are very deep, and outcrops very scarce; I have been unable to ascertain how much of the "blue rock" belongs to the Rotten Limestone, and how much, if any, to the Tombigbee Sand Group, which the dark micaceous material seen at Breuton's contract resembles exceedingly. On Parmeechee Creek, S. 33, T. 2, R. 6 E., there is an outcrop of very micaceous, sandy marl, the shells of which (very imperfectly preserved) seem to place it within the Ripley group; between

which and the Rotten Limestone there appears to be a zone of transition, characterized, among others, by the frequent occurrence of hard ledges of conglomerated shells, and of *Baculites gigas;* while having some shells in common with both groups. Outcrops of this character on the upper Hatchie and on Old Town Creek, will be described under the head of the Ripley group (¶134.)

Near (W. and N. W. of) Danville, Tishomingo county, bald prairies are said to occur. The occurrence of the white "joint clay" at Polk's cut has been mentioned (¶110, Sec. 7.)

119. At Boone's cut, S. 16, T. 5, R. 7 E., on the Mobile & Ohio R. R. (about 3 miles N. W. of Boyer's mill—¶111) a section of about 60 feet is obtained in the cuts and branches. In the cuts, the white, calcareous "joint clay," teeming with *Gryphaea mutabilis*, is underlaid by "blue rock," but there is no stratification line between ; the "joint clay" conforms to the surface of the hills, and every stage of transition from the one to the other may be traced, showing that the difference in aspect is owing to atmospheric influences. Still further downward, the "blue rock" passes over into a blue, micaceous, non-effervescent sand similar to that on Okalilly (¶112). Such, probably, on a larger scale, is the succession of strata in the deep wells mentioned in R. 6 E.—A few miles W. of Boone's cut, bald prairie hilltops appear, with abundance of shells.

At Mr. William Yates', S. 11, T. 6, R. 6 E., bald prairie spots are common, and clusters of *Gryphaeae* cemented by calcareous sand (similar to that of the *upper* stratum on Okalilly—¶112) were taken out of his well.

Both the localities just mentioned are on the eastern edge of the Rotten Limestone region. Due W. of it, near Blackland, the characteristic rock appears abundantly in the beds of the creeks, and thence constantly on the road to Carrollville; good exposures occur on Twenty mile Creek.

120. Due E. of Blackland there rises a high ridge, on the summit and in the ravines of which, the marl of the Ripley group appears, with its characteristic fossils.

In T. 6, R. 5 E., Tippah county, the dividing ridge between the waters of the Hatchie and Tallahatchie, and those of the Tombigbee, also forms the line between the Rotten Limestone and the Ripley Group; the former, or its equivalents, crop out with frequency on the creeks of the S. E. slope, especially on the main Tishomingo, and on Yoonaby Creek. On the hills in which these creeks head, there are numerous "bald prairie spots," on which *Exogyra* and *Gryphaeae* are lying about.

A bluff on Tishomingo Creek, near Mr. J. H. Kennedy's, S. 14, T. 6, R. 5 E., affords a remarkably fine opportunity for study ; similar exposures are found on the creek for several miles.—The bluff is about 60 feet high ; a bluish, soft, somewhat sandy marl, the uppermost 8 feet of which consist of a material rather more clayey than the rest, of a yellowish tint, and very similar to the Rotten Limestone of the hilltops. Among its fossils, which are numerous and well preserved, are *Exogyra costata*, *Gryphaea mutabilis* and *convexa*, (*incurva ?*), *Ostrea falcata*, *O cretacea ?*, *Anomia argentea ?*, *Placuna scabra*, &c.

Belemnitella mucronata, Baculites gigas; numerous small *Inocerami.*—Not far from (N. W. of) this locality there is a well (Nelson's) 330 feet deep. Wells decrease in depth pretty regularly from here eastward to Carrollville, owing, however, not only to the dip of the strata, but also to the descent from the ridges on which these wells are situated. Lower down, Tishomingo Creek shows outcrops of the common Rotten Limestone, while the same material seen at the bluff near Kennedy's, crops out on the Yoonaby, on S. 10, T. 7, R. 5 E. The occurrence of the Rotten Limestone at Guntown Station, M. & C. R. R., has been mentioned.

121. It would be tedious to enumerate the numerous localities at which the rock crops out on the territory laid down on the map, since each one is little more than a repetition of the other. N. of Old Town Creek, Pontotoc county, prairie occurs only locally, in limited patches; S. of the stream mentioned we find the "Chickasaw Old Fields," called so probably from their resembling a clearing; they are nothing more than small prairies, in which the Rotten Limestone lies very near the surface, so as to be at times touched by the plow, while the rain-water also cuts its channels into it. Their soil is black, or whitish where the rock itself forms a large quotum of it, and very fertile; but that which results from its intermixture with the yellow soil of the adjoining, gently undulating uplands—"mahogany soil"—is preferred as being safer. Still further S., on the Coonewar, Chiwapa and Tallabinela, the regular prairies set in, with their 6 to 10 foot stratum of yellow clay overlying the Rotten Limestone; while the beds of the creeks usually cut into the latter. In Pontotoc county, the western line of the Rotten Limestone region is generally pretty distinctly marked by the steep slope of the Pontotoc Ridge, on whose summit the strata of the Ripley group appear. Thus, on the road from Tardyville to Ellistown, a mile W. of the latter place; on the Redland and Camargo road, immediately W. of the crossing of the E. fork of Tallabinela Creek; on the Okalona and Coffeeville road, at the crossing of Chuckatonche Creek. W. of the points mentioned, the country becomes hilly, dark tinted Orange Sand sets in, and bald hilltops on which the material is sandy, with fossils of the Ripley group, are seen.

122. The Pontotoc Ridge terminates, or at least, loses its peculiar character between the Houlka and Chuckatonche, N. E. of Houston. At Houston, and E. and S. E. of the same, the cretaceous material struck in the wells is lithologically intermediate between the micaceous Owl Creek (Ripley Group) marl and the Rotten Limestone, and its fossils likewise indicate an intermediate position; for while the leading shells of both groups appear to be wanting, it does contain some of the fossils of each. At Houston, immediately on the edge of the Flatwoods, this stratum (as ascertained in wells) is about 100 feet in thickness, being underlaid by water-bearing sand. At Sparta, S. E. of Houston, the same stratum is struck in shallow wells, and cisterns, but in deep wells no water is found at any depth less than 300, and S. of Sparta, 1000 feet is no uncommon depth. Sparta is probably on the eastern edge of the transition stratum in question, for eastward of the place (around which, as at Houston, the country

is but slightly undulating) there is a gradual ascent; we first strike several small Orange Sand ridges, then ascend a high one, on which Clear Spring P. O., (Dr. Kilgore's) is situated, and which divides the waters of the Houlka and Chuckatonche from those of the Tibby.—The general section of the cretaceous formation in this latitude (Fig. 2 of Tab. I.) will convey a better idea of the general structure of the country, than could be given in words. It was necessary, of course, to exaggerate the dips and elevations in this profile; hence the prairies, which to the eye seem level, here appear as a slope.

123. The western slope of Kilgore's ridge is thickly covered with Orange Sand, so that wells 70 to 80 feet deep are dug in the same, yielding freestone water. But as we approach the eastern slope, we observe on the hillsides a terrace gradually ascending, on top of which the Orange Sand appears thinner and finally disappears on the crest, on which, as well as on the eastern slope itself, to its foot, large patches of bald prairie, strewn with *Exogyra* and *Gryphaeae*, *Ostrea falcata* and *Placuna scabra*, are of constant occurrence; they are frequently destitute of any soil whatsoever, appearing at a distance like fields of snow.—This ridge preserves its S. E. and N. W. course, terminating at the S., where the Chuckatonche and Tibby meet; northwestward from Kilgore's, it may be traced up to Houston, skirting on the W. a gently undulating tract of oak uplands. Cretaceous outcrops are abundant on its crest and eastern slope up to where Reed Creek breaks through it, in the N. E. corner of T. 15, R. 3 E.; beyond, few are to be seen—the ridge becomes lower, and terminates in the Flatwoods N. W. of Houston.—On the eastern summit of this ridge, a well has been bored by Mr. William T. Dexter, S. 16, T. 15, R. 4 E., in which at about 500 feet he passed through the Rotten Limestone into ledges of hard rock alternating with water-bearing beds of loose micaceous sand with shells—probably of the Tombigbee Sand group. Similar beds continued up to 650 feet, several streams of water being struck, but without raising the water higher than 150 feet from the surface. When last heard of, the well remained at the above depth, but will, it is to be hoped, be further pursued, since according to the wells at Aberdeen, water would probably rise to within available distance of the surface, whenever the beds corresponding to those which supply the Aberdeen wells should be reached, at 800 to 850 feet. This well is of some interest, as from its location on the highest point of the outcropping stratum, it is likely to afford reliable data in relation to its total thickness.

124. The prairies on the eastern slope of this ridge form part of the western branch of the prairie belt which, beginning in S. E. Pontotoc, as above mentioned, extends its main body, (with scolloped edges, and an average width of about five miles) to the southward, between the Chuckatonche and Tombigbee—between whose waters it forms a dividing plateau—to Tibby Creek. The surface of the prairie has a gradual ascent towards the east, as may be perceived in the high hills and bluffs which skirt the Tombigbee on the W. side, and whose, highest points, generally speaking, are nearly on a level with the surface of the prairie. The western branch, (or rather perhaps succession of patches), which leaves the main body below Okalona, after crossing the Chuckatonche and

Houlka, rejoins the main body on the Oka Tibby, below Palo Alto, on the Mayhew Prairie. South of the latter creek, the prairies, are distributed rather irregularly over the surface of the cretaceous territory, yet on the whole retain their character of dividing plateaux, between the Noxubee and Tombigbee, and the several confluents of these streams. They are largely interspersed with gently undulating uplands, whose soil is generally greatly inferior in native fertility to the prairie, and of a totally different character. It is on the outskirts, in these wooded portions, and on the streams, not in the prairie proper, that the Rotten Limestone most frequently crops out, forming "bald prairie spots." In all the larger bodies of prairie, the rock is covered with a stratum of heavy, pale yellow clay containing small round ferruginous concretions ; on whose surface, by the addition of vegetable matter, the black prairie soil is formed, to the depth of 12 to 18 inches. The thickness of this clay stratum varies greatly —from 2 to 10, on the average about 5 to 7 feet.

125. That under these circumstances, both springs and sipe-wells cannot, as a general thing, exist in the prairies, may be readily imagined. The streams, while flooded during the rainy season and in fact, at every heavy rain, are dry during the greater portion of the year, unless indeed, like the Houlka, Tibby and Noxubee, their supply derives from beyond the prairie region. Hence the vast importance which the boring of deep, and partly artesian, wells has acquired in this region. Where these have not been obtained, cisterns are in general use, which are excavated into the Rotten Limestone, without any cement being required to make them hold water ; for the rock is sufficiently impervious for all practical purposes.

126. Fossils of the Rotten Limestone.—The larger streams, as may be supposed, have mostly excavated their channels into the Rotten Limestone, which appears at every turn, in localities too numerous to be mentioned, not only on the immediate banks, but frequently also on bluffs at some distance from the channels, whose summits are on a level with the prairie. The Noxubee River at Macon flows in a deep channel in the Rotten Limestone; the Houlka, Chuckatonche, Tibby, Scooba, and others, exhibit the same phenomena with frequency, and one outcrop is very nearly a copy of every other.

The shells most commonly found have been mentioned above (¶116), besides which, *Gryphaea vomer*, *Ostrea plumosa*, *O. cretacea*, *Anomia argentea*, *Plicatula urticosa*, a *Lima* (resembling *Ctenoides acutilineata* Con.) and two species of *Pecten*, flat, and finely ruled ; together with shark's teeth, are among the more common.

In Noxubee and Kemper, however, there is one stratum peculiarly rich in fossils, and containing them chiefly as nuclei much harder than the mass of the rock and therefore in the best condition to be washed out, unharmed, by rains and streams. The mass of this stratum is rather more clayey, and softer, than is usually the case—as may be perceived at an extensive exposure on a hill-side E. of Wahalak Creek, where a stratum of gray calcareous clay, about 15 feet thick, is over and underlaid by the common Rotten Limestone. This clay stratum contains a fauna rather different from that usually found in the latter, approaching somewhat, in character, to those of the gray clay overlying the limestone of the Ripley Group(¶137); and the same as collected by L. Harper and myself, in 1855, on the bald prairies S. W. of Macon. It is characterized by the comparative scarcity of the usual oysters, (except *Ostrea falcata* which is very abundant), the absence of *Janira 5-costata* and the presence of numerous univalves. *Natica petrosa*, *Natica* sp., *Pyrula trochiformis*, *P. Richardsoni*, and several other species of *Pyrula* and *Fusus*, *Pterocera* sp., several *Rostellariae*, *Voluta cancellaria*, *Cerithium nodosum*, *Scalaria Sillimanni*, *Actaeon* (*Bullopsis?*) 2 sp. This great prevalence of univalves is very unusual, as is that of the bivalves whose nuclei are abundant here, viz: *Crassatella*, 2 sp., *Cucullaea vulgaris*, *C. ungula*, *Nucula*, 2 sp., *Cardium* sp., *Lucina* sp., *Solen*, *Tellina*, *Astarte?* sp., *Clavagellideae*, *Hamulus Onyx*; and others. Besides the shells already mentioned, *Placuna scabra*, *Plicatula urticosa?*, *Anomia* sp., *Ostrea pleumosa*, *cretacea?*, and two other small undetermined sp.; *Gryphaea convexa*, *Pitcheri*, *Exogyra costata*, *Ichtyosarculites cornutus*, *I. loricatus*, *I. quadrangularis*, *Nautilus Dekayi*, *Hamites torquatus*, *Turbinolia* sp., teeth and vertebræ of *Mosasaurus*, teeth of *Otodus appendiculatus*, *Corax appendiculatus* and *Carcharias*, were found here.

The abundance and variety of fossils occurring in this locality, and no less the great prevalence of univalves, are very unusual in the Rotten Limestone of Mississippi. Unfortunately, with the exception of the oysters, little more than the interior cast of the fossils is usually preserved in this stratum, rendering identification difficult. In Alabama, according to Tuomey, this group of fossils is rather more commonly found. In the collection of the Alabama Survey at Tuscaloosa, there are several nuclei from the Rotten Limestone, of a *Cardium* closely resembling, if not identical with, *Cardium Spillmani*, Con. It is observable at first sight, that the facies of the fauna of this stratum approaches very closely to that of the uppermost clay stratum of the Ripley Group (¶133, 137); although a close examination may demonstrate the species to be *representative* only, and not identical.

127. The Radiolites (*R. Aimesii* and *undulatus*), though a very striking palæontological feature, are by no means common, and being a conspicuous fossil, those specimens which had been washed out of the rock on the bald prairies, early found their way to cabinets and private mantels—which is the only source from which I have as yet obtained them. The Ichtyosarculites likewise, are rare.

Very perfect impressions of fish have been found in several localities, mostly in digging cisterns; as at Camargo, Palo Alto, and Okalona. I have never been so fortunate as to obtain even a fragment of one.

Irregular, rounded nodules of iron pyrites, of a radiated structure, called "Sulphur Balls," are common throughout the Rotten Limestone, and sometimes cause considerable difficulty in boring wells, on account of their hardness, and tendency to divert the auger from the vertical.

IV. THE RIPLEY GROUP.

128. The surface of the territory occupied by this, the uppermost stage of the Cretaceous in Mississippi, is generally hilly, and to a great extent, thickly covered with the strata of the Orange Sand, which have filled up the gaps occasioned by fracture or denudation in the ridges formed by the upheaved strata of the group. Small prairie spots are met with in many localities, but usually on or around isolated hilltops or ridges, where some soft calcareous stratum has approached the surface. On these "bald prairie hill-tops," we often find in abundance the *Exogyra costata* and *Gryphaea mutabilis* (*G. convexa* is less common), but associated with them are always *nuclei*, at least, of fossils characteristic of this group.

There are two materials especially, which in their various modifications, compose the strata of this group, viz: hard crystalline limestone, more or less sandy and glauconitic, which forms the highest strata; and bluish micaceous marls, more or less sandy, and often interstratified with subordinate ledges of sandy limestone, which latter become less and less frequent as we descend in the series towards the strata forming a palæontological as well as lithological transition into the Rotten Limestone.

In the uppermost, hard varieties of the limestone, the substance of the shell of fossils is generally replaced by crystallized, transparent calcareous spar, which often forms specimens of great beauty and perfection. Lower down, we often find hard nuclei, while the substance of the shell is soft and friable crystalline matter, or at times, is altogether wanting, so as to leave the nucleus either loose, or fixed at some point, standing free within the hollow space. In the marls, on the contrary, the preservation of the substance of the shells is very perfect, since it has not been replaced by any extraneous matter, but simply rendered friable by the decay of the animal glue. It generally exhibits, therefore, not only the finest details of structure, both external and internal, but even the iridescence of the mother-of-pearl is often beautifully preserved, so that the observer at first finds it difficult to convince himself that the beds before him have not, at a comparatively recent period, formed the sea-beach.*

129. In entering upon the territory of this formation from the west side (on which, in S. Tippah, Pontotoc, and N. Chickasaw, it is bordered by the flatwoods), there is a very striking change in the aspect of the country, which suddenly becomes hilly and broken the hillsides coming down steeply into the valleys, and exhibiting outcrops of hard limestone, while the surface is covered with deep-tinted Orange Sand.

Springs become abundant, and the growth of vigorous Black and Spanish ("*Red*") Oak and Hickory, intermixed with lime-loving trees like the Poplar (*Liriodendron*), Walnut, Butternut, Linn Umbrella Tree (*Magnolia auriculata*) and Locust on the hills, and of the Sycamore, Honey Locust, Wild Plum and Red Bud in the valleys, indicates the change of soil. In some portions of Pontotoc county, there is a pretty regular rise as we advance eastward from the flatwoods, the limestone strata, which at first were at the foot, gradually ascending to the top of the hills of the Pontotoc Ridge, until a sudden descent brings us down to the level territory of the Rotten Limestone, at the E. foot of the ridge. Such is the case on the road from Rocky Ford *via* Tardyville to Ellistown, and on the Tocapola and Camargo road *via* Redland. The outcropping ledges of rock there form the crest of the ridge, which runs parallel to the strike of the stratum.

130. The geological structure is not, however, always as simple as in the case just mentioned. Commonly, the rock strata fall far short of reaching the eastern summit of the ridge; and the hills, lower, and less distinctly co-ordinated

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*See also T. A. Conrad "*On a group of cretaceous fossil shells, found in Tippah county, Miss., with descriptions of fifty-six new species.*" Jour. Acad. Nat. Sc. Phila., n. s., Vol. 3, ¶323, ff.—Some of the fossils of the crystalline limestone were observed by L. Harper at Ripley, in 1855, but were by him accounted tertiary. Others were collected previously by Prof Wailes, on the bald hilltops of Pontotoc. In spring 1856, I explored the territory, and collected the fossils of the Ripley Group from the town of Pontotoc to the Tennessee line, and in autumn of the same year, its southern portion, from Pontotoc to Houston. Upon my information regarding these localities, Dr. William Spillman, of Columbus (whose splendid collection of fossils from the lower stages of the Cretaceous has already been mentioned), visited the Owl Creek locality in November 1856, and brought back a fine collection of its fossils; which he subsequently submitted to Mr. Conrad for description, there being then no prospect of anything being done with the collections of the Geological Survey. Great credit is due to Dr. S. for the energy and enthusiasm with which he has for years persued, during all his leisure hours, the study of the cretaceous formation of Mississippi. With the exception of a single locality (Kindrick's mill, visited by me in spring 1858), all the observations recorded here concerning this formation, are derived from my field notes of spring and autumn 1856.

into a ridge, are formed by the marl strata underlying the rock, capped usually by the Orange Sand. Such is the case in Tippah, in middle Pontotoc, and in Chickasaw county, N. E. of Houston. The Pontotoc Ridge is therefore, in fact, rather a belt of ridgy land, which is in several instances (Chiwapa, Chuckatonche) *traversed* by streams, though more commonly, it forms a "*divide*," between the waters of the Tombigbee and Hatchie on one side, and those of the Tallahatchie, Loosha-Scoona and Yallabusha on the other.

Interstratified with the blue marls, and in some instances replacing them entirely, we find strata consisting of sandy limestone of various degrees of induration within its own mass, so that the action of water wears it into fanciful, often perforated forms, which have obtained for it from the inhabitants the names of "bored limestone" and "horse-bone limestone." It abounds in fossils, which are, however, generally preserved as nuclei only.

131. *Localities of the Ripley Group.*—The most northerly outcrop which I know to exist, occurs near Jonesboro, on S. 11, T. 2, R. 4 E., Tippah county. Here we find outcropping on the sides of a small valley, a ledge 12 to 15 inches thick, of hard crystalline limestone, somewhat sandy, with grains of greensand interspersed. Its weathered surface is covered with projecting fragments of shells, chiefly of a large *Turritella* (allied to *T. Bauga* D'Orb., and different from *T. Tippana* Con. of Owl Creek), of *Gryphaea vomer*, a large *Venericardia* with flat radial costæ, and claws of a *Callianassa*. This rock is so hard that it has been used for millstones ; a fine chalybeate spring issues from beneath the ledge. A soft ferruginous variety of it, into which it shows occasional transitions, is said to crop out on Muddy Creek, due W. of the locality mentioned, while half a mile E. of it, the soft shell marl was found in wells.

At Mr. Wilhites, S. 27, T. 2, R. 4 E., a well was dug on a hill, at the foot of which the blue Owl Creek marl, with numerous fossils, crops out. The section thus obtained is as follows :

(Sec. 11.)

SECTION OF STRATA IN WILHITE'S WELL, TIPPAH COUNTY.

	FEET.	CHARACTER OF STRATA.	NO.
. . . . .	18	Clay and Orange Sand.	5
† †	18	Dark colored micaceous marl with Owl Creek fossils.	4
| | |	3	Bored limestone with shells; *Turritella* and *Baculites.*	3
o O o	3	Gravel and sand, with lumps of hard blue limestone.	2
. .	33	Coarse siliceous sand, loosely cemented by lime, with disintegrated shells.	1

The *Turritella* in No. 3, is the same as that in the limestone near Jonesboro'.

At Ruckersville, the effervescent shell marl is found in the wells.

At Kindrick's old mill, on Muddy Creek, S. 9, T. 3, R. 4 E., we obtain the following section:

(No. 12.)

SECTION AT KINDRICK'S MILL, TIPPAH COUNTY.

	FEET.	INCHES	CHARACTER OF STRATA.	NO.
. . . . .	25		Yellow Sand, ill stratified. Orange Sand; or lignitic?	4
— — —	1	6	Turritella limestone, with *Gryphaea romer*, *Ostrea crenulata? Callianassa, Baculites, Otodus appendiculatus.*	3
. .	2		Coarse glauconitic sand with disintegrated shells. No. 3 of Sec. 13.	2
† †	20		Dark micaceous marl with Owl Creek fossils, among which *Scaphites Conradi, Baculites Tippaensis, Crassatella Ripleyana, Nucula percrassa Dosinia densata, Ctenoides acutilineata, Meretrix Tippana, Legumen ellipticus, Siliquaria biplicata;* numerous univalves.	1

Stratum No. 3 contains, besides the large *Turritella* already mentioned, a smaller species with two acute revolving costæ, found also at Ripley, and on King's Creek.

From this S. to Ripley, the Owl Creek marl is frequently found outcropping in the branches tributary to the Hatchie, and in most wells. At Braddock's, S. 21, T. 3, R. 4 E., on Walnut Creek, the marl crops out without the overlying limestone; its thickness, as ascertained in wells, close at hand, is 18 feet—it is underlaid by yellow, water-bearing sand.

132. In the neighborhood of Ripley, there are numerous outcrops; the wells, also, have rendered the formation more accessible to study than is the case elsewhere. The general features of the outcrops may best be studied at an exposure in the S. portion of the town, at a bluff on the S. side of Tippah Creek, where we obtain the following section:

(Sec. 13.)

SECTION ON TIPPAH CREEK AT RIPLEY, TIPPAH COUNTY.

FEET.	INCHES.	CHARACTER OF STRATA.	NO.
25		Concretionary ("bored") Lim estone, with hard and soft ledges alternating; containing (sparingly) *Exogyra costata*, and numerous other, imperfectly preserved shells, mostly nuclei; throughout, in great abundance, a *Ceriopora*, which in the lowest, hardest ledges is associated with *Turritellae* and *Gryphaea vomer*.	4
1		Coarse glauconitic sand with disintegrated shells.	3
	3	Seam of yellow, non-fossiliferous sand,	2
3		Micaceous marl (Owl Creek) with *Baculites*, *Legumen* and *Siliquaria*.	1

Stratum No. 4 of this section is extremely variable, being frequently represented by a soft yellowish-white, calcareous sand, often associated with a soft yellow limestone, teeming with corals (*Ceriopora*) and containing casts of shells with loose nuclei (¶128). It may be studied to advantage in several outcrops E. of Ripley, among others, at the bluff above the crossing of Owl Creek on the Ripley and Jacinto road. In several of these, as well as in others S. of Ripley on the Pontotoc road, it may be seen overlaid by a black micaceous material, more or less clayey, and containing a few poorly preserved shells.

The locality on Owl Creek, 3 miles N. E. of Ripley, on S. 7, T. 4, R. 4, (first visited by me in May 1856) where Dr. Spillman's fossils were obtained, forms part of the bluff mentioned above, which contains on the west side of Owl Creek for several miles: at the point mentioned it affords the following section:

(Sec. 14.)

SECTION OF OWL CREEK BLUFF, NEAR RIPLEY.

FEET.	CHARACTER OF STRATA.	NO.
25	Concretionary limestone, with *Exogyra costata*, *Ceriopora* and *Turritella*. Same as No. 4 of preceding section, and No. 3 of Sec. 12.	2
20	Dark, bluish, micaceous marl, more or less clayey in its different portions, containing numerous fossils, whose shells retain their natural iridescence.	1

The uppermost 2 feet of the lower stratum, is particularly rich in bivalves. mainly *Nucula percrassa*, *Crassatella Ripleyana*, *Meretrix Tippana* and *Dosinia densata*, which frequently occur with both valves still in juxtaposition. Lower down *Baculites* are very abundant; they sometimes form beds 6 to 8 inches in thickness and several yards in length, which when broken up, exhibit a dazzling play of intense rain-bow tints.

Most of the fossils mentioned in the catalogue given below (excepting those marked with an asterisk) occur in this locality and are in the collection of the Survey; many of them being thus far undetermined. Outcrops corresponding to different portions of the sections just given, occur W. of Ripley for 2½ miles, when (on S. 28, T. 4, R. 3 E.), the soft yellow limestone disappears under the gray clays of the Lignitic, which also overlie it in the northern portion of the town of Ripley. The entire thickness of the calcareous strata overlying the waterbearing sands, as ascertained in wells, is about 60 feet.

133. In S. Tippah, the same strata crop out on all the tributaries of the Tallahatchie, E. of the line given on the map. One outcrop of the blue marl, at Col. Berry's, S. 4. T. 6, R. 1 E., is peculiarly rich in univalves, comprising many species not found on Owl Creek. The most common are *Turritella Tippana* and *Athleta leioderma*; a large, beautifully sculptured species of *Pyrula*, and *Tudicla perlata* also occur.

On S. 23, T. 5, R. 4 E., at a church near Mr. Stubbs' place, there is an isolated cretaceous hill, surrounded on all sides by deep Orange Sand wells. At this spot, in a ravine, the following section obtains:

(Sec. 15.)

SECTION OF AN ISOLATED CRETACEOUS HILL NEAR THE MEETING-HOUSE ON S. 23, T. 5, R. E., TIPPAH COUNTY.

	FEET.	INCHES	CHARACTER OF STRATA.	NO.
	20		Yellowish-gray, calcareous clay, with veins of lime, and containing *Exogyra costata.*	5
	20		"Bored Limestone," with *Ammonites placenta, Cucullaea capax, C. Maconensis, Trigonia.*	4
		10	Coarse glauconitic sand, with disintegrated shells.	3
	2		Black laminated clay, with veins of the above sand.	2
	12		Soft ferruginous limestone, similar to that found E. of Ripley.	1

Here, as in Pontotoc and Chickasaw, gray calcareous clay takes the place of the black micaceous sand which usually overlies the limestone in Tippah (¶123)

134. While in Pontotoc county, as has been mentioned, the rocks of the Ripley Group reach the western border of the Rotten Limestone, the same is not the case in Tippah, except in the extreme S. E., on the Pontotoc line. Two fossiliferous outcrops only are known to me, on the E. fork of Hatchie; and it is doubtful whether these do not assimilate more closely to the Rotten Limestone than to the Ripley Group. In N. Tippah, the calcareous strata occupy only a a narrow belt (3 to 4 miles), W. of the line between ranges 4 and 5, E., while on the W. fork, and main Hatchie below the junction, a black, fetid lignitic clay interstratified with gray and greenish sand, forms the bluffs; and also the base of the hills, which are very high and thickly capped with Orange Sand, and largely timbered with pine, which is wanting on the territory of the calcareous strata.—Outcrops of this black clay, interstratified with sand, and greatly resembling, at times, the materials of the Eutaw Group, appear on the main Hatchie in S. 5, T. 2, R. 5 E., and in other localities lower down; on S 31, T. 2, R. 5 E., near Walker's mill; on a branch of Hatchie on S. 16, T. 5, R. 5 E., and other points in this region, where it is very generally struck in wells. These prove, however, that its surface also has suffered great denudation before the deposition of the Orange Sand, for frequently, wells 70 to 80 feet deep do not reach the black clay, when on adjoining farms, at the same level, it is near the surface.

Near a bridge on E. Hatchie, in N. E. ¼, T. 3, R. 5 E., there is an outcrop exhibiting a black, very micaceous, sandy clay, non-effervescent, and with indistinct impressions of fossils. Nevertheless, Turritella Tippana was recognized, also a Nucula, Venericardia, Cytherea ? and Tellina ?—Near Kellum's mill, on E. Hatchie, on a creek, S. 25, T. 3, R. 5 E., there is a bluff in which about 20 feet of cretaceous strata are exposed, the upper portion being blue micaceous marl, containing the Owl Creek fossils, the lower more sandy and containing concretions rich in fossils of a character somewhat different ; among them *Baculites gigas*, and a beautiful *Pterocera* with winged thorns of enormous length as compared with the body of the shell. This lower stratum greatly resembles, in character, that found outcropping on Parmeechee (¶ 118). E. of this locality, in the Dry Creek region, near Jumpertown, shell marls are found in wells, whose palaeontogical character I have not ascertained ; they crop out on the summit of the ridges W. of Blackland (see ¶ 120) and resemble the Owl Creek marl, but are very poor in fossils. They appear to form the transition from the Ripley Group to the Rotten Limestone. The same is probably true of an outcrop on the head of Old Town Creek, at the E. foot of the Pontotoc Ridge, on S. 16, T. 8, R. 4 E.

135. The ridges S. of Wilhite's Creek, in Tippah, in the S. portion of T. 6, R. 4. E., known as "The Buncombes," may be considered as the N. end of the Pontotoc Ridge proper. The general geological character of this ridge has already been described ; from the Tippah line to its termination N. E. of Houston, its hillsides and ravines exhibit numerous outcrops, both of "bored limestone" and of blue marl, generally interstratified with irregular limestone ledges, and containing the leading fossils of the Owl Creek marl, with many local variations and additions. While in some localities the uppermost limestone retains the great hardness of the Turritella limestone of Tippah (as on Labatubby, S. 36, T. 8 R. 2, where it appears in a solid ledge about 30 feet in thickness, and Mr. Daggett's, S. 32, T. 10, R. 36—both on the edge of the Flatwoods), at others it appears as a yellowish white, sandy, soft calcareous mass, which very frequently forms the bald prairie hilltops of the Ridge. Characteristic outcrops of this material may be seen at the mouth, and in numerous spots along the bluff of King's Creek, and of Okonatyhatchie ; as also near Redland, overlying the bored limestone, into which it shows frequent transitions, by partial induration within its mass.

136. Where soft strata intervene between beds of rock comparatively solid, the soft stratum is sometimes washed away, so as to form caves, etc. Thus, on S. 25, T. 7, R. 2 E., a branch of King's Creek flows out of a cave between two beds of sandy limestone, and is spanned, 15 yards from the mouth of the cave, by a natural bridge 18 feet long, and about 5 above the level of the branch ; it is 14 feet wide at one end, 5 at the other, and the ledge 2 to 2½ feet thick. The cave at its mouth is about 9 feet wide by 6 high, but rapidly contracts, so as to become little more than a channel for the water ; then again it expands into a long chamber of about the dimensions at the mouth, whose roof is covered with short stalactites. Subsequently it contracts again, forks, and cannot be followed up for more than about 120 yards, winding about, but generally in a S.S. W. direction. About 70 yards S. E. from the mouth of the cave, there are several

sink-holes, which lead down into the subterranean channel probably of the same stratum.*

Similarly, on S. 36, T. 6, R. 4 E., near Parson Montgomery's place, there is a natural tunnel, about 25 yards long by 4 to 5 feet high and 3 to 7 yards wide; under a ridge. Several small caves and sink-holes exist in the neighborhood. Near the tunnel there is a fine outcrop of blue marl interstratified with indurate ledges; among the fossils found here is *Trigonia thoracica*; an *Ostrea* resembling *O. falcata* in shape, but 6 inches long; *Ammonites placenta*, and nuclei of a very large *Cucullaea* (*C. Maconensis*, CON ?).

137. Phenomena similar to these, and those already mentioned as occurring in Tippah county, on the territory of this formation, characterize, more or less, the whole of the Pontotoc Ridge, save where (as for instance, in a large portion of T. 9, R. 3 E., and also of T. 11, R. 4 E.) the Orange Sand overlies so thickly as to allow of traces only of the cretaceous formation being observed, in the deep hollows, and in springs with limy water at the foot of the ridges—there being also, freestone wells 40 to 50 feet deep. The bored limestone which crops out on the hillsides E. of Redland, in S. Pontotoc, and that seen E. of Houlka P. O., in N. Chickasaw (*e. g.* on SS. 4 and 35, T. 12, R. 3 E.) is undistinguishable in all respects from that of S. Tippah. The face of the country, timber, etc., is also strikingly similar, the chief differences being caused by the more frequent recurrence of bald hilltops, exhibiting the white calcareous sand mentioned above (¶135), and of ridges characterized by an excessively heavy soil bearing the Black Jack Oak, and popularly termed "beeswax hommocks." These hilltops are usually caused by the gray calcareous clay which, as has been stated, frequently overlies the limestone (as well as, of course, its representative, the whitish calcareous sand) in Pontotoc and Chickasaw; and on them we generally find strewn about, numerous dark colored, hard, smooth nuclei of shells of the Ripley group, together with white concretions of carbonate of lime. The position of the gray clay stratum (also found near Stubbs'; ¶133, No. 5 of Sec. 15) may be observed *e. g.* at an outcrop about a mile S. of the town of Pontotoc, on the Houston road, where a stratum of about 3 feet of this clay, teeming with black nuclei, overlies an outcrop of the "horsebone limestone" filled with *Exogyra costata* and *Gryphaea mutabilis*. The same material is seen on S. 34, T. 12, R. 3 E., Chickasaw county; it is here overlaid by a thin sheet of soft gray laminated limestone, and is poor in fossils.

138. *Ammonites placenta*, about a foot in diameter, together with a *Cassidulus* (?) is very common in some portions of the Ridge, where hard limestone crops out; as on the heads of Okonatyhatchie, and of King's Creek. On the S. bluff of the latter stratum, there are fine localities for fossils; as at the place of John Herring, Esq., S. 17, T. 8, R. 2 E., and a few miles above, on S. 29, T. 7, R. 3 E. In both these localities, most of the fossils of the Owl Creek marl are found, imbedded in a loose, peroxidized glauconitic limestone; the claws of *Callianassa*,

*Close to this spot was the residence of the king of the Chickasaws, whence it is known as "The Kings Place."

a *Pectunculus*, several *Rostellariae*, and numerous minute univalves being superadded—many in a very fine state of preservation. The bald hilltops of Chickasaw, as well as, for instance, an outcrop of gray sandy marl on Cherry Creek, near the P. O. of that name, furnish abundance of two small species of *Hemiaster* (about ¾ of an inch in diameter), which I have not thus far observed in Tippah county, in whose marls and limestone Radiata are very rare. They occur, however, associated with *Baculites Tippaensis*, *Crassatella Tippana*, and other unquestionable Owl Ceek fossils.

139. Fossils of the Ripley Group.—I give below a list of the fossils thus far collected by myself from the strata of the Ripley Group in Tippah, Pontotoc and Chickasaw, naming, generically, as far as the limited time at disposal allowed of their determination, those which could not be identified with species heretofore described. (See ¶128; note.)

I have to regret that at the time of preparing this list, in which I have been kindly aided by Prof. W. D. Moore, the latest publication of Mr. Conrad on this subject (Jour. Acad. Nat. Sc. Phila., Vol. IV, n. s., pp. 275–291) had not come to my hands; for which reason, a part only of the new species there described by him (which have since been identified by Prof. Moore) will be found in this catalogue, although no doubt, several more of the undetermined species are described in the paper referred to. I shall, therefore, mention separately the species named by Mr. Conrad, found in Tippah county by Dr. Spillman, but not thus far identified with specimens in the collection of the Survey.—Species marked with an asterisk (*) have thus far been found only in the uppermost crystalline limestone.

I subjoin also the interesting comparative list of the fossils of Tippah, New Jersey and Eufaula, Alabama, (prepared by Mr. Conrad, assisted by Mr. Wm. M. Gabb), given in the place above referred to; to which I would add that in 1856, I identified at least ⅔ of a collection, made by Tuomey, of fossils from the crystalline limestones and blue marls of Chunnenugga Ridge, Macon county, Alabama, with species previously found by myself on the territory of the Ripley Group in Mississippi. It thus appears that the beautiful and singular fauna represented by this group, is much more widely diffused than was at first supposed, and is well connected by transitions with other stages of the Cretaceous. The unusually large *proportion* of univalves as compared with bivalves, no less than many of the *forms* of both classes of Mollusca, are strongly suggestive of the approach of the Tertiary epoch, to whose strata as developed in Mississippi, those of the Ripley Group bear an extraordinary lithological resemblance. The very perfect state of preservation of the fossils, also, is somewhat startling at first sight, and instinctively recalls to mind the beds of the Tertiary.

CEPHALOPODA.

Ammonites placenta, Mort.
Ammonites syrtalis, Mort. ?
Scaphites Conradi, Mort.
Scaphites Iris, Con

Turrilites spinifera, Con.
Nautilus Dekayi.
Baculites gigas, Con.
Baculites Spillmani, Con.
Baculites Tippaensis, Con.
Baculites, 3 sp. undet.
Nautilus circulus, Thom.

BIVALVES.

Teredo sp.
Teredina sp.
Pholas, 2 sp.
Pholadomya anteradiata, Con.
Pholadomya sp., allied to *Ph. elegantu*, Munst.
Pholadomya sp., allied to *Ph. Marroti-ana*, D'Orb.
Pholadomya Tippana, Con.
Anatina? sp.
Trigonia thoracica, Mort.
Trigonia sp., allied to *thoracica*, smaller.
**Trigonia* sp., very large; Chunnenugga Ridge.
Trigonia sp.
Legumen ellipticus, Con.
Legumen depressus, Con.
Siliquaria biplicata, Con.
Periploma applicata, Con.
Tellina, 2 sp.
Psammobia? nucleus. 6 in's. long by 4 high.
Papyridea bella, Con.
Meretrix Tippana, Con.
Dosinia densata, Con.
Dosinia depressa, Con.
**Venericardia*, 2 sp.
**Cyprina?* sp.
Isocardia sp., allied to I. cretacea.
Venilla Conradi, Mort.
Cardium Tippanum, Con.
Cardium Spillmani, Con.
Cardium Eufaulense, Con.
Cardium Tippanum var?
Cardium sp., all. to *C. Hillanum*, Sow.
Crassatella Ripleyana, Con.
Crassatella lintea, Con.
Crassatella pteropsis, Con.
Cibota lintea, Con.
Cucullaea vulgaris, Mort.
Cucullaea ungula, Mort.?
Cucullaea Tippana, Con.
Cucullaea capax, Con.
Cucullaea Maconensis, Con.
Arca sp., allied to *A. angusta*, Lam.
**Arca* sp.
**Axinaea* sp., 2 ins. long.
Axinaea 2 sp.
Nucula percrassa, Con.
Nucula peraequalis, Con.
Nucula cuneifornis, Con.
Pulvinites argentea, Con.
Gervillia ensiformis, Con.
Dreissena Tippana, Con.
Inoceramus argenteus, Con.
Inoceramus costellatus, Con.
Inoceramus sp., allied to *S. Goldfussianus*.
Inoceramus sp.—a very large hinge.
Inoceramus sp.
Pecten striatopunctatus Roem.?
Pecten simplicius, Con.
Ctenoides acutilineata, Con.
Placunanomia sp.
Anomia sellaeformis, Con.
Ostrea peculiaris, Con.
Ostrea confragosa, Con.
Ostrea denticulifera, Con.
Ostrea crenulata, Thom.
Ostrea n. sp., shape of *O. falcata*, 6 in's. long.
Gryphaea mutabilis, Mort.
Gryphaea convexa?
Gryphaea vomer.
Exogyra costata.
Exogyra interrupta.

UNIVALVES.

**Dentalium* sp. (smooth.)
Dentalium sp., deeply 6 ribbed.
**Natica alveata*, Con.
Natica rectilabrum.
**Natica* sp.
Natica 2 sp.
Nerita sp., May be *N. densata* Con., but is smaller than the figure. Purplish dots on the surface perfectly preserved!
Solidulus linteus, Con.
Bullopsis cretacea, Con.
Globiconcha sp.
Turbinopis Hilgardi, Con.
Cytherina Tippana, Con.
Conus (?) *canalis*, Con. (Conrad's figure of this shell resembles very closely imperfect specimens of *Athleta leioderma*, Con.)
Ancilla cretacensis, Con.

Cerithium sp., allied to *C. Dupinianum*, D'Orb.
Cerithium sp.
Turbo ? sp.
Rapa supraplicata, Con.
Turritella Tippana Con.; numerous varieties.
Turritella vertebroides, Mort.
Turritella trilira, Con.
Turritella altilis, Con.
Turritella sp., with two acute revolving costae.
Turritella sp., allied to *T. Bauga*, D'Orb.; shell of the "Turritella Limestone" (¶131, ff.)
Turritella sp., very small, smooth.
Volutilithes Eufaulensis, Con. ?
**Voluta*.
Athleta leioderma, Con.
Athleta ?—A beautiful fusiform shell, 4½ in's. long, with numerous acute revolving costae. Also found on Chunnenugga Ridge, by Tuomey.
Drillia novemcostata, Con.
Chemnitzia interrupta, Con.
Chemnitzia interrupta var. ?
Chemnitzia laqueata, Con.
Chemnitzia distans.
Chemnitzia Melanopsis.
Chemnitzia Spillmani.
Ficus octoliratus, Con.
Ficus novemliratus, Con.
Turris Ripleyana, Con.
Fusus Tippanus, Con.
Fusus bellaliratus, Con.
**Fusus* sp.
Fusus 6 sp.
Strepsidura Ripleyana, Con.
Pyrifusus subdensatus, Con.
Pyrula, 6 sp.
Tudicla perlata, Con.
Rostellaria sp., allied to *R. Reussii*, Gein.
**Rostellaria* allied to *R. velata*, Con., about half as large.
Rostellaria sp.
Strombus densatus, Con.
Aporrhais decemlirata, Con.
Pterocera sp., with long winged thorns (¶134).
Harpago Tippanus, Con.
Pugnellus densatus, Con.
Trichotropis cancellaria, Con.
Purpuroidea Ripleyana, Con.

RADIATA.

Hemiaster, 2 sp.
**Cassidulus* (non Desor) *subquadratus*, [Con.
**Cassidulus ?* (*Echinanthus ?*) sp.
**Cassidulus* Con. (non Desor), shape of *Faujasia apicalis.*

ANNELIDÆ.

Serpula 2 sp.

CORALS.

**Ceriopora* sp.

Numerous undetermined nuclei of univalves and bivalves.

Tippah Fossils described by Conrad, but not identified in the Survey collection:

Actaeon modicellus.
Natica crenata.
Anchura abrupta.
Thylacus cretaceus.
Turbonilla corona.
Plicatula tetrica.
Mysia parilis.
Dosinia obliqxata.
Sanguinolaria cretacea.
Morea cancellaria.
Pholadomya post-sulcata.
Pholadomya papyria.
Pholadomya occidentalis Mort.
Pecten argillensis.
Pecten Mississippiensis.

Species common to the Upper and Lower Cretaceous.

(Conrad & Gabb, Jour. Acad. Nat. Sc. Phila. Vol. IV n. s., p. 275).

Pholadomya occidentalis, Mort.,		Tippah,	New Jersey.	
Dosinia excavata (*Cytherea*), Ib.,		"	"	
Fragilia elegantula (*Cardium*), Roem.,		"	"	Texas
F. protexta, Con.				
Cardium Spillmani, Con.,		"	"	
Trigonia thoracica, Mort.,		"	"	
Pycnodonta vesicularis (*Gryphaea*), Lam.,		"	"	
Gervillia ensiformis, Con.,		"	"	
Exogyra costata, Say,		"	"	
Pinna bicarinata, Math.,	Eufaula,	"	"	
P. laqueata, Con.,				
Axinaea (*Pectunculus*) *australis*, Mort.,		"	"	
Meretrix Tippana, Con.,		"	"	
Ctenoides pelagica (*Lima*), Mort.,		"	"	
Crassatella vadosa, Mort.,	Eufaula,	"	"	
C. lintea, Con.,	"	"	"	
Barbatia uniopsis, Con.,	"	"	"	
Pecten Burlingtonensis ? Gabb,		"	"	
Anomia argentaria, Mort.,		"	"	
Turritella vertebroides, Mort.,	"	"	"	
Ficus octoliratus, Con.,		"	"	
Turbinopsis Hilgardi, Con.,		"	"	
Nautilus Dekayi, Mort.,		"	"	
Baculites carinatus, Mort.,		"	"	
B. Spillmani, Con.,				
Solenoceros annulifer,		"	"	
Hamites annulifer, Mort.,				
Vermetus (*Hamulus*) *onyx*, Mort.,		"	"	

USEFUL MATERIALS OF THE CRETACEOUS FORMATION.

140. These consist essentially of *Marls* or mineral fertilizers *Limestones*, and *Building Stones*. It is probable also that among the materials embraced in the two former classes, some will be found to possess *hydraulic* properties.

Marls.—No material deserving the name of marl, occurs within the *Eutaw Group*.

Tombigbee Sand.—The micaceous sands of this group in some localities are sufficiently calcareous to render its use as a fertilizer profitable, especially as lime is generally very deficient in the soils which it underlies. In Tishomingo county, the materials occurring at Boyer's mill (¶111) and on lower Big Brown's Creek generally, deserve attention and trial; none of them will, however, bear much transportation, nor should they be applied to soils already very sandy. The greenish calcareous sand of Dr. Tindall's bluff, near Aberdeen (¶113), has been used with advantage by that gentleman. Similar deposits occur in many localities along the Tombigbee at and below Aberdeen; at Barton (¶107); and at Plymouth Bluff (¶114).

Of these materials, the only specimen I have as yet analyzed, was taken from the bluff at Waverley, Lowndes county, just under Col. Young's warehouse.—A greenish gray, micaceous, soft, sandy mass, with few fossils, forming steep bluffs.

SAND FROM WAVERLEY BLUFF.

Micaceous Sand	88.702
Potash	0.204
Soda	0.190
Lime	1.351
Magnesia	0.723
Peroxide of Iron, and Alumina	5.598
Phosphoric Acid	0.328
Sulphuric Acid	0.018
Carbonic Acid	0.472
Water	2.308
	99.884

The small amount of nutritive ingredients contained in this mass would not pay for the cost of hauling out, on the large scale, unless it were very conveniently at hand, and the sand were needed as a mechanical manure. The amount of phosphoric acid shown by this analysis is nevertheless as large as is usually found in the marls of Mississippi.

The sand of the Columbus bluff is poorer, probably, than that of Waverley; but in many points (*e. g.* at Plymouth Bluff) the materials are sufficiently rich in lime to deserve the earnest attention of agriculturists. The region has not as yet been examined specially enough in this point of view.

141. *Marls of the Rotten Limestone Group.*—I regret having been unable, as yet, to bestow more special attention on the white and gray clay marls of Tishomingo and adjoining portions of Pontotoc and Itawamba. Those of Breuton's contract (¶118), Parmeechee (¶118), Tishomingo and Yoonaby Creeks, and others of N. E. Pontotoc, appear to assimilate more nearly in their character to the Houston marl than to the Rotten Limestone proper. An analysis of the latter will be given below; that of the marl dug from cisterns at Houston, Chickasaw county—a bluish gray mass, quite hard when dry, but somewhat plastic when wet—gave the following result:

HOUSTON MARL.

Insoluble Matter (micaceous clay)	35.750
Potash	0.681
Soda	0.197
Lime	20.558
Magnesia	1.366
Brown Oxide of Manganese	0.305
Peroxide of Iron	4.190
Alumina	9.475
Iron Pyrites	1.743
Carbonic Acid	16.760
Organic Matter and Water	8.774
	99.799

The iron pyrites contained in this marl (which is otherwise admirably adapted to light soils), renders necessary some caution in its application. It should be allowed to lie exposed to the atmosphere as long as possible (several months at least), in order to effect the decomposition of the minute crystals of pyrites, which results in the formation of gypsum—enhancing the value of the material as a fertilizer, in several respects.—Outcrops of the Houston marl (which extends eastward to Kilgore's Ridge, and probably southward to the Tibby) are scarce, but it is generally not far underground in the district of its occurrence, as is known in each neighborhood where wells have been dug.—A determination in the yellowish-white, micaceous clay marl from Breuton's contract (near Chawalla) on the M. & C. R. R., of the Carbonic Acid, considered as belonging to carbonate of lime, yielded a result corresponding to 21.0 per cent. of the latter substance, or to 11.8 per ct. of pure lime.

142. As for the Rotten Limestone—itself, strictly speaking, a marl, in most cases—it is unnecessary to mention its outcrops, since no one who has his eyes open can fail to find them where they exist. It is to be considered chiefly as a calcareous, stimulant manure; yet, as the analysis shows, it carries with it some nutritive ingredients, which account for its favorable effects even on the whitish, highly calcareous bald prairie soil. In regard to the many important uses which this calcareous material may subserve, the reader is referred to what is said under the head of Lime and Marls, in the General Part of the Agricultural Report.

143. *Marls of the Ripley Group.*—Their distinguishing feature is the visible grains of *greensand*, or glauconite, which they contain, and to which they owe a higher percentage of potash, and (with silica), in a more available condition, than seems to be the case with the clay marls of the Rotten Limestone. This, and the carbonate of lime contained in them, constitutes their chief value, and since the former can be judged of by the eye, and the latter by the strength of its effervescence ("boiling") with strong vinegar,

or muriatic acid ("spirits of salt"), it is not difficult for the planter to obtain an approximate idea of the value as fertilizers, of most of these marls; especially as, in the majority of cases, the greater or less abundance of shells is itself somewhat indicative of the amount of lime in the mass. When fresh and moist, its tint is usually bluish-gray, with white specks (being fragments of shells) and glistening scales of mica ("isinglass"); and when cut, if the mass contains any notable amount of greensand, dark green, or almost black streaks will be visible on the surface, which may be traced back to rounded grains, from the size of a grain of rifle-powder to that of a gumbo seed, with a smooth surface, and generally of a flattened shape. Sometimes, however, the grains are so small as to be perceived only by the aid of a magnifier, or by the general tint of the mass.

In searching for these marls in the region of occurrence indicated on the map (by the bright green tint), it should be recollected that, as has been stated, they generally *underlie* the limestone; and that if they have been struck in wells on the ridges, they are likely to be found at the same level, at no great depth, on the hill-sides.

144. The marl at Wilhite's (¶131) showed the following composition:

WILHITE'S MARL.

Insoluble Sand and Clay	73.410
Potash	0.702
Soda	(detn. lost)
Lime	6.315
Magnesia	0.886
Brown Oxide of Manganese	0.050
Peroxide of Iron	7.055
Alumina	5.888
Phosphoric Acid	0.046
Carbonic Acid, Water and Loss	5.640
	100.000

This marl, while containing a large amount of potash, contains at the same time so much inert matter, that it will not bear transportation to any great distance, inasmuch as a "dressing" will require a quantity greater in proportion as the active ingredients are less. No overdressing with a marl like this will be likely to happen.

This is the only marl of this character which I have thus far analyzed, but judging from appearance, it represents very nearly the marls of the following localities: in Tippah, Kindrick's mill (¶131, Sec. 12), Ruckersville; Braddock's (¶131); Owl Creek (¶132); lowest stratum at Tippah Creek bluff, at Ripley (¶132, Sec. 13); Edick's place, S. of Ripley; blue marls on Ripley and Molino road; at Col. Berry's (¶133), and at Lewis L. Nabors',

S. 22, T. 4, R. 5 E. Some of the marls mentioned are probably more calcareous than the one analyzed, as appears to be more generally the case in Pontotoc county; as for instance, at Parson Montgomery's (¶136); at Mr Wages', on one of the heads of Okonatyhatchie, S. 18, T. 7, R. 4 E; at the old mill on Cherry Creek, near the post-office of that name; on the hill S. of the crossing of Brown's Creek, on the Ellistown and Pontotoc road, and on the E. slope of the ridge on the same road, in T. 8, R. 4 E., (e. g. on S. 21); on the branches near the mill on S. 36, T. 9, R. 4 E., E. of Pontotoc, and probably on many of the heads of the Chiwapa, S. of Pontotoc; at the Baptist church on S. 28, T. 12, R. 3 E., Chickasaw county; etc. While the specimens from these localities appear to contain about the same amount of greensand as the marl from Wilhite's, their stronger effervescence with acids and greater coherence shows them to be richer in lime. Yet as a general thing, these blue marls are not so limy that an overdressing of any moderately clayey soil need be feared with any quantity less than 4-to 600 bushels per acre.

145. In Tippah county, at Ripley, and W. of the same, there occurs another kind of marl, generally richer in greensand grains than that just described, and containing few shells not disintegrated. The stratum is seen in the outcrops of Kindrick's mill (¶131, Sec. 12, stratum No. 2), and on Tippah Creek at Ripley (¶132, Sec. 13, stratum No. 3); it is also found in wells at the latter place, and is well developed in the outcrops just W. of town, and particularly at Mr. Wernor's place, S. 22, T. 4, R. 3 E., where it is very remarkable for the large amount of greensand it contains. An analysis of rather a poor specimen of this marl, from Mr. O. Davis' well, at Ripley, gave the following result:

MARL FROM O. DAVIS' WELL, RIPLEY.

Insoluble Matter (chiefly coarse Sand)	62.441
Potash	0.730
Soda	0.272
Lime	7.952
Magnesia	1.560
Brown Oxide of Manganese	0.160
Peroxide of Iron	11.849
Alumina	5.865
Phosphoric Acid	0.266
Carbonic Acid, Water and Loss	9.905
	100.000

On an average, this kind of marl is undoubtedly superior to Wilhite's, containing as it does, more potash, lime and phosphoric acid. It has already been used with fine effect in the neighborhood of Ripley.—A material very similar to this, is found at the church near Stubbs' (¶133, Sec. 15, stratum No. 3), but its quantity is insufficient for practical purposes. Otherwise, I have not found it at any great distance from Ripley, except to the westward.

146. The white or gray calcareous sand mentioned (¶ 135), may in many cases serve as a marl, when it is not too sandy—it would generally, no doubt, improve greatly the "beeswax hommocks." That found at Tocshish church, and near Redland (¶ 135), is scarcely more sandy than the limestone it overlies. But its character in this respect is so variable, that each one must be left to judge for himself in his particular locality.

The gray calcareous clay which frequently overlies the limestone and calcareous sand in Pontotoc and Chickasaw, (¶ 137), I have not yet examined as to its fertilizing qualities; but judging from the rich growth of timber where it mingles with the sandy ridge soils, it possesses other useful ingredients besides the lime, to render it a serviceable manure. Outcrops of this material are mentioned in the passage just quoted.

147. Limestone.—None is found within the territory either of the Eutaw, or of the Tombigbee Sand Group. The most calcareous rocks of the latter only deserve the name of calcareous sandstones.

Rotten Limestone Group.—In numerous localities, the rock of this group is well suited to the manufacture of lime of good quality, and is so used quite extensively in the prairie region. Notwithstanding its uniformity of aspect, however, there is considerable variation in this rock as regards its suitability for lime-burning. These variations often occur without any striking indication of a change by the stratification, color, or otherwise: and a few directions concerning the selection of this rock for lime-burning, will not, therefore, come amiss.

The *hardest* varieties in one and the same bed are usually the purest (unless they be sandy), and should be selected in preference to the soft.

Those which are chalky, and exhibit the least gloss on cut surfaces are preferable to those showing a smooth shining cut.

Another good distinctive mark is the degree of plasticity which the rock attains when crushed and kneaded up with water. The less it works like clay, and the more like prepared chalk; and the less, in moistening, the clay odor is perceived, the purer is the rock—also, the more vividly it effervesces ("boils") with (one and the same) strong vinegar, muriatic, or sulphuric acid.

147[1] The difficulty in the manufacture of lime from the Rotten Limestone, is not so much caused by the *amount* of foreign (usually clayey) matter it contains, as by the extremely fine state of division in which the carbonate of lime and clay are mixed together, which renders the rock liable to *overburning*, unless great care is had in the management of the fire. Experience must determine in each locality the proper amount of burning to be given; it ought to be *less* in all cases than would be employed in burning pure, hard limestone, and the heat ought to be equalized as much as possible. It is not easy to regulate these circumstances in an ordinary kiln, in which the whole process is interrupted in order to draw the burnt lime. The kilns used ought to be of the "perpetual" kind, where the process is carried on without interruption and, once properly adjusted, goes on evenly, turning out a product always of the same quality. Such, moreover, consume much less fuel than the common ones—an item of importance in the prairies. There can be no doubt that if the kilns were improved, lime of good quality could be made in numerous localities where it is now deemed impracticable, after a trial with the ordinary kiln. In burning lime for agricultural purposes, especially, any other than a perpetual kiln renders the article too expensive.

148. The material of the Rotten Limestone Group in Tishomingo county, is generally too impure for lime-burning; the purest rock found occurs, probably, on the heads of Twenty Mile Creek, W. and S. of Blackland, and on lower Tishomingo Creek, near the Ripley and Carrollville road. The materials found further N. are generally too clayey for quicklime, but some of them will, no doubt, answer for hydraulic cement. Lime has, it is true, been made in several localities on the cretaceous territory in Tishomingo county, but it was from the shells of oysters, (*Exogyra costata*, *Gryphaea convexa* and *mutabilis*), which yield a very strong lime. The supply of these, however, is too small to be of more than very local importance.

I am not aware that any rock sufficiently pure for lime-burning, exists in Itawamba county—none, at least, E. of Old Town Creek. W. of the same, on the prairies and "Chickasaw Old Fields" of Pontotoc, the rock is very similar to that of Monroe.

149. Good lime is made at Camargo, where a ledge of hard rock yields white lime for plastering, while the underlying softer strata furnish common mortar. At Okalona, also, lime is made: an analysis of the rock, taken from a cistern here, gave the following result:

OKALONA ROTTEN LIMESTONE.

Insoluble Matter	10.903
Potash	0.248
Soda	0.320
Lime	45.791
Magnesia	0.877
Peroxide of Iron	1.421
Alumina	1.957
Carbonic Acid	35.725
Water	2.840
	100.082

One cwt. of this rock will therefore yield about 61 lbs. of burnt lime, containing about 15 lbs. of impurities which, while causing it to slake with less energy, must impart to it some hydraulic properties.

It would seem advisable, therefore, not to slake and mix into mortar very large quantities of this lime, at any one time, and to use it, when made, as rapidly as possible. In this manner the hydraulic properties, which would impair the quality of the mortar if prepared in large quantities beforehand, may on the contrary be turned to advantage.

150. *Ripley Group.*—In numerous localities, the limestones overlying the blue marls of this group, are well suited to lime-burning. Here, however, the hardness of the rock is not always a safe criterion as to its purity, since *that* is not unfrequently owing rather to the presence of a large amount of sand firmly cemented by lime, than to the solidity of the calcareous mass itself. While in the Rotten Limestone, as we have seen, the impurities of the rock are in an impalpable condition, finely diffused throughout the mass, the impurities of the rocks of the Ripley Group are generally present in shape of visible and tangible sand-grains, and can therefore be detected and judged of with less difficulty. There is, also, less danger of overburning, than in the case of the Rotten Limestone; and its relative purity may be ascertained conveniently by dissolving a fragment of the rock in vinegar or muriatic acid, which will leave the sand behind.

It has been found that in the neighborhood of Ripley the *soft* varieties of the limestone yield a better lime, than the hard "Turritella Limestone" (owing probably, to the large amount of sand which the latter contains, and which contributes largely to its hardness); notwithstanding that its color is purer than that of the soft rock.

151. In general, the purer varieties of this rock may be looked for chiefly along the *western* edge of the territory of the Ripley Group, where it *overlies* the Owl Creek marl. The ledges *interstratified* with the marl, are rarely sufficiently pure to be suitable for quicklime, although in many cases they would yield a product well adapted for agricultural purposes. These *marlstones* are much richer in the nutritive ingredients of plants, than any of the rocks of the Rotten Limestone Group, and burning renders these ingredients more soluble, and highly effectual. For this reason, the product of burning these impure marlstones, is generally preferable even to the purest lime, for use in agriculture. It is generally not difficult to distinguish the varieties to be preferred in this point of view: they either possess a general greenish tint, or else rounded grains of a dark green color (greensand *proper*, or *glauconite*) may be seen dotting the freshly broken surfaces. A large—perhaps the greater portion of the "bored" or "horsebone limestone" belongs to this class, although not unfrequently, ledges of sufficient purity for quicklime occur in the same.

152. The limestone occurring near Jonesboro', on S. 11, T. 2, R. 4 E., (¶131) contains many greensand grains, but will doubtless answer for quicklime. That at Kindrick's mill (¶131) is best suited, probably, for agricultural purposes. At both the localities mentioned, however, the quantity is small. The rock may probably be found outcropping in numerous ravines descending to Muddy Creek; as near to the W. line of the formation in Tippah generally.

The outcrops E. of Ripley furnish, probably, the best material for quicklime in that neighborhood: that which contains numerous *st ms of corals* seems to be best. Most of the bored limestone occurring there is rich in greensand. On the road from Ripley to New Albany, the coralline limestone crops out in numerous localities; the same is the case on the Ripley and Molino road, and also no doubt, in the country intervening between the two roads. The locality near Stubbs' (¶ 133) will no doubt furnish good material both for quicklime and for agricultural purposes. In the "Buncombes", limestone frequently crops out on the hillsides; that at Parson Montgomery's (¶ 136) is known to make good lime, and so probably will that at the King's Place (¶ 1 6). On S. 29, T. 7, R. 4 E., on the Tardyville and Ellistown road, good limestone appears on the surface; as it does in many localities in the hills S. of King's Creek. The bluff on Labatubby, S. 36, T. 8, R. 2 E., affords a fine chance for an establishment on a large scale, so far as the quality and quantity is concerned, and the same may be said with reference to the outcrops on the edge of the Flatwoods at Mr. Stephen Daggett's, on SS. 3 and 30, TT. 9 and 10, R. 3 E.

153. An analysis of an average specimen of Daggett's limestone, such as is used by him in burning lime for sale, gave the following result:

DAGGETT'S LIMESTONE.

Insoluble Matter (chiefly sand)	8.374
Potash	0.359
Soda	0.089
Lime	48.815
Magnesia	0.751
Brown Oxide of Manganese	0.173
Peroxide of Iron, and Alumina	2.412
Sulphuric Acid	0.077
Carbonic Acid	38.485
Water	0.832
	100.367

One cwt. of this rock will yield somewhat over 60 lbs. of burnt lime containing about 11 lbs. of impurities; which, however, for want of intermixture with the lime, do not impart hydraulic properties to the latter, since it slakes with energy. This lime answers every architectural purpose except whitewashing. It is due, no doubt, to the large amount of potash which the lime made from this limestone contains, that effects unusually favorable were observed to follow its application to soils, in the neighborhood of Pontotoc. Yet this rock contains but few visible grains of greensand.—In this respect, it is greatly surpassed by the rock of an outcrop 1 mile S. of Pontotoc, on the Houston road, which nevertheless, by careful burning, could also be made to serve for quicklime. The "horsebone limestone" near Redland, and southward to the end of the formation, is generally of a similar character.

154. Building Stones.—The *Eutaw Group* furnishes none: all the rocks found on its territory belong to the Orange Sand Group, which see (¶ 57). Very nearly the same holds true of the *Tombigbee Sand Group*: the soft micaceous sandstones occasionally found are of little value and easily destroyed by frost.

The *Rotten Limestone* is generally too soft to resist the action of the atmosphere; in sheltered situations, it sometimes stands well, and is easily cut into shape. At Palo Alto, and at other localities, fireplaces, and the sheltered portions of chimneys, have been built of it. It will not resist many alternations of wet and dry above ground, without scaling off: although different localities differ greatly in this respect.

The limestones of the Ripley Group, where they are solid and uniform in their mass, resist the action of the atmosphere remarkably well, and are suited to every common purpose in building. There are few localities, however, in which large solid blocks can be obtained: the best I know of occur on the Labatubby, and at Daggett's (see above, under *Limestone*). Usually the *solid* ledges are thin (seldom exceeding 15 inches, and frequently broken up into blocks which require only the peck and crow-bar to quarry them. Little reliance is to be placed in the continuity of a stratum with the same character of material; a solid ledge on one ridge may be a bed of loose calcareous sand on the next.—For localities where rock is found, see under the head of Limestone.

155. Waters of the Cretaceous Formation.—Specialities concerning the depths and character of wells in the various districts of the cretaceous territory, will be found under the head of "The Northeastern Prairie Region," in the agricultural portion of the present Report. A few general remarks, however, must find their place here.

Water-bearing strata are abundant in both the Eutaw and the Tombigbee Sand Group, but especially in the former, which furnishes the source of by far the greater number of artesian wells in the State, in Lowndes and Monroe counties. It is between the solid, blue and reddish clays of this group, in the intervening gray sands, that the head of water which enables the latter to run out at the mouth of the bores, is collected. While, however, there is considerable consistency in the depths of the wells, in the direction of the dip, there is much less regularity observed in the direction of the strike; the strata evidently running out sometimes on the large scale, as they commonly do on the small. Almost all the waters of artesian and bored wells are more or less limy, and few if any are free from iron in some form; sulphuretted hydrogen, too, is usually present. The springs flowing from the strata of the Eutaw Group in Tishomingo and Itawamba, are all more or less chalybeate and usually magnesian, but contain mostly chlorides and carbonates, and very little lime; and the same is the case with those bored, and especially *artesian* wells, which touch little or none of the calcareous Tombigbee Sand or Rotten Limestone. It is likely, therefore, that in most cases, the lime is imparted to these waters by standing in, or passing through, the calcareous strata which overlie the water-bearing formation.

156. In the bored wells in which the water is stationary, the iron is usually contained as proto-carbonate, which is soon precepitated by the air, forming a dark brown scum or sediment on the bucket. In some of the artesian wells, however (as in the case of Gen. R. Davis', at Aberdeen), there is proto-sulphate of iron, producing a yellowish brown sediment of basic persulphate. Perhaps the iron is in most cases contained originally as proto-sulphate, derived from the "sulphur balls" occurring in the dark-colored clays, and is thereafter transformed into carbonate, and partially precipitated, by the contact with the carbonate of lime. Some waters derived from the Eutaw Group contain a large amount of silica; as for instance, that of Dr. Rabb's well at Columbus, which incrusts tumblers immersed in it with a firmly adhering, brown film. When the surface thus coated is heated with hydrochloric acid, the iron is removed and a whitish film remains, which is soluble in potash and insoluble in salt of phosphorus.

The elevated portion of the strata which furnish the water of the Columbus and Aberdeen wells, is doubtless to be sought in the high ridges bordering on the Buttahatchie and Looxapalila; although these show on their surface, and sometimes at great depths, nothing more than Orange Sand strata.

Few wells are sunk in the Tombigbee Sands alone; they have very limy water.

157. On the territory of the Rotten Limestone, little water is to be found, unless in surface tanks, or by passing through the whole stratum, into the Tombigbee Sand, or Eutaw Group. Locally, however, small water-bearing strata have occasionally been struck within the Rotten Limestone. Thus at Okalona, at 75 feet, water excessively limy and with little rise, and insufficient in quantity, was obtained. At Houston and Sparta, the same thing happens (¶122), the water at the latter place being in some cases a perfect ley of gypsum and Epsom salt. For a supply of water in the prairie region, therefore, the alternative generally lies between deep bored wells and cisterns; unless indeed, as on Kilgore's Ridge, there should be a mass of Orange Sand of sufficient thickness, overlying the rock.

158. On the territory of the Ripley Group, there is little difficulty about water. In the first place, springs are abundant. Orange Sand very commonly forms the higher portions of the ridges, while the cretaceous marls underlie as an impervious statum; finally, good water (though somewhat limy) may frequently be struck in the strata of the Ripley Group themselves. Such is the case in Tippah, where the calcareous strata of the Ripley Group are passed through at 40 to 70 feet, into water-bearing sand. So also, the

sandy strata intervening between the ledges of limestone, in Pontotoc and Chickasaw, are frequently water-bearing, so that in the meridian of the town of Pontotoc, water is generally obtained between ledges of limestone at depths between 70 and 130 feet; the water rising 20 to 40 feet from the bottom of the well. The water of these wells, also, is frequently sulphureous and chalybeate, and springs of the same character are abundant in numerous localities on the territory of the Ripley Group.

THE TERTIARY FORMATIONS.

159. By far the greater portion of the State of Mississippi is occupied by deposits of the tertiary age, if we leave out of consideration the strata of the Orange Sand, which undeniably forms the greater portion of the *actual* surface.

The position of the Tertiary strata appears to be more or less in conformity with that of the cretaceous beds. It certainly is so in the southern portion of the State, where their dip is distinctly southward. Whether or not the same is true in reference to the strata occupying the northern portion of the State, I have thus far been unable to determine, in consequence both of the rare accessibility of the strata, and of their character. If, however, any westerly dip exists in the tertiary strata of N. Mississippi (as is the case in the cretaceous strata) it is certainly much less than that of the latter.

The tertiary of Mississippi exhibits, essentially, three different facies, viz: That of lignitiferous clays and sands, varying in color from black to brown, blue, green, yellow, gray and almost white, with remains of vegetables; that of siliceous sandstones and claystones with marine fossils; and that of limestones and calcareous marls, with marine fossils.

160. The several marine stages are in most cases separated by intervening strata of dark colored, often lignitic clays, as above mentioned; moreover, both the base and the top of the older tertiary are formed by strata of this character, of considerable thickness. Small estuary deposits of marine fossils are occasionally found in the Lignitic strata; and *vice versa*, small masses of lignitic deposits sometimes occur in the calcareous tertiary, as they do in the upper cretaceous formation. Chemically, the Lignitic strata are characterized (with very rare exceptions) by the absence of the carbonate of lime, and the presence, *per contra*, of sulphate of lime or gypsum in its various forms, usually accompanied by sulphate of magnesia or Epsom salt, and common salt; while these ingredients are almost entirely absent from the marine Tertiary.*

161. The following general section of the Tertiary of Mississippi will serve to show its prominent traits, as far as ascertained up to the present time. The approximate thickness given may be taken as *minima*, which are often greatly exceeded.

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*I shall not include, for the present, in the general remarks on the tertiary of Mississippi, the imperfectly known strata of the Sea-Coast, which may be Pliocene or Post-pliocene, and will be treated of at the conclusion of the description of the more ancient Tertiary.

GENERAL SECTION OF THE TERTIARY STRATA OF MISSISSIPPI.

FEET	NAME, CHARACTER AND FOSSILS.	NO
150	GRAND GULF STAGE, OR SOUTHERN LIGNITIC.—White or gray sandstones, usually soft; black, blue, green and gray clays and sands, with small Lignite beds, tree palms, exogenous trees, *Arundinaceae*.	10
80	VICKSBURG STAGE—1. Crystalline limestones and blue marls, with *Ostrea Vicksburgensis*, *O. gigantea*, *Cardium diversum*, *Arca Mississippiensis*, *Navicula Miss.*, *N. lima*, *Crassatella Miss.*, *Dentalium Miss.*, *Panopaea oblongata*, *Fulgoraria Miss.*, *Cypraea lintea*, *Madrepora Miss.*, *Pecten Poulsoni*, ORBITOIDES MANTELLI.	9
12	2. Ferruginous rock of Red Bluff, with *Plagiostoma dumosum?*, *Fulgoraria Miss.*, *Mitra Miss.*, *Busycon spiniger*, *Conus sauridens*, *Rostellaria velata*, *Cassidaria lintea*, *Madrepora* (all. to *M. Miss.*), *Dentalium thalloides*, *Trochita trochiformis*, *Natica Vicksb.*, *Flabellum Wailesii*, *Osteodes* n. sp., *Venericardia planicosta*, *V. rotunda*, *Cypricardia* sp., and many peculiar species.	8
20	LIGNITIC CLAY AND LIGNITE, at Vicksburg, and N. of Brandon.	7
80	JACKSON STAGE.—White (often indurate) and blue marls, with *Venericardia planicosta*, *Rostellaria velata*, *Cardium Nicolleti*, *Corbula bicarinata*, *Leda multilineata*, *Cypraea fenestralis*, *Conus tortilis*, *Gastridium vetustum*, *Mitra Millingtoni*, *M. dumosa*, *Voluta dumosa*, *Morio Petersoni*, *Umbrella planulata*, *Osteodes irroratus*, *Flabellum Wailesii*, *Trochita alta*, ZEUGLODON MACROSPONDYLUS.	6
	LIGNITIC CLAY AND LIGNITE, at Jackson, Garlandsville, Coonupy Cr.	5
	CLAIBORNE STAGE.—*A. Calcareous.*—White (sometimes indurate) and blue marls, with *Ostrea sellaeformis*, *O. divaricata*, *O. panda*, *Venericardia planicosta*, *V. rotunda*, *Rostellaria velata*, *Monoceros pyruloides*, *M. fusiformis*, *Orbis rotella*, *Natica gibbosa*, *Anolax gigantea*, *Oliva Alabamensis*, *Marginella larvata*.	4
	b. LIGNITIC CLAYS AND SANDS of N. Clarke county ?	3
	B. Silicious Claiborne.—S. Neshoba, N. Newton, S. Lauderdale, N. Clarke; sandstones and claystones with *Venericardia planicosta*, *V. rotunda*, *Monoceros*, *Pyrula*, *Voluta petrosa*, *Corbula gibbosa*.	2
425	LIGNITIC OF N. LAUDERDALE !, Neshoba. Dark brown and yellow clays and sands with Lignite—sometimes obscure casts of shells.	1
	? LIGNITIC OF N. MISSISSIPPI: *a.* Gray clays and sands of Tippah, sometimes transformed into red shale, with *Quercus* n. sp., *Carya* n. sp., *Populus dendroidea*, *Populus* n. sp., *Morus!*, *Ficus lanceolata*, HEER?, *Laurus* n. sp., *Persea* n. sp., *Cornus sericea?*, *Olea Americana!*, *Rhamnus* n. sp., *Terminalia* 2 n. sp., *Magnolia laurifolia* LESQ.!, *M. acuminata* MICHX.!, *Dryandroides?*, *Rhus*. *b.* Gray clays of Lafayette and Calhoun, with *Sabal*, *Cinnamomum*, *Quercus*, *Ficus?*, *Smilax?* *c.* Gray clays and sands of Winston, with *Cycas*, *Smilax?* *d.* Small estuarian deposits of sandstone with marine shells. Tippah: *Venericardia planicosta*, *Cardium Nicolleti*, *Trochus*, *Ostrea*. Shongalo: *Ostrea divaricata*, *Solarium*, *Voluta petrosa*, *Venericardia rotunda*, *Turritella vetusta*, LEA?, *Cardium Nicolleti*, *Nautilus zigzag*.	1*

162. The only doubt as to the stratigraphical position of the members of this series, exits with reference to the strata designated as the Lignitic of North Mississippi. The conformation of the surface, the scarcity of fossil remains, and the variability of the strata, both as to thickness and lithological character, render a direct determination of the stratigraphical relations between this group and the calcareous tertiary, extremely difficult. While there can be no doubt whatsoever, as to the position of stratum No. 1, the equivalence of No. 1* to the same still remains to be proven by a comparison of the respective floras, for which, thus far, the materials are incomplete. For the determinations of genera and species of plants given in the table, I am indebted to the kindness of Leo Lesquereux, Esq., of Columbus, Ohio. Thus far, however, only the fossils of locality *a* (Red Shale) have been specially studied by him, and it remains doubtful how far the floras of the respective districts may be related. Although not susceptible, at present, of strict, direct stratigraphical proof, the probable equivalence of the lignitic beds underlying the siliceous strata of the Claiborne age, in Lauderdale, and of those overlying the Upper Cretaceous in N. Mississippi certainly impresses itself strongly upon the mind of the observer in the field. An uninterrupted belt of lignitic strata, often outcropping, and always reached in wells, extends along the W. border of the cretaceous territory [where it gives rise to the Flatwoods (¶164),] from the Tennessee line to the northern border of the marine tertiary. The strata show no observable dip in this direction, until we reach the region last mentioned, where they disappear under the marine siliceous claystones and sandstones on the E. half of the territory, and under the calcareous marls on the W. On the whole of this line, there is no more change of *lithological* character, than may be observed in almost any single locality ; even to the minute particulars, the same phenomena which we saw in Tippah, Marshall, Pontotoc, Lafayette and Calhoun, may be observed in Choctaw, Winston, Kemper and Lauderdale.

163. Several of the plants from the red shale (locality *a*) determined by Mr. Lesquereux, are considered peculiar to the Miocene of Europe ; the rest appear to be analogous at least, and would therefore place the strata containing them *above* the marine tertiary of the State—assumed to be of *eocene* age, and certainly not referrible to any *newer* stage, since it does not contain a single fossil identical with living species.—On the other hand, we find in N. Tippah, on the border of the cretaceous formation, a limited stratum of siliceous sandstone, undistinguishable, lithologically, from that found on the territory of the Siliceous Claiborne stage, underlaid and overlaid by gray Lignitic clays, similar in all respects to that of the rest of Tippah, and connected with the latter by numerous outcrops, although the stratum is not strictly traceable. The rock mentioned contains *Venericardia planicosta !*, *Cardium Nicolleti ?*, and other fossils, apparently peculiar ; whence it appears that this estuary deposit, at least, is of eocene age—and with it, we should naturally presume, the rest of the lignitic clays of Tippah and Pontotoc, whose *highest* strata frequently exhibit a ledge of rock of a similar character, in which ill preserved remnants of marine fossils are occasionally, though rarely, found, together with grains of greensand (¶166). Near Shongalo, Carroll county, also, there occurs a deposit of marine origin, with fossils corresponding to the *Claiborne stage*, which is certainly *under*laid, and probably also *over*laid by lignitic clays, the territory of which surrounds it on all sides (see map). The imperfect state of preservation of most of the fossils of the estuary deposit of Tippah, just mentioned, render its identification with any particular stage of the eocene somewhat difficult.—It appears, however, from extensive comparisons made by Prof. W. D. Moore, of the number of ribs found in *Venericardia planicosta* from different geological horizons, that the average *number of ribs* in that fossil decreases in proportion as we descend in the series ; as exhibited in the following table :

(Paris.................................. 36)
Lower Vicksburg? stage.......................34 to 35
Jackson stage...................................31 to 34
Claiborne stage............................ 26 to 30 (Conrad)
Siliceous Claiborne (lower).....................25 to 26

The latter numbers (viz : 25 to 26) are also those of the fossil occurring in the estuary deposit of Tippah : affording an additional presumption in favor of the lower eocene age of the bed in question.

Leaving open the question of the age of these Lignitic strata, until settled, perhaps, by a comparison of the floras, I shall comprehend under the head of the "Northern Lignitic", as a whole, all the beds found on the territory N. of the line of the marine Tertiary, and W. of the Cretaceous.

I. THE NORTHERN LIGNITIC GROUP.

164. The territory occupied by this group—marked on the map by the lighter shade of brown—is generally hilly, with the exception of the level belt immediately bordering on the cretaceous formation—the "Post Oak Flatwoods," which will be more specially described in the Agricultural Report. In these, the material of the Lignitic formation itself (generally in a disintegrated condition), forms the surface : on the rest of the territory, the Orange Sand generally overlies the latter thickly, having been, as usual, deposited on a deeply denuded surface, whose hills and valleys cause great irregularity in the occurrence of outcrops, as well as uncertainty, in many cases, as to the very existence of the lignitic formation, unless accidentally demonstrated by deep borings. Nevertheless, there are extensive regions in which these strata appear at and above the level of the drainage, forming the base of the hills, and the beds of the streams ; and being, very generally, the water-shedding stratum.

165. In the Flatwoods, and the hills immediately adjoining them to the westward, the material of the formation is usually a hard, gray or whitish clay, sometimes laminated, but more usually of a massy cleavage, with a tendency to conchoidal or nodular forms, which are conspicuous in most of the outcrops found on whitened hillsides in the Flatwoods. This clay shows but little tendency to disintegrate by the atmospheric agencies alone ; it does not "slake" readily, so long as it retains its original structure, and hence, it is very generally worn into genuine pebbles by the streams. When however, it has once been broken up and worked into a plastic mass by mechanical means (as for instance by denudation and re-deposition, or in roads), it resumes this condition with extraordinary facility. Such is the nature of the surface material of the Flatwoods, obviously derived from the (originally hard and intractable) clays of the underlying strata, which it covers to a depth of from two to ten feet, forming, to a great extent, both the soil and subsoil. These surface clays possess a cleavage strictly massy, the cleavage planes being generally of a reddish tint ; a rain falling on this mass, instantly converts it into the toughest mud. This toughness is rarely impaired through the presence of sand ; the uncombined siliceous matter contained in the mass is usually in a state of fine division, and is to a great extent perhaps derived from subsequent infiltration with siliceous solutions, which evidently have been active within the mass after its deposition. For not only do we often find the clay itself indurated into a claystone of considerable hardness, through the intervention of a siliceous cement, but we fre-

quently meet, within the mass, irregular veins and lenticular sheets of a very hard, gray or brown siliceous rock (at times almost a pure hornstone, at others consisting in part of clay), whose drusy, nodular surface plainly shows its origin.

166. Stratified claystones (6 to 18 inches in thickness) are of common occurrence at or near the top of the Lignitic strata of Tippah and Pontotoc, at no great distance from the border of the cretaceous formation. These claystones sometimes differ from the clay itself in little else than their greater hardness, but usually they are somewhat sandy, and contain numerous black grains—in some instances, *grains of greensand.* Through these claystones, every degree of lithological transition from the pure, almost white clay, to the fossiliferous sandstone of N. Tippah (¶168) may be traced, and careful examination will sometimes detect in them unequivocal remnants of marine fossils. Such is the case with the (glauconitic) claystone overlying the lignitic clays at Mr. Brougher's place, S. 7, T. 5, R. 2 E., Tippah county, and at an outcrop a mile W. of Pontotoc. At the latter place a *Turbinolia !* and part of the nucleus of a *Natica ?* was found, with other impressions too indistinct to be recognized; at the former, the exterior cast of a small, deeply ribbed *Venericardia ?* or *Arca ?*

I have not met with any of *these* claystones on the territory of the Northern Lignitic S. of the outcrop mentioned, near the town of Pontotoc. Thence S. to the Succarnoche River, I have seen only the whitish "Flatwoods Clay;" where the latter is massy or nodular, it rarely contains unequivocal signs of vegetable fossils. Westward of the Flatwoods proper, however, the clays are commonly laminated, less uniform in their character, and interstratified more or less with sand. Such usually are the clays associated with the lignite beds, and containing impressions of leaves; nevertheless, the genuine "Flatwoods Clay" character frequently re-appears, locally, over the whole region.

167. The greatest deversity of material generally obtains in connection with the *Lignite* beds. They are usually overlaid, and sometimes underlaid also, by yellow sands, or sandy clays, or numerous alternating layers of these materials, often strongly lignitic themselves, and correspondingly dark colored. On the other hand, pure, refractory, blue or green clay, of a massy cleavage, and void of sand, is sometimes found associated with the lignite beds, and especially as forming the subjacent stratum.

A special description of the lignite beds will be found under the head of the Useful Materials of this group (¶252, ff.). Within the light colored, laminated clays of this formation, are not unusually found rounded masses, from the size of a mans head to that of several bushels, of a black substance so much resembling stone-coal, as to render it undistinguishable, at times, even to a practised eye. It is a kind of bitumen, similar to that found sometimes in the Rotten Limestone; in the fire it is semi-fused like Cannel coal, swells and burns with a brilliant, smoky flame, producing a light, spongy coke, which burns with difficulty, leaving but very little, white ash. A more eligible material for the manufacture of illuminating gas could scarcely be procured; but thus far, no continuous deposit of this substance has been discovered. Among the localities where it has been found, I may mention: Mr. Brougher's place, S. 7, T. 5, R. 2 E., Tippah county; Dr. John Thompson's, S. 8, T. 12, R. 2 E., Calhoun county; Mr. Madison Carr's, S. 6, T. 11, R. 5 W., Yallabusha county; between Sun Creek and Trim Cane Creek, in Mr. Dillon's neighborhood, Ocktibbeha county.

168. *Localities of the Northern Lignitic Group.*—Near Mr. David Reeve's, S. 36, T. 1, R. 3 E., N. Tippah county, we obtain, along the bed of a branch, the following section:

(Sec. 16.)

SECTION OF THE LIGNITIC STRATA, AT D. REEVE'S, N. TIPPAH.

FEET.	CHARACTER OF STRATA.	NO.
	Orange Sand—Hilltops.	5
1?	Red Shale, non-fossiliferous.	4
4?	Gray laminated clay, washing into pebbles—non-fossiliferous.	3
2	Clay-sandstone, spotted blue and yellow, with green-sand dots. *Venericardia planicosta, Cardium Nicolleti?, Trochus, Ostrea,* etc.	2
1	Gray laminated clays—not visible at the outcrop, but struck in wells in the neighborhood, after passing through the rocks; below the clay, white, water-bearing sand.	1

The precise thickness of Nos. 3 and 4 could not be ascertained, from the overlying detritus. No. 4 is precisely similar to the fossiliferous shale at Hurley's schoolhouse (¶170, Sec. 17, No. 2), but like the underlying clay, of which it is probably a metamorphosis (¶41), is without fossils. The same rock, as No. 2 of the preceding section, occurs on a ridge on the E. side of Muddy Creek, on SS. 16 and 17, T. 2, R. 4 E. Here a ledge quite similar to that at Revees' but with only here and there an imperfect fossil, appears on the summit of the ridge, jutting out in an abrupt hillock at its northern end, whence it dips southward and crops out on the hillside for a mile, disappearing about 30 feet below the summit of the ridge, which consists of Orange Sand. A lower ridge, intervening between the one just mentioned, and Muddy Creek, shows bald hilltops consisting of a tough gray clay soil, underlaid by gray laminated clay.

169. In the country on the heads of Muddy Creek, Wolf River and Tippah Creek, in TT. 2 and 3, RR. 2 and 3 E., outcrops of the gray nodular "Flatwoods Clay" are very common on the hillsides, which often appear quite similar, at first sight, to the "bald prairie spots" of the Rotten Limestone country. Several outcrops of this kind occur on the Ripley and Salem roads, and they are common in the bluffs of streams. On S. 29, T. 3, R. 3 E., (Squire Street's) there is a bed of lignite—which, however, I had no opportunity of observing personally. In townships 4, 5 and 6, ranges 1 and 2 E. (S. W. Tippah), we generally find the clays laminated rather than nodular, frequently interstratified with sand, and rarely destitute of vegetable remains—which, however, as a general thing, are poorly preserved. Characteristic outcrops of this kind occur on Ocklimita Creek. Thus on S. 33, T. 5, R. 1 E., near Hickory Flat, there is a bluff about 70 feet high, which consists of alternating strata, from ¼ inch to 2 feet in thickness, of gray and brown clay, sand, and sandy clay; the whole overlaid by a few feet of Orange Sand. The strata here show a slight westward dip; in a small outcrop on S. 35, the dip is 15 deg. W. *b* S.—which is probably, however, owing to a local fault.—Higher up on the Ocklimita, above the crossing of the Hickory Flat and Ripley road (about S. 8, T. 5, R. 3 E.) the bluffs exhibit the following section.

(Sec. 17.)

SECTION AT A BLUFF ON OCKLIMITA CREEK, W. TIPPAH.

	FEET.	INCHES	CHARACTER OF STRATA.	NO.
	15 to 20		Orange and Yellow Sand, with ferruginous sandstone and large pieces of silicified wood.	4
	2 to	6	Small fragments of silicified wood, imbedded in a soft mass consisting of sand and comminuted silicified wood.	3
	1		Large white quartzite pebbles, with sand.	2
	6		Gray clayey sand, with traces of fossil leaves.	1

Large fragments of silicified wood, the centre of which is black, lie in the bed of the creek; whether derived from stratum No. 1. or from the sand above, does not appear.

170. About 2 miles E. of this locality, at Hurley's schoolhouse, on a ridge, we obtain the following section:

(No. 18.)

SECTION AT HURLEY'S SCHOOLHOUSE, W. TIPPAH.

	FEET.	CHARACTER OF STRATA.	NO.
	15	Orange Sand hilltops, with the common ferruginous sandstone, and a few fragments of the white siliceous rock with fissures resembling grass leaves.	3
	3	Fine grained red shale, hard, with impressions of leaves an the cleavage planes—*Salisburia*, *Populus rhomboidea*, *Morus*, *Ficus*, *Laurus*, *Olea Americana*, *Cornus sericea*, *Rhamnus*, *Terminalia*, *Magnolia rotundifolia*, Lesqx., *M. accuminata*, Michx., *Rhus*, *Quercus*, *Carya*.	2
		Blue clay, similar to *c* of Diag. No. 5; forming the body of the ridge.	1

According to O. Davis, Esq, of Ripley, red leaf-bearing shales, probably of a similar character, occur on S. 8, T. 2, R. 2 E., about 5 miles S. E. of Spring Hill, Tippah county; fragments of a similar rock I have observed myself, N. of Tippah Creek, in T. 4, R. 1 E. H. A. Gwyn, Esq., of Saulsbury, Tenn., possesses fine specimens of leaves occurring in a red, micaceous, schistose sandstone, near Gov. Matthews' place, in N. E. Marshall county. Of the precise position of the rock in these localities, I am not informed. All of them are probably metamorphoses of different materials of the Lignite formation, by means of ferruginous solutions derived from the Orange Sand.

171. The following section, from a bluff in T. 6, R. 1 E., on the Cornersville and Hickory Flat road, as well as that mentioned as occurring near the latter place on Ocklimita Creek, will give a fair idea of the character of the outcrops observed in S. W. Tippah and S. E. Marshall.

(Sec. 19.)

SECTION OF LIGNITE STRATA, FROM AN OUTCROP IN T. 6, R. 1 E., TIPPAH COUNTY.

	FEET.	INCHES.	CHARACTER OF STRATA.	NO.
	6		Gray sandy clay with conchoidal cleavage, non-fossiliferous.	3
	1	3	Black laminated clay with impressions of leaves, and a seam of lignite at the base.	2
	8		Blue massy clay, non-fossiliferous, same as No. 1 of Sec. 18, and lowest stratum of Diag. No. 5.	1

This section also represents faithfully numerous outcrops in S. Lafayette, and N. Calhoun counties—some sections, however, exhibit nothing but sharp, yellow sand, with faint impressions of leaves. The region in which the above section occurs, is remarkable for the number and large size of the ferruginous nodules occurring on the surface of the formation (¶ 12); silicified trunks also being very common in the same position, and remarkable for the perfect preservation of their vegetable structure.

172. At Rocky Ford, Pontotoc county, the S. bank of the Tallahatchie River contains an exposure of about 12 feet of black, very *micaceous*, sandy, laminated clay, passing in spots into a soft micaceous sandstone. In the upper portion of this mass (which is overlaid by Orange Sand capped with white siliceous sandstone—¶58) there are large, flattened ferruginous nodules.

The outcrops in ranges 1 E. and 1 W., in Pontotoc and Lafayette, are merely repetitions of those just mentioned, while R. 2 E. is occupied chiefly by the Flatwoods. W. Marshall, and N. and W. Lafayette, exhibit chiefly the Orange Sand strata, though here and there a deep well reaches the "black dirt," yielding fetid water. In S. Lafayette, however, on the waters of the Yockeney-Patafa, the lignite formation is well developed; as also in Calhoun and E. Yallabusha. The following section occurring on the Yockeney River, S. T 9, R. 3 W., will serve to characterize the strata of that region :

(Sec. 20.)

SECTION AT PRICE'S OLD MILL, ON THE YOCKENEY RIVER.

	FEET.	INCHES.	CHARACTER OF STRATA.	NO.
			Orange Sand—hilltops.	5
	12 to 16		Sandy transition layer, with ferruginous nodules. Whitish clay of nodular cleavage ("Flatwoods Clay") without leaves; passing into Dark colored, bluish clay, thickly laminated, with obscure remnants of leaves.	4
§ §	1	3	Dark colored, fetid, lignitic clay, with seams of lignite.	3
	8 to 10		Black clay, somewhat sandy, with traces of leaves.	2
§ §			Lignite—thickness not ascertained—bed of river.	1

Lower down, on Dr. John Taylor's land, S. 30, T. 9, R. 3 W., the lignite crops out, 2 to 3 feet thick, a little above the bed of the river, which is formed by a tenacious blue clay—probably No. 1 of Sec's 18 and 19.

173 Higher up, also, on the heads of the Yockeney, lignite is found. A bed said to be 8 feet thick occurs at Mr. Vineyard's, S. 1, T. 10, R. 1 W.; it is found in wells in T. 9, R. 2 W., and also on branches of Potlockney Creek, in T. 10, R. 2 W., where I have had an opportunity of examining it. It crops out in bluffs and gullies on Hughes' branch, on S 8, T. 10, R. 2 W., overlaid by some 30 feet (as far as visible) of sharp yellow sand with ferruginous veins. The sand, which is evidently a member of the lignite group, occurs in many bluffs in the neighborhood, and sometimes contains impressions of leaves In a branch near Mr. S Ragland's, on S 9, T. 10, R. 2 W., there is an outcrop of great interest, of which Diagram No. 5 will convey an idea.

The stratum of greenish yellow sand at *a* contains impressions of leaves, chiefly of a *Cinnamomum* not unlike the Sassafras. *c* is a bed of yellowish white clay of irregular, or thickly laminated cleavage, containing numerous leaves of a *Sabal*, also a variety of other, chiefly dicotyledonous plants, among which a *Quercus* and *Ficus*?, which seem to be identical with species found in the red shale of Tippah. In the yellow sand at *d*, immediately overlying the clay stratum, there occur large billets of silicified wood, the interior of which is black. The bed of the branch on the N. half of the bluff, is formed by blue clay *e*, of massy cleavage, similar to No. 1 of Sec.'s 18 and 19, which appears to underlie horizontally. The N. dip of the strata of the outcrop seems, therefore, to be owing to a fault or landslide. The yellow fossiliferous sand found in other localities in the vicinity, is high above the level of the leaf bearing clay stratum of this diagram.

In the sands just mentioned, there frequently occur ferruginous, rust-colored stripes, which at first sight appear to be stratification lines, since they very commonly run parallel to the latter. Sometimes, however, these stripes exhibit fanciful undulations and contortions, and would lead the observer to suppose that the stratification is exceedingly irregular, but for the fact that they may at times be found crossing the true stratification lines. The dotted lines in the accompanying diagram exhibit these stripes. *b* is two masses of gray sandy clay vertically laminated, imbedded in regularly stratified sand.

In the same township (T. 10, R. 2 W.) lignite has been struck in numerous wells (¶263).

174. Outcrops similar to those exhibited in S. W Tippah and S. Lafayette (see sections 19 and 20) are of constant occurrence in N. Calhoun.

These strata are, of course, frequently struck in wells, and are known under various names, as black or blue "dirt" or "mud"; leaves referred by the people to various living trees, also "palm leaves" (*Sabal*), and even "acorns" and "hickory-nuts" have been often reported as having been found. The wells at and near Sarepta, especially, have furnished many examples of this kind; no specimens of which, unfortunately, have been preserved. In a well on S. 28, T. 11, R. 1 W. (Mr. Hunter's), there was found, besides the leaf bearing stratum, a trunk of a tree, round, but lignitized.

175. I have not personally examined the portion of Calhoun county lying S. of Loosha-Scoona River, but according to all accounts, its geological phenomena do not differ essentially from those just described N. of the Scoona. According to L. Harper, the lignite stratum which crops out near the town of Pittsboro, has there in some wells been found to be 30 feet in thickness.—The most westerly range of townships in Chickasaw county, is occupied almost entirely by the Flatwoods, with their characteristic materials, described above.

The E. portion of Choctaw county is in most respects a copy of Calhoun and S. E. Lafayette, though on the whole the Orange Sand ridges, underlaid by the lignitic strata, are lower, and the soil more fertile, pine being usually absent; here also, the line of the lignitic strata is generally marked on the hillsides, by ferruginous nodules. Outcrops of dark colored, laminated clays occur near Bellefontaine; also one of a bed of lignite; the same strata are struck in wells, and in one of these, a round lignitized trunk was found. Silicified wood is abundant in the overlying Orange Sand strata. On the higher ridges, such as that on which Greensboro' is situated. wells 40 to 60 feet deep still remain within the Orange Sand; but S. of Greensboro', on the Bankston road, and at the latter place itself, the Lignitic strata, of the same facies as those seen in N. Calhoun, are near the surface and crop out in the branches, although I have not

Section of Lignitic strata at Ragland's Branch.

No.

ascertained the occurrence of lignite proper in that immediate neighborhood. Beds of lignite occur, however, eastward of Bankston, in several localities (¶265), forming generally the water-shedding stratum. While the lignite at Mr. Bridges' is solid and shows woody structure, being evidently derived from forest trees, that in Mr. Wood's neighborhood seems to be composed of indefinitely shaped fragments of wood, roots and leaves, chiefly endogenous—the deposit perhaps of a bog or swamp, intermingled with clay, and crumbling to pieces in drying. In both places, the lignite stratum is overlaid by gray clayey sand with bits of leaves, similar to that observed on Ocklimita Creek, (No. 1 of Sec. 17, ¶169). Silicified wood is very common in the Orange Sands of the region. To the eastward, in Oktibbeha county, the flatwoods are said to present precisely the same features as further N.

176. The mineral waters at Black's Wells, Choctaw county, are derived from divers dark colored clays and sands overlying a lignite stratum, which was struck and passed through—4 feet thick—in deepening a well which at first yielded a strong sulpher water; the latter suddenly disappeared, during a thunderstorm, leaving freestone water behind. In spite of repeated borings all around the well, the sulphureous vein has not as yet been recovered.

The whole of Winston county, as well as N. Neshoba, appears to be underlaid by a stratum—or perhaps several—of lignite, of very variable thickness: from 2 to 12, on an average, 4 to 5 feet. In N. W. Winston, this stratum is found in wells, overlaid by sand and leaf-bearing clays of irregular cleavage, similar to that found on Ragland's branch (¶175).—A good locality for obtaining specimens of the fossil flora, is at Mr. Wm. R. Coleman's mill, near New Prospect P. O., on S. 35, T. 17, R. 10 E., where the bluff of the pond consists of yellowish, somewhat sandy clay of irregular cleavage, in which the leaves occur as impressions of a deep brown tint. Here the leaves of a *Cycas?*, a *Smilax?* and other plants are abundant (Locality *c.* of General Section).

177. On the heads of the Noxubee River, in N. E. Winston, lignite is also abundant; it is found in wells, crops out in the branches, and on hillsides—which would seem to make probable the existence of several successive strata of this material. A few years ago, a bed of lignite which cropped out on both slopes of a ridge, about 5 miles E. N. E. of New Prospect, took fire from the burning of the woods, and kept burning for twelve months, during which time, the "burning hill" was quite an attraction for the curious.

At Louisville, shallow wells are obtained in the Orange Sand before reaching the lignite strata; the deeper wells, however, pass through gray and black clays and beds of lignitic 2 to 10 feet thick; lignitized trunks retaining their rounded shape, have also been found in the region. Fine impressions of leaves are frequently found in these wells; in one dug at the residence of G. G. Snedecor, Esq., of Louisville, a stratum of grayish-red, fine-grained rock, 8 feet thick, was found at 28 feet, most of the overlying material being gray clayey sand of a laminated structure. The rock resembles closely the ferruginous shale of Hurley's Schoolhouse (¶170) and contains beautiful impressions of exogenous leaves.

178. In S. E. Winston, S. W Noxubee, and N. W. Kemper, high ridges of Orange Sand conceal entirely the Lignitic formation, until we reach the slope which descends into the Flatwoods, where lignitic clays are met with half-way up the hillside, with ferruginous nodules, etc., but no lignite. The character of the Flatwoods, however, is the same as ever. Similarly we see the lignitic clays outcropping on the E. slope of the DeKalb ridge, and according to L. Harper, a bed of lignite 3 to 4 feet thick crops out a few miles N. W. of DeKalb; but *on* that ridge itself nothing but Orange Sand is to be seen for some distance S. of Dekalb. On the waters of Patickfaw Creek, however, dark colored clays appear on the hillsides, with ferruginous nodules. Near Blackwater P. O., a soft yellow sandstone containing white shells, was said to have been struck at 40 feet, in a well; the ledge was a few feet in thickness, *below* it "black mud"

appeared and at 60 feet water was obtained in sand. Lignite is said to be found in the neighborhood in several places. At Daleville, lignitic clays are near the surface, and appear, more or less, all the way to Marion, Lauderdale county, where we reach the northern edge of the marine Tertiary, as given on the map. On Sowashee Creek, 2½ miles N. of Marion, we find on a hillside the following section:

(Sec. 21.)

SECTION ON SOWASHEE CREEK, LAUDERDALE COUNTY.

	FEET.	INCHES.	CHARACTER OF STRATA.	NO.
			Orange Sand—hilltop—with a log of silicified wood.	6
	20		Greenish-yellow sand, sharp, somewat laminated; gradually passing into the upper strata.	5
		6	Layer of ferruginous nodules.	4
	20		Gray laminated clay, alternating with sand.	3
	1	6	Earthy lignite.	2
	8		Gray laminated clay alternating with sand.	1

Silicified wood is very common all over N. Lauderdale.

179. The fossiliferous sandstone containing *Venericardia planicosta*, *Monoceros*, and other fossils of the Claiborne Group, is found on or near the summit of the ridge at Marion; while wells dug on the ridge penetrate into lignitic clays and lignite beds. In a deep cut on the N. E. & S. W. Alabama R. R., E. of Marion, on Mr. Spear's contract, the Lignitic formation underlying the fossiliferous sandstone, exhibits the following section:

(Sec. 22.)

SECTION AT SPEAR'S CUT, LAUDERDALE COUNTY.

	FEET.	INCHES.	CHARACTER OF STRATA.	NO.
	3 to 5		Loam and Orange Sand, with ferruginous nodules below.	9
	3		Yellow, sandy, laminated clay.	8
	8		Massy, yellow and whitish sand, with ferruginous dots.	7
	3 to 4		Blue clayey sand, on exposure becoming covered with persulphate of iron. Upper portion yellow, in thin layers, with a fluted exposure.	6
	9		Massy, gray, sandy and micaceous clay, lignitic above, and sometimes containing casts of a *Venericardia?*	5
		10	Solid Lignite.	4
	18		Gray laminated clayey sand, with specks of lignite, fragments of branches, etc. In its upper portion becomes strongly lignitic.	3
	1		Lignite.	2
	10		Bluish clayey sand, alternating with layers of "Flatwoods Clay." In this bed there occur at times large nodules of gray, radially crystallized calcareous spar. No fossils.	1

In a well bored at Marion Station, 2 miles W. of Marion, on the M. and O. R. R., strata similar to these were penetrated for 425 feet, when a ledge of hard sandstone 18 inches thick was struck, then 1 foot of bluish sand, then 1 inch of hard rock, then bluish clayey sand with comminuted shells—a sandy marl—and thereafter at 450 feet a bed of shells—chiefly oysters, judging by the fragments—in loose siliceous sand, about 5 feet thick; then blue clayey sand to 475 feet, when a very micaceous sand was bored up, to 480 feet. The material before me is insufficient to determine whether or not these shells are tertiary; but it is likely that they should be so, since the cretaceous formation (which might have been reached here) in this latitude, and far above, shows no trace of similar materials.

180. Of the geology of Neshoba county, I possess but few data—derived, in part, from a hasty trip in autumn 1855, the field notes of which, with others, have disappeared. The Orange Sand formation is said to be very largely developed N. of Pearl River, forming some of the highest ridges in the State. I have reliable information, however, of the existence of lignite beds and "black dirt" in the N. part of this county; while in the S. portion, we find a yellow or white, soft sandstone, sometimes showing transitions into claystone, in which fossils of the Claiborne stage appear (¶190[2]). Its resemblance to the fossiliferous rocks both of S. Lauderdale, and Tippah, is very striking.

Of Leake county I know nothing as yet, save that in its N. W. corner, near Thomastown (as in a large portion, at least, of Attala county), fetid gray clays, yielding saline and purgative waters, often impregnated with sulphuretted hydrogen, are found in wells at no great depth (30 to 50 feet). The same is true of the adjoining portions of Madison county, where, although outcrops are very scarce, I have had the opportunity of examining the material freshly dug from wells—as at Mr. R. A. McMillans, S. 33, T. 13, R. 5 E, where at 28 feet, beneath the Orange Sand, fetid laminated clays of various dark tints, with vestiges of leaves, and small crystals of gypsum—interstratified, more or less, with dark-colored sands, were struck, and water obtained in a stratum of black sand at 47 feet. The material is absolutely identical with that observed at Vaiden, in the deep cut (¶183), and the same is found only a few feet beneath the surface, in many points in N. Holmes, *e. g.*, at Rockport.

181. Further E., we find in several cuts on the N. O., J. and G. N. R. R. (*e. g.* on S. 29, T. 12, R. 5 E.), dark colored, fetid clays, charged with iron pyrites, and containing numerous small layers and veins of glossy lignite. Where these clays are exposed to the atmosphere, they speedily become covered with a white efflorescence, which sometimes also appears in fields, on the surface soil,—a mixture chiefly of copperas, alum, and gypsum.—The same strata are struck in wells, and give rise, probably, to the mineral waters of the "Artesian Springs." No regular beds of true lignite, so far as known, have been struck in this region, but such beds are found in Yazoo (according to L. Harper), W. Holmes, Carroll, Yallabusha and Panola, and probably also in DeSoto county. Of the Lignitic formation, as it exists in the country bordering on the Mississippi bottom, I cannot speak from personal observation. According to information obtained from intelligent inhabitants, and observations quoted in various places in L. Harper's Report, the character of the lignitic strata of that region coincides closely with that observed further E., and it would seem that through the counties of Marshall, Lafayette, Yallabusha, Carroll and Madison, an immediate connection of the Lignitic of the interior with that of the Mississippi bluff, can be traced. In a single locality (S. 27, T. 9, R. 4 W., Yazoo county), an outcrop mentioned by L. Harper (Report, p. 168) offers a phenomenon not observed elsewhere, viz: a stratum of lignite *underlaid* by pebbles; on the strength of which, he considers the *whole of the Northern Lignitic* as being geologically connected with the Orange Sand—to which, for the rest, it shows no more special relation than to any of the other formations of the State. He does not describe the character of the pebbles, nor does it appear that special care was taken to ascertain beyond a doubt, the important fact that the pebbles were in their original place, and that a case like that figured by him on p. 50 (copied from my field notes) was out of question. Siliceous pebbles, however, occur in the fossiliferous sandstones of S. Neshoba; so that, even if the facts as alleged by L Harper should be substantially correct, they would prove nothing against the probable supposition of the equivalence of the lignite stratum of the Mississippi bluff to those of E. Mississippi. They may, nevertheless prove to be an independent formation.—Oak and hickory leaves, and acorns associated with fragments of lignite, are said to have been found in wells in W. Panola, Carroll and W. Holmes; the same has been the case in N. Marshall and in DeSoto, in several localities. Generally, however, the Orange Sand, represented largely by the pebble beds appears to be the prevalent formation even to great depths, in this region.

182. The character of the formation in E. Yallabusha has already been mentioned (¶171) as being similar to that of N. Calhoun. In the central portion (N. and S.) of the county, lignite does not seem to occur; gray or white clays, laminated, and more or less sandy and micaceous—often resembling, at first sight, the Rotten Limestone, and not unfrequently claimed as such by the inhabitants—and gray sand, form the usual material of the outcrops, which are by no means abundant. W. of Water Valley, in Mr. Madison Carr's neighborhood, white laminated clay appears on hillsides falling off towards Otuckalofa Creek;

in bluffs on the banks of the latter stream, gray sand appears. The wells at Coffeeville have freestone water, but a short distance W. of town, wells strike "black dirt" and poor water. Traveling S. we next meet an outcrop on the S. bluff of Okachicama Creek, the steep hillside being altogether denuded of surface material, and exhibiting some 30 feet of laminated clay, which is gray while wet but when dry almost white. Like the clay of the Flatwoods, when once disintegrated, it readily forms a highly tenacious mud, which has given some unpleasant notoriety to this hillside, among the waggoners. This clay is found for about a mile each way from the crossing, on the banks of the creek; but wells dug on the ridge prove it to be only a very narrow band, since it is struck no more a few hundred yards S. of the creek, at 50 feet. Very shallow wells prove the impervious clay to be not far from the surface on Perry's Creek, on the S. side of which it crops out, not far above the crossing of the Coffeeville and Grenada road. Near Grenada, according to L. Harper, dark, laminated micaceous clay crops out on S. 13, T. 22, R. 4 E., giving rise to an alum spring.

183. Little else than Orange Sand is to be seen in N. Carroll, along the line of the M. C. R. R. A few miles N. of Middleton, however, we hear of "blue dirt" in the wells, and it appears in these, as well as in a few outcrops, between Middleton and Shongalo. Near the latter place, at Vaiden Station, we find in a R. R. cut, associated with gray and brown clays more or less lignitic and gypseous, a mass composed of sharp, coarse siliceous sand and grains of glauconite, cemented by hydrated peroxide of iron, with more or less clay, and containing numerous impressions of shells, apparently of the Claiborne Group.

The position of the strata in this interesting locality cannot, unfortunately be very clearly observed, in consequence of the southward ascent of the grade of the R. R. from the two small cuts containing the ferruginous greensand, towards the deep one in which the gray lignito-gypseous clays appear, so as to leave unexposed the line of contact between the two materials. There can, however, be little doubt that the fossiliferous deposit is both *over*-and *under*laid by clays like those exposed in the deep cut at Vaiden; for while, in the latter, they occur at a level considerably *above* the fossiliferous strata, and are without any perceptible dip, wells and cisterns dug at the station find, at a level far *below* the latter, nothing but clays precisely similar to those in the deep cut—of brown and gray tints, with rosettes and laminæ of gypsum, frequently incrusted with a yellow ferruginous mineral (Yellow Iron Ore, ¶224). In the middle cut, the coarse, glauconitic, dark orange-colored, ferruginous sandstone forms a pretty uniform stratum about 3 feet thick; it is in this that the fossils are most abundant. These are preserved as impressions and nuclei only, among which thus far, the following have been recognized :

Nautilus zigzag !	*Voluta petrosa*, Con. !
Ostrea divaricata, Lea !	*Dentalium.*
Venericardia rotunda, Lea !	*Turritella vetusta*, Lea ?
Cardium Nicolleti, Con. ?	*Terebra venusta*, Lea ?
Avicula.	*Solarium.*

Underlying this rock, and in the cut adjoining northward, alternating with it there occurs a stiff amorphous clay, with sharp sand and some greensand grains, also of a deep orange tint, and exhibiting traces of fossils. These materials also contain, both in these cuts and in some further N., variously shaped ferruginous concretions, whose shell is of limonite character, and filled usually with fine yellow ochre.

The peculiar deep tint of the heavy subsoil in several localities in this neighborhood, (contrasting strongly with the unusually pale tint of the post-tertiary surface loam commaly seen in S. Carroll), renders it evident that the red clay above mentioned, has contributed to form the same. No other outcrops, however, seem to occur in the immediate neighborhood ; but cuts exhibiting similar materials occur on the R. R., between Vaiden and Rockport.

184. In the bed of Peechyhaly Creek, S. of Shongalo, on S. 2?, T. 16, R. 5 E., there occurs, associated with blue clayey sand, a soft sandstone, mottled blue and yellow, very closely resembling that of S. Neshoba and Lauderdale; no fossils were, however, discovered in it. Large billets of silicified wood have been found in the neighboring streams, by Wm. Batey, Esq., in whose well on S. 35, T. 17, R. 5 E., laminated clay like that in the deep cut at Vaiden, with rosettes of gypsum, was struck at 28 feet, continuing, with little change of character, to 44 feet; a level fully as low, probably somewhat lower, than that of the ledge of rock in Peechyhaly Creek, in the edge of the bottom of Big Black River. Crossing the latter at Kirkwood's Ferry, about S. 11, T. 16, R. 5 E., we find on the S. side a steep bluff about 70 feet high, on which the following section is exhibited:

(Sec. 23.)

SECTION OF TERTIARY STRATA AT KIRKWOOD'S FERRY, ATTALA COUNTY.

	FEET.	CHARACTER OF STRATA.	NO.
	1	White siliceous sandstone, non-fossiliferous.	7
	3	Yellow sand, grains rounded, no fossils—Orange Sand.	6
	2	Dark orange-colored, glauconitic sandstone—fossils as at Vaiden.	5
	30	Ferruginous sand, somewhat glauconitic, with few fossils.	3
	¼	Gray laminated clay.	2
	20	Yellow sand, without fossils.	1

The white siliceous sandstone, No. 7, which is very abundant on the ridges of N. Attala (¶59), strews the hillside.

185. The facts just stated, in connection with this section, can leave no doubt as to the fact, that the lignito-gypseous strata both overlie and underlie this marine ferruginous deposit, which is quite extensively developed in N. Attala, and acquires some practical importance through the large amount of greensand it contains; which not only renders some of its materials suitable as manures, but is also scattered through the heavy "red hills" soil of that portion of the county, rendering them both fertile and durable. In numerous steep gullies on the Shongalo and Kosciusko road, as well as on the bluffs of Zilla, and both forks of Poukta Creek, the several materials observed on the bluff at Kirkwood's Ferry, crop out; and the fertilizing powers of the very sand deposits of these creeks (in which, of course, the greensand is concentrated), are already known and appreciated among the agriculturists of the region.

186. I have not traced out this formation in E. Attala county, but have looked closely for traces of it in Winston. The deep characteristic tint of its materials, which is unmistakeable in the "Red Hills" of Attala and Holmes, again meets

the eye in the subsoil of the "Noxubee Hills" in N. E. Winston, and, as an intermediate point, at Mr. Coleman's (¶176). The peculiarly sharp, unpleasantly gritty sand which the red clay of this formation contains, seems to be recognizable at several points in the Noxubee Hills; as at Mr. Davis' mill on the Noxubee River, where on a hillside we find, overlying the white laminated clays of the Lignitic, a singular conglomerate, consisting of pebbles of the latter clay, sometimes several feet in diameter imbedded in a dark orange colored, gritty clay, resembling greatly that of the Shongalo strata. The conglomerate *as such*, I suppose to belong to the Orange Sand Formation, under the head of which, but for their intimate connection with the fossiliferous strata of N. Attala, these phenomena would more properly have been noticed. The proclivity of the Orange Sand to appropriate the materials of other formations, I have already sufficiently exemplified. At the outcrop on Sowashee Creek, as well as in other intermediate localities, a similar state of things obtains. It would therefore seem, that the marine deposit of which we find an outlier at Vaiden, and the main body in N. Attala, originally covered a much greater area, but has been greatly denuded during the Orange Sand period.

187. I have not found any indications of this formation much S. of the S. prong of Poukta Creek. At Kosciusko, the lignito-gypseous clays alone are struck in the wells (in one lately dug on Dr. C. B. Galloway's place, 5 ms. from the town, a bed of several inches of white fibrous gypsum has penetrated), and the surface material is of a *pale* hue. Nor do we find any trace of marine fossils S. of the Poukta, until we reach, at Canton, the calcareous strata of the Jackson Group. Whether or not any connection is traceable through S E. Attala, and the adjoining portions of Winston and Leake, into the fossiliferous sandstones of S. Neshoba (¶190[2]), still remains to be determined.

I have been reliably informed that "red hills" similar to those of N. Attala, exist in N. E. Holmes. Moreover, I owe to C. G. Armistead, Esq., of Yallobusha, information concerning the existence of a ferruginous rock containing marine fossils, on the waters of Wolf Creek, S. W. Choctaw county, which will probably prove to be identical with the Shongalo rock.

In the wells bored in S. Madison, by the Rev. Mr. Lambuth (¶322), the fossiliferous marine strata of the Jackson Group were passed through at about 90 feet, after which, "blue dirt," with selenite, several ledges of sandstone, and a lignite bed of 40 feet thickness, were struck, but no more marine strata were reached at a depth of 415 feet. At Jackson, however, at the Penitentiary well, after passing through 32 feet of surface material and fossiliferous strata of the Jackson age, Lignitic clays were, penetrated for 418 feet, after which, a bed of shells 20 feet thick, extremely rich in greensand, was passed through into water bearing sand. The friable shells brought up by the auger are too much comminuted to allow of determination.—Whether this bed is a continuation of the Shongalo deposit, or an independent basin or estuary: there can be little doubt that it, also, is of the Claiborne age.

II. THE CLAIBORNE GROUP.

A. THE SILICEOUS CLAIBORNE STRATA.

188. The character of the rocks of this group has already been mentioned in connection with the Northern Lignitic Group, of which, in analogy to the deposits of N. Attala, it seems to form, as it were, a subordinate member. Its fossiliferous, aluminous (but rarely siliceous) sandstones, and claystones, do not impart any peculiar feature to the surface of the country, which bears as a general thing, the character of the Orange Sand Group.

Thus far, it is only in S. Lauderdale and N. Clarke, that I have examined the rocks of this group somewhat specially. At Marion, as before stated, we find a stratum only a few feet thick, of rather coarse sandstone, of variable degrees of hardness within its mass, and containing silicified fossils of the (lower) Claiborne age, overlying immediately the Lignitic strata, as seen in Spears' cut (¶179). Some portions of this rock are of excessive hardness, from others, the silicified shells can be picked by hand, and in weathering, the shells are left projecting above the surface, as in the Turritella Limestone of Tippah. In view of the impossibility of obtaining fragments of any considerable size, or uniform hardness, the supposed adaptability of this rock to the manufacture of buhrstones is somewhat utopian. The softer varieties disintegrate very readily, and more especially under the influence of fire. It appears that many of the ridges in the neighborhood of Marion were once capped with ledges of this rock, as some are even now: for on some of these, especially W. of the town (as for instance, on S. 33, T. 7, R. 17, and ridges connecting therewith) we find imbedded in the soil and subsoil great numbers of silicified shells, which seem to have been gradually washed down from above. They are generally in a poor state of preservation, with the sole exception, perhaps, of Venericardia planicosta, of which I have obtained large, well preserved specimens at the locality mentioned. Of the univalves (*Voluta, Monoceros, Pyrula*) only the columella is commonly preserved, and decay has often brought out prominently the lines of growth, where the rest of the shell is extant. When freshly dug from the soil, these shells are often quite soft and friable, but harden by exposure. The soil is, of course, largely composed of the coarse sand which forms the body of the rock.

189. The rock is not on the whole very common in S. Lauderdale; it is commonly found on the hilltops and crests of ridges, in limited deposits, the greater portion having, probably, been unable to resist the denuding agencies of the Orange Sand.

The rock found at Marion, like that of Tippah, contains occasionally "galls" of gray, fine-grained claystone. On a hillside near the 10 mile post on the Marion and Quitman road, we find a solid ledge of this whitish claystone, about 6 in's thick, forming the top ledge of an outcrop of sandstone, some of which is very coarse, slightly glauconitic, and the sand-grains consisting apparently of chalcedony. Other portions of the rock resemble very much the spotted rock at Reeve's, Tippah county (¶168), and all are slightly fossiliferous.

Southward of the point mentioned, these rocks are very common on the ridges—mostly, however, poor in fossils; consisting of ledges 6 in's. to 2 feet thick, each of which is slightly different from the others. Such is the case on the S. bluff of Dry Creek, where 18 feet of the rock appear, and here may be seen underlaid by a gray sand, similar to some seen at Spear's cut. S. of the N. half of T. 4, R. 16 E, however, no more of the rock is to be seen: Orange Sand hills with Long-leaf Pine cover the face of the country, and deep wells reach nothing but yellow and red sand.

190¹ Westward of the line of travel just described, we find a good opportunity for the study of this formation, on Chunkey Creek; in the cuts of the M. & O. R. R.; and on the banks of the Chickasawhay, at Enterprise.

I regret being unable, in consequence of the disappearance of the field notes relating to it, to give in detail the highly interesting section occurring in a R. R. cut on S. 33, T. 5, R. 15, Lauderdale county, about 5 ms. N. E. of Enterprise. Here the white claystone mentioned above is largely developed; as in the other cases, it forms the highest stratum, is sometimes seen in solid ledges several feet in thickness, and is remarkable, when dry, for its extraordinary lightness. Though not rich in shells, it contains fine casts of a *Leda*, and of *Cardium Nicolleti*?—In its upper portions, this bed passes into yellowish sandstone resembling that of S. Neshoba, and sometimes into a hard cherty rock, which forms huge, rounded nodules.

Below it, at the N. end of the exposure, lies a green clay almost destitute of fossils: in this was found the supposed ovarium of a *Pyrula* (L. Harper's Rep., p. 149). Further S., however, we find intervening between this clay and the chert or claystone, with a rapidly increasing thickness and strong dip southward, a stratum of coarse greenish sand, whose grains consist mainly of chalcedony, and some greensand grains (see above). At this point, the stratum contains no fossils; it may be traced, however, thence to Enterprise, where we find it in the banks of the Chickasawhay River, partly cemented by lime and teeming with fossils—chiefly *Ostrea divaricata*, *Cardium Nicolleti*, *Venericardia rotunda*, *Pecten Lyelli*, and *Scutella*—and strongly glauconitic. The greenish clay found underlying it at the R. R. cut, is also present—as shown in the following section:

(Sec. 24.)

SECTION OF TERTIARY STRATA ON THE CHICKASAWHAY, AT ENTERPRISE, CLARKE COUNTY.

FEET.	CHARACTER OF STRATA.	NO.
10	Orange Sand.	4
6	Course glauconitic sand, frequently indurated by a calcareous cement, with *Ostrea divaricata, vomer, Cardium Nicolleti, Venericardia rotunda, Pecten.*	3
10	Coarse ferruginous sand, glauconitic, with indistinct fossils.	2
	Green clay, apparently non-fossiliferous. Bed of river.	1

Bed No. 3 of this section is also seen in a branch W. of Enterprise, filled with *Mortonia*, and a similar one appears in Chunkey Creek, above Chunkeyville.

190². I have mentioned above (¶187) the yellow aluminous sandstone of S. Neshoba. It is very poor in fossils at its northern edge, but becomes richer as we advance southward. The following shells occur in specimens derived from a locality near the S. line of Neshoba, on the Philadelphia and Enterprise road.

Venericardia planicosta, *Venericardia rotunda*, Lea.
Voluta petrosa, Con. *Corbula gibbosa*, Lea ?

A *Turritella*—shell smooth, and remarkable for the small angle formed by the sides of its spire.

The rock is sometimes of a uniform yellow tint, but more generally spotted with blue, and contains galls of indurate clay, like the sandstone of N. Tippah (¶162 ff., 168).

It occurs likewise in N. Newton, but I have no personal knowledge of its character there. There are several cuts of the Southern R. R. in this county, which from the accounts of the engineers must be highly interesting and instructive, and contain fossiliferous rocks: I have not as yet had an opportunity of examining them.

191. *Beds intervening between the siliceous and the calcareous Claiborne strata.*—I have not as yet been able to trace along the Chickasawhay river, the precise relation of the strata seen at Enterprise (the first in which carbonate of lime

appears) to those which appear at Quitman. Little chance for observation occurs on the Enterprise and Quitman road, until within about 5½ miles of the latter place, where we find outcropping in bluffs and on hillsides, strata resembling those of the lignitic rather [illegible], consisting of alternating layers of gray and yellow sand, and gray and brown clay. Whether or not this stratum underlies the Quitman marls, intervening between them and the Enterprise strata, I have been unable thus far to determine with certainty; the outcrop occurring on the banks of the Chickasawhay near Quitman (see below) seems, however, to render this supposition probable.

B. THE CALCAREOUS CLAIBORNE STRATA.

192. The area underlaid by this division of the tertiary is smaller, apparently, than that occupied by any of the other groups. I am not certain of its western limits, having examined it personally only in Clarke county, on the Chickasawhay and its tributaries. In the county just named, it does not give rise to any very striking peculiarities in the surface conformation. Though outcropping on the banks of streams, and in the valleys, imparting to these a more fertile soil and a forest growth indicative of the lime contained in the former, it does not, so far as I know, form any prairies—a feature of constant occurrence on the territory of the Jackson Group. Not being in possession of any palæontological evidence concerning the counties of Scott and Newton, but learning that prairies do exist there, on which the bones of the *Zeuglodon* occur, I have upon analogy supposed the tertiary strata of these counties to belong to the Jackson Group, and have laid them down as such on the map, for the present.

193. The materials of this division consist, so far as I have seen, of blue, and white marls, the latter always sandy and often indurate.

In both, all fossils except the oysters are very poorly preserved, so as to render their recognition always difficult, often impossible. Its beds differ remarkably, in this respect, from those of Alabama, so noted for the fine preservation of their fossils. The most northerly, and most westerly outcrop of the marl of this division, which I have seen, occurs under a bridge on Suanlovey Creek, W. S. W. of Enterprise. It forms the bed, and a foot or two of the bank, of the creek, for about 200 yards; is of a bluish tint, speckled with white from the detritus of shells, and sometimes contains indurate slabs. The oysters alone are well preserved—Ostrea divaricata, O. sellæformis—the other shells are broken and mostly comminuted. Pecten Lyelli ?, a Turritella, and a Dentalium were recognized.

194. At Quitman, this marl is found in wells, and crops out near a sulphur spring (Smith's Spring) S. of town—scarcely distinguishable from that on Suanlovey. *Ostrea divaricata*, *Pecten Lyelli*, and *Corbula gibbosa*. LEA, are the only fossils which I have been able to recognize distinctly. The same marl occurs in the branches in the neighborhood of Quitman, and also, according to reliable information, on the waters of the Buckatunna in S. E. Clarke.

On the banks of the Chickasawhay, W. of Quitman, we find a section exhibiting, beneath the surface materials, a stratum about one foot thick, of gray, very fat and tenacious, laminated clay, and beneath this, to the waters edge, a bluish-gray, non-effervescent, and non-fossiliferous clayey sand, with yellow dots, which wash out readily, so as to produce a cellular surface.—If the marl at Smith's Spring immediately overlies the gray laminated clay of this section, the difference of level would give it about 10 to 12 feet thickness.

195. S. of Quitman, we find the same marl cropping out on a branch 2 miles from town. Then, at the crossing of Falling Creek, 1½ ms. in the same direction, we obtain the following section:

(Sec. 25.)

SECTION ON FALLING CREEK, S. OF QUITMAN, CLARKE CO.

FEET	INCHES	CHARACTER OF STRATA.	NO.
1	6	Gray calcareous sandstone.	4
[illegible]		Blue marl, with *Ostrea divaricata*, *O. sellaeformis*, and another large, round oyster, undet.	3
2		Yellowish-gray calcareous sandstone (indurate marl).	2
6		White sandy marl, almost void of fossils.	1

The oysters mentioned in No. 3 of this section, are the only fossils seen here—occurring more or less, in all the materials exhibited.

I have not observed any outcrops S. of this, although the appearance of the Poplar (*Liriodendron*), Wild Plum, and Crab Apple in the gullies, still indicates the presence of the calcareous strata.

196. *Beds intervening between the Claiborne and Jackson Groups.*—Where the Quitman and Winchester road crosses Coonupy Creek, on S. 5, T. 1, R. 16 E., the blue marl of the Claiborne strata does not appear in the bluffs, but a sienna-brown clay, stratified in layers 1 to 8 inches in thickness, with sand intervening. It is well exhibited at the point mentioned, in a mill race, and I was informed that in digging it, a great abundance of fine impressions of leaves were found—chiefly *dicotyledonous*, it appears, but among them also a palm (*Sabal ?*) leaf. I was also informed, that on the banks of the Chickasawhay, due W. of the place, the same clay is found *underlaid* by marl containing numerous indurate ledges, and large round oysters—the same, no doubt, as those occurring at Falling Creek.—Immediately S. of this locality, on the verge of the bottom of Coonupy Creek, we find prairie hilltops, and on the hillsides, outcrops of white marl containing fossils of the Jackson Group, underlaid by brownish clayey sand. According to level, the thickness of this lignitic, leaf-bearing stratum cannot greatly exceed 30 feet.

197. At Garlandsville, Jasper county, on S. 8, T. 4, R. 11 E., we find on Suanlovey Creek, an outcrop of lignite of good quality, of which about 2 feet are exhibited above the bed of the stream; it is overlaid by about 2 feet of a lignitic clay, or earthy lignite. Higher up on the hills just S. of the outcrop mentioned (at Dr. Loughridge's), we find the bald prairie with *Zeuglodon* bones, oysters, and other fossils of the Jackson Group. I have had no means of ascertaining its thickness at this point.

Near Jackson, on Moody's branch, we find beneath the shell-bearing sand, first blue sandy clay with ferruginous concretions, and beneath, earthy lignite underlaid by gray laminated clays and sands (¶ 201). The great thickness of this lignitic stratum, as ascertained in the well bored at the Penitentiary, has already been referred to (¶ 187). In the town of Jackson it is commonly struck in dug wells, and various kinds of leaves, as well as acorns, have been found in them. It is evident that the stratum thins out to the eastward, and at Claiborne, and Bettis' Hill, Alabama, according to Lyell (Sill. Am. J., Vol. IV, 2d s., p. 189) and Tuomey, it is entirely wanting, the Claiborne strata being immediately overlaid by the Zeuglodon or Jackson bed, and this by the Orbitoides Limestone, of the Vicksburg Group.

III. THE JACKSON GROUP.

198. The territory of this group, although to a considerable extent occupied, like the rest, by Orange Sand ridges, is strongly characterized in many regions by the occurrence of the black prairie soil on its surface, and also, of bald prairies—both very similar to those of the Rotten Limestone region, though of much less extent. It shares this character to an inconsiderable extent only, with the strata of the Vicksburg Group. The material to which this prairie soil owes its origin, possesses considerable analogy to the Rotten Limestone itself– at times, it is a soft yellowish limestone or indurate marl, containing a good deal of clay; at others, it is in reality, nothing more than a soft, gray or yellowish, calcareous clay. The rock and clay mentioned are ordinarily the matrix of the huge *Zeuglodon* bones, which are therefore to be sought chiefly in the prairies, and have not, to my knowledge, as yet been found at any great distance from them, in Mississippi.–These bones, an oyster somewhat resembling *Gryphaea convexa* of the Cretaceous, the vertebrae and teeth of fish, and a branching coral (*Eschara* sp.) are the common fossils of the tertiary prairies of S. Mississippi.

Other bivalves and univalves, as also echinoderms, may sometimes be found in a tolerably well preserved condition, in the more sandy varieties of this material; but as a general thing, imperfect casts only of these occur in the prairie rock, and usually it requires considerable care to detect their presence at all.

199. About 70 feet of rocks of this character form the upper division of the Jackson stage. The lower portion is formed by from 10 to 20 feet of sandy strata, commonly of a bluish tint, and containing greensand grains.

It is this lower bed, cropping out on the banks of Pearl River, at Jackson, which has furnished the fossils described by Conrad, and figured in Prof. Wailes' Report; and whose state of preservation approaches very closely to that of the well-known Claiborne fossils, in Alabama. I have not thus far found any vestiges of the *Zeuglodon* in this lower division, but I have identified most of its characteristic fossils in the upper strata, at various times and localities.

200. Whilst the stratigraphical relations of this group to that next above it (the Vicksburg Group) may be traced with considerable regularity of (southward) dip, along the channels of the two rivers which cross both belts (the Chickasawhay, and Pearl River), there appears to be some irregularity in the form of the stratum on its northern portion. According to the levelings of the N. O., J. and G. N. R. R., the city of Jackson is situated 45 feet higher than Canton, Madison county, which is distant 25 miles due N. from the former place; by the levelings of the Gulf and Ship Island Railroad Survey, however, the difference is only 25 feet. At Canton, we find the *highest strata*, apparently, of the Jackson Group—the gray calcareous clay matrix of the *Zeuglodon*, occupying the surface,

though at a moderate depth (20 to 30 feet) the lignito-gypseous material is struck, yielding undrinkable water. The same strata are seen all the way between Canton and Jackson, and crop out very characteristically half a mile N. of the State House. Yet we find lignitic strata cropping out on Moody's branch, a mile N. E. of the State House, and that at a hypsometrical level obviously *higher*, than that at which, a mile below, we find the beds of blue fossiliferous sand cropping out on Pearl River and in the bed of Dry Creek. Making due allowance for the undulations of the surface at both stations (Canton and Jackson), the *surface* of the lignitic strata, so far from exhibiting a southward dip, is still slightly higher at Jackson than at Canton. It seems difficult to account for this condition of things unless by supposing a local upheaval of the underlying formation to have taken place before the deposition of the lowest of the Jackson stage. I am not aware whether or not similar irregularities exist in other meridians; it is certainly not the case on that of the Chickasawhay River, where the same strata sink regularly below the water level, as we advance southward.

201. *Localities of the Jackson Group.*—I am not personally acquainted with the extreme western portion of the formation, in Yazoo and S. W. Madison. According to L. Harper, the marine eocene strata first appear a short distance S. of Satartia, Yazoo county, where the material is of a clayey character, and contains, among other fossils mentioned by him, *Venericardia planicosta* and *Castridium vetustum* ("*Eburna*")—sufficient to distinguish it from the Vicksburg marls, further S. I have also been informed, that bones of the *Zeuglodon* have been repeatedly found in the neighborhood of Satartia; and vertebræ of the same have been kindly forwarded to the collection of the Geological Survey, by W. S. McKee, Esq., residing near Satartia, Yazoo county. Harper further mentions the occurrence of compact limestone containing *Venericardia planicosta*, on the bluff near the Warren county line, and of a bed of marl (fossils not mentioned) on S. 1, T. 18, R. 5 E., Warren (Yazoo ?) county; I have seen no specimens of these materials.

202. About 3 miles N. of Canton, the most northerly indications of a calcareous formation are met with, in the shape of soft white concretions of carbonate of lime, appearing in a rather stiff yellow loam, at the bottom of gullies. These indications increase as we advance southward, and in some small R. R. cuts N. of Canton, we find profiles in which the common yellow surface loam is underlaid, at the depth of about 3 feet, by a heavier loam containing calcareous concretions, of about the same thickness. This in its turn, is underlaid by a stiff, bluish white clay of massy cleavage ("joint clay"), with white, calcareous concretions and veins, but containing no fossils. There are not, between these several materials, distinct stratification lines; there is rather a gradual transition from one to the other, the upper being probably derived, in the main, from the blue clay below, but changed by oxidation, the admixture of sand and the partial removal by lixiviation of the lime, which has accumulated in the lower portion of the mass.

203. The country between Canton and Calhoun Station, on the N. O., J. & G. N. R. R., is so level as to afford little opportunity of examining the formation. The peculiar greenish hue, however, which the yellow surface loam assumes in the deeper washes, sufficiently indicates the proximity to the surface, of the calcareous clays, which are also struck in cisterns—shallow wells yielding either undrinkable water or none at all. S. of Calhoun Station, the strata of the calcareous tertiary are well exposed; affording the following section in the "Montgomery cut:"

(Sec. 26.)

SECTION IN A R. R. CUT NEAR CALHOUN STATION.

	FEET.	CHARACTER OF STRATA.	NO.
. . .	5	Yellow loam, concretions of lime in its lower portions.	3
c	15 to 20	Stiff, greenish yellow, calcareous clay, of massy cleavage, containing calcareous concretions. In its lower portions almost blue, cleaving into large, smooth, irregular fragments.	2
† † †	8 to 10	Grayish white clay marl, resembling Rotten Limestone, stratified in layers (of massy cleavage within themselves) 2 to 3 inches in thickness. Contains numerous fragments and impressions of shells, mostly indistinct, some oysters, and bones of *Zeuglodon*.	1

In No. 1, a very large skeleton of *Zeuglodon*, (remnants of which are still abundant in the pile thrown out of the cut), was found, but unfortunately, its portions were scattered all over the country. Here also, the stratification lines are not very distinct, and the thickness of the Zeuglodon stratum, especially, varies greatly. At Rev. J. R. Lambuth's, about 2 miles E. of the cut, this stratum, struck in a cistern, was found only 18 inches in thickness.—It is chiefly stratum No. 2 of this section, which causes the troublesome caving of the sides of this cut.

204. The banks of Pearl River, and the hills bordering the bottom, do not exhibit any outcrops in this region, nor are these very common until within a few miles (N.) of Jackson, where strata closely resembling the matrix of the *Zeuglodon* at the cut (Sec. 26), appear in washes on the roadside ; containing large numbers of the oyster before mentioned, but only traces of other fossils. The same material is found outcropping near the Lunatic Asylum, about ⅔ mile N. of the State House.

The following general section, deduced from observations at Moody's branch and in the McNutt Hills, 1 to 2 miles N. E. of Jackson, will best illustrate the condition of things in this neighborhood.

(Sec. 27.)

SECTION OF JACKSON STRATA, AT MOODY'S BRANCH AND McNUTT HILLS.

FEET.	CHARACTER OF STRATA.	NO.
30 to 45	Yellowish-white marl, more or less sandy, sometimes indurate and forming a soft rock; gives rise to "bald prairies" in the McNutt Hills. Contains bones of *Zeuglodon*, vertebrae and teeth of fish, *Echinus !*, *Scutella*, *Hemiaster ?*, and casts of univalves and bivalves of the Jackson Group.	7
6 to 10	Yellowish white, clayey marl, with few fossils—*Pecten nuperus*, *Pinna*, *Ostrea*.	6
8	Coarse yellow sand, somewhat clayey, with "Jackson fossils" in a fine state of preservation.	5
..	....	..
2	Blue sand, with Jackson fossils, mostly detritus.	4
10	Blue sandy clay, fetid, somewhat micaceous; its upper portion filled with oddly shaped, ferrugino-siliceous concretions. No fossils.	3
1	Earthy Lignite.	2
10	Gray laminated clay, interstratified with sand, with traces of stems and leaves.	1

No. 6 of this section may correspond to the gray calcareous clay seen N. of Jackson. It seems, however, that in No. 7 also, sandy and clayey materials alternate more or less.

205. On Pearl River, just *above* and *at* the bridge, strata No. 4 and 5 appear *in the bed of the river*, the whole being, apparently, of a bluish tint, and its fossils well preserved. The bluff at the bridge, and the hillsides below the State House, exhibit the yellow surface loam, adn sometimes pebble beds, underlaid by greenish yellow, massy clay or loam, which lower down becomes bluish-white, and in all respects similar to stratum No. 2 of Sec. 26 (Montgomery cut), containing soft calcareous veins and concretions. Beneath these, 15 to 25 feet below the hilltops, we find yellow calcareous sand with numerous corals and imperfect casts of shells, and the same concretions as in the clay above. Beneath this stratum, which is 12 to 18 feet thick, there appears, in the bed of the river, the blue sandy marl with Jackson fossils—strata Nos. 4 and 5 of the preceding section. The same strata, the matrix of the "Jackson shells," also crop out on Dry Creek, S. of Jackson, where, as well as at Moody's Branch, I have obtained fine collections of fossils. They are also seen on the opposite bank of Pearl River, to the left of the road embankment, and in the bed of the river below Jackson for several miles.

206. The following is a list, prepared by Prof. W. D. Moore, of the fossils found in strata Nos. 4 and 5 at Moody's Branch and Dry Creek. With a few differences in the relative prevalence of species, the character of the fauna at both localities is essentially the same. Four species not found on Dry Creek are represented at Moody's Branch, while 15 species not occurring at the latter place were found on Dry Creek. It will be perceived that 8 of the species mentioned below (marked with an asterisk*), are also found at Vicksburg, thus rendering the gap between the two faunas less wide and abrupt, than the lists heretofore published would make it appear.

FOSSILS OF THE LOWER SHELL-BED, AT JACKSON.

NOTE.—*Fossils common to the Jackson and Vicksburg Stage, are marked with an asterisk*. All the species not otherwise marked have been named and described by* CONRAD.

FISH.

The teeth of several species of sharks occur in the strata of the Jackson Group; all those mentioned in the catalogue of the Vicksburg fossils (¶220) seem to be represented. Prominent among them, both for frequency and size, are teeth of *Carcharodon angustidens*, of which specimens 4 in's in length have been found near Jackson.

BIVALVES.

Venericardia planicosta.
**Venericardia rotunda*, LEA.
**Cytherea sobrina*
**Cytherea imitabilis.*
**Mactra funerata.*
Cardium Nicolleti.
Astarte parilis.
Crassatella flexura.
Corbula densata.
Corbula bicarinata.
Corbula, 2 n. sp.
Egeria, 3 n. sp.
Tellina, sp.
**Psammobia lintea.*
Psammobia, sp.
Lucina, 2 sp.
Lucina ?
Corbis, n. sp.
Solen.
Panopaea n. sp. (all. to P. oblongata).
Nucula, 3 n. sp.
Leda multilineata.
Leda, n. sp.
**Navicula lima.*
Navicula aspera.
Glossus filosus.
Avicula, n. sp.
Pinna.
Pecten nuperum.
Pecten, 2 sp.
Teredo Mississippiensis.

UNIVALVES.

**Dentalium Mississippiense.*
Capulus Americanus.
Trochita trochiformis
Trochita, n. sp.
Umbrella planulata.
**Natica Vicksburgensis.*
Natica permunda.
Natica, n. sp.
Pyrula sp., (fenestrated).
Strepsidura dumosa.
Clavelithes humerosus.
Clavelithes varicosus.
Clavelithes Mississippiensis.
Fusus sp.
**Turbinella Wilsoni.*
Caricella polita.
Mitra dumosa.
Mitra Millingtoni.
Voluta dumosa.
Voluta symmetrica.
Rostellaria velata.
Rostellaria extenta.
Morio Petersoni.
Conus tortilis.
Marginella 2 n. sp.
Cypraea fenestralis.
Cypraea pinguis.
**Cypraea lintea.*
**Cypraea sphaeroides.*
Ancillaria.
Gastridium vetustum.
Turritella alveata.
Turbo sp.
Architectonica acuta.
Architectonica bellastriata.
Phorus reclusus.

RADIATA.

Scutella Lyelli ? — *Clypeaster* sp., Des.
Hemiaster sp., Des.

CORALS.

[illegible] — [illegible]
Osteodes irroratus. — *Eschara* 2 sp.
Ceriopora 5 sp.

207. Of the geology of N. Hinds, northward of Brownsville, and of the adjoining portion of Madison, I have thus far no personal knowledge ; *Zeuglodon* bones have, however, been found in that region ; and also in the bank of Pearl River, 5 miles S. of Jackson.

The formation of N. Rankin (N. of the Peelahatchie), as well as those of Scott county, still remain to be examined ; prairies and *Zeuglodon* bones, however, which are currently reported as existing in that region, are sufficiently indicative of its character. Outcrops of shell marl are mentioned as occurring on Coffee-bogue Creek, by Prof. Wailes, and near Hillsboro', by D. Harper ; the characteristic shells are not mentioned.—Since the geological map of the State went to press, I have been informed by J. A. Crooker, Esq., Asst. Engineer on the Southern R. R., that a marl-bed was passed through in a road-cut on S. E. ¼ S. 31, T. 6, R. 12 E., Newton county, showing that in that region, the calcareous Tertiary extends further N. than it appears on the map. From the description given, this marl seems to belong to the Jackson Group. Fine specimens of marl, containing disintegrated shells of the Jackson Group, have been found by Rev. E. B. Sims, on his plantation, near Morton, Scott county.

On the prairies of S. Scott and N. Smith, the *Zeuglodon* bones, as well as oysters, are very abundant, and are nowhere more easily freed from the matrix, which is generally a very tenacious, greenish-yellow, or bluish, calcareous clay, of irregular cleavage, containing traces only of shells, except when preserved in flat ferruginous concretions occasionally occurring in the same. Such is the case, for instance, in the outcrops near Mrs. Nichols', S. 15, T. 3, R. 9 E., Smith county, where this clay forms the subsoil ; it contains here, not only the carbonate, but also sulphate of lime, in crystals. *Zeuglodon* bones have been plowed up, and washed out in gullies, repeatedly. The bones here are very little changed by petrification, and very light as compared with those found in Clarke county, so that complete skeletons could, when found, be extricated and transported with less trouble than in any other locality I have seen. Very nearly the same condition of things obtains further N., in the prairies near, and southward of, Homewood, Scott county.

208. Of the Jackson shell-bed I have thus far seen nothing in this region ; both here and in N. Jasper, the clayey *Zeuglodon* beds alone seem to crop out, forming very heavy soils, partly "black prairie", partly "hog-wallow prairie". The latter soil is seen on all the dividing ridges in N. W. Jasper, while the black prairie soil, with the calcareous strata themselves, appears only on the slopes towards the streams, and in the bottoms of the latter. Thus, in passing from Mrs. Nichols' place (see above) to Garlandsville, we find on the whole route no signs of a calcareous formation, save in the bottom of the West Tallahala—a black, calcareous prairie soil ; and within a short distance of Garlandsville, the prairies on the Suanlovey. Here again we see the yellow, more or less calcareous, clay subsoil, gradually passing into a massy, bluish clay with calcareous concretions ; and underlying this, the grayish-white more or less clayey matrix of the *Zeuglodon* bones ; he latter, accompanied as usual by a large oyster, corals, etc., are abundant on the S. side of Suanlovey Creek, on the N. half of S. 14, T. 4, R. 11 E. (Dr. Loughridge's land), where it forms bald or "shell prairies", as they are termed here, in contra-distinction to the "Post Oak" or "hog-wallow" prairies. At the foot of the low ridge which bears these prairies, we find the blue, calcareous, non-fossiliferous clay often mentioned, which

seems to be in many cases the result of disintegration, rather than a stratum occupying a distinct position in the Tertiary—properly, perhaps, in its present condition, a member of the Orange Sand Group. Lower down, on S. 8, we find black prairie soil in the bottom of the creek. I have not heard of the occurrence of any calcareous strata N. of Garlandsville. The road from Garlandsville to Paulding runs on a sandy ridge, on both sides of which belts of black prairie, on which the *Zeuglodon* is found, extend along the streams. In the "lime country" S. of Paulding, however—(about Claiborne P. O.,(no *Zeuglodon* bones are reported to have been seen.

209. In Clarke and Wayne, the Jackson Group, although its territory is diminished in width, is well and characteristically developed, and affords good opportunities for observation.

From the hillside on Coonupy Creek, where it first appears on the Quitman and Winchester road (¶196), we trace the whitish marl of this group southward, through outcrops and prairies, to the neighborhood of Dr. Ogburn's, S. 21, T. 1, R. 16 E., Clarke county. Here we find on the bluff of the Chickasawhay River, about 50 feet of calcareous, fossiliferous materials, *under*laid by gray and reddish laminated clays—the same, no doubt, as those cropping out on Coonupy Creek. The upper portion of the marl stratum resembles greatly stratum No. 6 of the section at Moody's branch, and contains, among other fossils, *Morio Petersoni*, *Leda multilineata*, *Rostellaria velata*, *Mactra funerata*, *Cytherea imitabilis*, *Turritella alveata*. My last visit to this point having happened during high water, I was unable to determine whether Nos. 4 and 5 of the Jackson profile (Sec. 26) are represented here; specimens of the underlying clay, however, were collected by me in 1855.—They are unequivocally present, however, in an outcrop about a mile S. of Dr. Ogburn's, at the bridge across Garland's Creek.

210. There are about 7 feet of the tertiary strata visible above the bed of the stream, which itself flows on a material closely resembling that on Pearl River, at Jackson—a blue sandy marl, with numerous shells, and greensand grains. This material extends, unchanged, up to about 5 feet above the bed; then, there overlies a mass consisting of shells and numerous, large grains of greensand—an analysis of which will be found in another place (¶292). Both beds contain, in well preserved condition, the shells of the Jackson Group, among which even a superficial search detected twenty-two species of the leading Jackson shells.

Between Garland's Creek and Suck Creek, 1 mile S. of the former, we again find prairies, and at the crossing of the latter stream, we find its bed entirely excavated into bluish white marl containing but little sand, and essentially the prevalent fossils of stratum No. 7 of the McNutt Hills (Sec. 27), viz: corals, oysters, *Pecten nuperus*, *Scutella*, and vertebræ of fish.

211. At and near Gen. W. B. Trotter's plantation, S. 3, T. 10, R. 7 W., the Jackson strata are finely exhibited. The country between this locality and Suck Creek, is also chiefly of a prairie character, and so is the greater portion of the plantation itself. The black prairie soil is underlaid by a stratum, of variable thickness, of yellow, and lower down, greenish yellow underclay, more or less calcareous, without fossils. Beneath this we find on the hillsides, about ten feet of a soft, whitish, calcareous mass, apparently without fossils; beneath this again, there is a ledge more or less indurate in its different portions, not well exhibited, but about 4 to 7 feet in thickness. In this ledge, which is touched by the plow, *Zeuglodon* bones and oysters abound, together with teeth of *Carcharodon*, large vertebrae of fish, and nuclei of bivalves and univalves. Among the latter, *found associated with the vertebrae of Zeuglodon*, is *Cypraea fenestralis!*—and *Conus tortilis!*—also, a very large (4 to 5 inches long) *Pyrula*, not seen elsewhere.

A few feet below the level of this stratum, is the top ledge of the profile given by L. Harper (Report, p. 144), occurring in a gully about 18 feet deep, in which several ledges, 6 to 12 inches thick, of whitish rock, resembling the *Zeuglodon* matrix above, alternate with sandy glauconitic marls, similar in general to the lower stratum at Garland's Creek, save in that the fossils are very poorly preserved. The same strata appear on the banks of the Chickasawhay River, not far hence, containing vertebræ of *Zeuglodon*, *Ostrea*, *Pecten nuperus*, *Scutella*—generally much broken.

212. On the highest points in the plantation, we observe fragments of a fine-grained ferruginous rock containing a few white fossils, not represented in the Jackson Group. In passing thence towards Red Bluff Station, on the M. & O. R. R., we remain on a level with this hilltop, and at several points, high precipitous bluffs come in close to the river. At a point about a mile from the Stn., a bluff about 70 feet high, coming down in terraces to the waters edge, affords the following profile :

(Sec. 28.)

SECTION OF TERTIARY NEAR RED BLUFF STATION, WAYNE CO.

	FEET.	CHARACTER OF STRATA.	NO.
* * * *	12	First terrace—surface materials only visible.	4
———	4	Greenish, non-effervescent clay.	3
| | |	4	Irregular masses of fine-grained ferruginous rock, imbedded in a brownish or greenish clayey mass ; both with well preserved fossils.	2
† † †	52	Bluish calcareous clay, with indistinct fossils. It is least calcareous, and most clayey, above ; near the waters edge, approaches in character to the blue marl in Trotter's field. A fragment of a *Clypeaster*, vertebræ of a shark, *Pleurotoma* sp.	52

Descending to the water level, we see, several hundred yards above, ledges of whitish limestone dipping under this stratum and disappearing at the waters edge. These ledges contain the same fossils as those seen on the banks of the river near Trotter's plantation ; and this is the last characteristic outcrop of the Jackson Group with which I am acquainted ; for whether or not the material of stratum No. 1 of the preceding section properly belongs to this group, the fossils thus far found have not enabled me to determine. It still continues to be seen in the river bluffs for some distance, as we advance southward, but it gradually sinks and brings the fossiliferous stratum No. 2 close to the waters edge.

213. *Beds intervening between the Jackson and Vicksburg Group.*—The fossiliferous bed No. 2 of the preceding section seems to stand intermediate, by position as well as by its fossils, between these two groups, though on the whole, it seems in its fauna to approach more nearly the Vicksburg, than the Jackson Group ; but while it has some fossils in common with *each* and *both* of the other groups, it is no less remarkable for the predominance of peculiar species—a trait

which distinguishes as widely the several stages of the Southwestern Eocene of the United States, as even the primary divisions of the entire Tertiary of the old continent.

The perfect state of preservation in which we find the fossils of this Red Bluff Group, the easy accessibility of its strata, and withal the narrow limits to which, thus far, I have found it to be confined—the bluffs of the Chickasawhay from Trotter's plantation (where the ferruginous rock, peculiar to this group, first appears on the hilltops—see ¶ 212) to Red Bluff Station, or a little below—impart a special interest to this deposit. At low water, the sloping bed of the Chickasawhay River may in spots be found strewn with perfect shells of this group, washed down from above by the rains out of their easily disintegrated clay matrix. I give below a list (for the compilation of which I am indebted to Prof. W. D. Moore, Univ. of Miss.) of the fossils thus far collected from this stratum, determined so far as they are identical with species described by Conrad and Lea, the rest being determined generically only. The species in common with Vicksburg are marked with an asterisk*, those in common with Jackson, by a dagger†.

Venericardia planicosta †.
Venericardia rotunda, Lea.*
Cypricardia.
Pecten nuperus.
Plagiostoma
Ostrea, 2 n. ? sp.
Pectunculus.
Astarte (allied to *A. recurva*, Lea.
Cardium diversum, Con.*
Corbula.
Leda.
Cytherea.
Dentalium thalloides, Con. ?
Natica Vicksburgensis, Con.*
Natica sigaretina, Con.*
Capulus.
Capulus.
Pileolus.
Trochita trochiformis, Con.
Mitra Mississippiensis, Con ?*
Cypraea sphaeroides, Con.
Clavelithes humerosus, Con ?†
Clavelithes.
Pyrula 2 n. sp.
Busycon spiniger, Con.*
Fusus (1) (allied to *F. Mississipp.* Con.*)
Fusus.
Turbinella perexilis, Con.*
Turbinella protracta, Con.*
Murex, 3 sp.
Triton.
Rostellaria velata, Con.†
Buccinum Mississipp. Con.* ?
Buccinum.
Cassis.
Cassidaria lintea, Con.*
Fulgoraria Mississipp. Con.*
Caricella.
Conus sauridens, Con. * ?
Bulla 2 n. sp.
Solarium.
Flabellum Wailesii, Con. †?
Osteodes, Con. ! (not *O. irroratus*).
Madrepora (allied to *M. Mississippi.* Con.*, but distinct.)
Serpula.

Southward of the locality mentioned the green clay (No. 3 of Sec. 23.) appears in greater thickness; it is this, no doubt, from which the heavy soil on top of the terrace, or "hommock" (which closely resembles the "hog-bed" soil of Jasper, and is so termed by the inhabitants) is derived—intervening, here as elsewhere, between the prairies of the Jackson and Vicksburg Group. Crystals of selenite, also, have been obtained from the banks of the river, and from wells, in this neighborhood.

214. *Lignitic Beds.*—At Vicksburg, and at Brandon, lignitic clays and sands underlie the lowest visible strata of the Vicksburg Group. Whether or not similar beds are accessible on Pearl River and Chickasawhay, I have not ascertained. At Vicksburg, about 25 to 30 feet of black lignitic clays and sands, and lower down, of lignite, underlie the calcareous marine strata. The lignite was supposed to extend to a considerable depth, but according to an observation made by Prof. W. D. Moore, at extreme low water, its thickness does not exceed 3 feet, it being underlaid by a soft whitish limestone, of which he obtained a small

specimen at the waters edge. It resembles the indurate marl of the McNutt Hills; the only fossil which is distinguishable on the specimen obtained (now in the cabinet of Oakland College) is a cast of *Cardium*, not sufficiently distinct to allow of observing the differences distinguishing the *Cardium diversum* of Vicksburg age from *C. Nicolleti* of Jackson and Claiborne.

215. The position of the Brandon bed is given in Sec. 30 (¶218; stratum No. 1). Its relation to the Jackson beds cannot, however, be observed there. N. of Brandon, at Mr. John Parker's place, S. 19, T. 6, R. 4 E., there is an alternation of calcareous and gypseous strata, represented in the following profile obtained in a well by that gentleman:

(Sec. 29.)

SECTION OF TERTIARY IN MR. JOHN PARKER'S WELL, RANKIN COUNTY.

	FEET.	CHARACTER OF STRATA.	NO.
* * * *	8	Yellow, massy ("joint") clay, in its lower portions with white calcareous concretions.	5
	4 to 6	Gray massy clay, with smooth cleavage planes, and rosettes and lenticular masses of *Selenite.*	3
c	2	White calcareous stratum, with numerous concretions.	4
( )	26	Gray massy clay, with numerous well preserved shells.	2
† † †	40	Blue marl, less clayey than the above, and with shells partially disintegrated.	1

Unfortunately, I was unable to obtain specimens of the shells contained in strata Nos. 1 and 2; there can be little doubt, however, that they are of the Jackson age. The gray gypseous clay No. 3 crops out near the mouth of a creek into the Pelahatchie, S. 7, T. 6, R. 4 E.; it there contains both selenite and small masses of lignite. It seems to be this clay chiefly, from which the soil of the "gypseous prairies" of N. Rankin and Hinds is derived, while the calcareous strata (No. 4, and part of 5) form small prairies or 'prairie hilltops" on the intervening hills. Strata 3, 4 and 5 occur at Clinton, and in a R. R. cut S. of Jackson; specimens of selenite occurring in gray clay, have been collected by Prof. Wailes, 7 miles N. W. of Jackson, and are mentioned as occurring abundantly at Ball Prairie, 6 miles W. of Jackson.

216. I have also obtained crystals of selenite from Scott county, where, from all accounts, the gypseous prairies are well developed. In Smith county also, N. of Raleigh, at L. E. Crook's place on the Okahay, there is a body of gypseous and black prairie intermingled, precisely as we find it at John Parker's. It might appear at first sight that these gypseous strata could be referred to the Grand Gulf Group, and such was my first impression. But it is difficult to reconcile this supposition with their geographical and hypsometrical distribution, besides which, their lithological character is entirely different from the blue or brown laminated clays of the lignito-gypseous strata which unequivocally overlie the Vicksburg strata, and form "salty spots" in the soil, but nowhere so far as I have seen, anything resembling the gypseous prairie. On the other hand the clay found in the outcrop on the Peelahatchie is undistinguishable from specimens of the calcareo-gypseous matrix of the *Zeuglodon* in Mrs. Nichols' field. In Wayne county, too, on the Chickasawhay, heavy, greenish or bluish clays intervene between the Jackson and Vicksburg strata, and everywhere we find intervening between the black prairie territory of the two groups, either the gypseous, or "hogbed prairie" soils.

The absence, thus far, of deep wells or borings on the territory occupied by the Vicksburg Group and by these doubtful clays, has prevented me from obtaining satisfactory evidence on this question. If, as I suppose, the material of the gypseous prairies is derived from an irregular stratum intervening between the Jackson and Vicksburg Group, it is nevertheless true that in some localities the soils derived from the strata overlying the latter, approach very closely, both in space and quality, to those derived from the lower stratum in question.

IV. THE VICKSBURG GROUP.

217. This interesting group, the highest of the marine eocene formation of Mississippi, and the only one which reaches the banks of the Mississippi River (at Vicksburg, where it was first studied by Conrad) occupies a narrow belt of nearly uniform width, southward of the territory of the Jackson Group, extending accross the whole of the State, to the Alabama line, and thence to the Tombigbee River, where it forms the well-known bluff at St. Stephens. It is the only one of the marine stages of the eocene, which exhibits *crystalline limestones ;* associated, however, with blue and white marls more or less indurate at times, as is the case with the other groups.

The marls, which have a tendency to be sandy rather than clayey, are the prevalent materials of the formation, and the chief repositories of the beautiful fossils of the group ; they usually alternate with ledges of blue (or by oxidation yellowish) limestone, more or less sandy and glauconitic, and not unfrequently contain within their mass, indurate, rounded nodules, often very rich in fossils.

218. It would be difficult, however, to give a description of these calcareous strata without referring at the same time, to the *lignito-gypseous** strata which generally accompany, usually overlie it, and might be considered as strictly belonging to the Grand Gulf Group, but for their being found in one locality at least, *overlaid* by a string of limestone nodules containing the characteristic fossil of the Vicksburg Group—the *Orbitoides Mantelli*. Through this, so close a connection is apparently established between the two groups just mentioned, as to afford a strong presumption in favor of the eocene age of the Grand Gulf Group itself. This circumstance, together with the occurrence of tree palms in

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**i. e.*, clays or sands containing more or less gypsum and lignitic matters.

latitudes where none exist at present, is the only clue we have thus far to the age of the latter group. I shall therefore give, first in order, the sections occurring near Brandon, Rankin county, in which these relations are illustrated. The outcrops from which this general section is compiled, embrace between them a space of nearly seven miles E. and W. along the line of the Southern R. R., from the junction of the old and new track near Brandon, to Batt's Summit. S. 3, T. 5, R. 3 E. The thickness of the strata, as given in the third column from the left, is the result of actual measurement; the *total* thickness, as given in the *first* column, is deduced from the R. R. levelings.

(Sec. 30.)

SECTION OF TERTIARY, FROM YOST'S LIME-KILN TO BATT'S SUMMIT, RANKIN COUNTY.

		FEET	CHARACTER OF STRATA.	NO.
LIGNITO-GYPSEOUS STRATA, 45 FEET.	Batt's Summit (Dent's Cut).	2.	Yellow surface loam.	14
		8	Greenish yellow clay, with calcareous concretions, and lumps of *Orbitoides Limestone.*	12
		7	Yellow or deep orange-colored clay, with massy cleavage; contains crystals of gypsum. Portions of it black with carbonaceous matter.	11
		1½	Cream-colored or white, tallowy mineral, with crystals of gypsum.	10
			Yellow and blue clay interstratified; blue lower down, and massy. Contains crystals and flakes of gypsum, efflorescence of salts on the surface.	9
	Ray's Summit (Burke's Cut).		Lignito-gypseous, clay and earthy Lignite, in cut at Brandon.	8
			Grayish-blue clays, massy or laminated, with crystals, sheets and rosettes of gypsum, and crusts of Yellow Iron Ore (¶224) on cleavage planes.	7
			Gray gypseous clays.	6
CALCAREOUS (VICKSBURG) STRATA, 70 FT.	R. R. cuts near Brandon Depot, (East of)	30?	Yellowish calcareous sands with *Ostrea Vicksburgensis, Pecten Poulsoni*, and casts; in its upper portion, rounded, dark-colored concretions ("nigger-heads") with well preserved Vicksburg fossils—*Arca Mississippiensis, Cardium diversum*, etc.	5
	(West of)		White marls, more or less indurate at times, alternating with hard ledges abounding in *Pecten Poulsoni* and *Orbitoides Mantelli*, which impart to the rock a laminated structure.	4
	A. P. Miller's [illegible], Yost's Lime Kiln.	6	Ledges of solid blue limestone. *Pecten Poulsoni, Orbitoides, Polyporia Miss., [illegible].*	3
		10	White marls, more or less indurate, with hard ledges; *Pecten Poulsoni, Orbitoides Mantelli. Echinoder.*	2
			Gray and yellowish laminated clays, interstratified with sand; non-effervescent, non-fossiliferous. Lowest visible.	1

219. On the ridges S. of Richland Creek, near Brandon, and on the high dividing ridges between the waters of Pearl and Strong Rivers in S. Rankin generally, as well as in S. Hinds (*e. g.*, between Auburn and Raymond), we find the white friable sandstones of the Grand Gulf Group, underlaid by, and

alternating with, lignito-gypseous clays entirely similar to those found in the outcrops on the Southern R. R., east of Brandon. Sandstone similar to this, as well as to the Fort Adams' rock (¶236), is found overlying the calcareous Vicksburg strata near Raleigh, Smith county, and thus generally along the southern line of the Vicksburg Group. But nowhere, except at Batt's Summit, have I found the lignito-gypseous strata overlaid by the marine fossiliferous limestone of that group. On the other hand, the former—or rather the gray gypseous clays resulting from their disintegration, sometimes occupy the surface of the territory, forming "prairies" (whose gray soil and exclusive Black Jack and Post Oak growth along their borders, readily distinguish them from the "black prairies" formed by the calcareous materials of the marine formations); and "salty spots" where efflorescences of various salts (chiefly sulphates of lime, magnesia, potash and sometimes iron, and chloride of sodium) appear on the surface, often injuring vegetation greatly. It would seem, however, that in some localities either the lower portions of the Vicksburg, or the upper of the Jackson beds, are interstratified with heavy, gray clays, gypseous or lignito-gypseous, to which the greater portion of the gypseous prairies owe their origin (see (¶215, ff.)

220. *Localities of the Vicksburg Group.*—The general features of the Vicksburg bluff, which have already been mentioned, are exhibited in the following section. I regret that want of space precludes me from giving the detailed section, in which no less than 21 distinct strata, recognizable at most points, are exhibited.

(Sec. 31.)

SECTION OF THE BLUFF AT VICKSBURG, WARREN COUNTY.

FEET.	CHARACTER OF STRATA.	NO.
10 to 20	Calcareous silt with snails—Bluff Formation.	7
5 to 20	Bluish and yellowish hardpan, often pebbles—Orange Sand.	6
60 to 65	Alternating strata, 1 to 6 feet thick, of limestone and marl, containg the *Vicksburg fossils*, and some bands of non-effervescent, gray sand and clay.	5
5	Black lignitic clay, and gray sand, with *Ostrea gigantea, Corbula alta, Natica Mississippiensis, Cytherea sobrina, Madrepora Miss.*	4
25	Gray or black, lignitic clays or sands, with iron pyrites; exuding salts and sulphuretted hydrogen.	3
3	Solid, lustrous lignite, with whitish cleavage planes.	2
3	White limestone, of the Jackson Group ?	1

Within the bed or series of beds, here marked as No. 5, the thickness of the several ledges varies greatly, so that detailed sections taken at different points of the bluff, exhibit notable variations in this respect. There are, however, several horizons which may be recognized almost everywhere, if the land slides which have taken place at many points, be left out of consideration. Thus, about 25 to 28 feet above bed No. 4 (containing the large oysters), we find a succession of 4 to 5 narrow bands (each 8 to 15 inches thick) of marl and laminated clay, which may be identified at all points, and acquire some importance from the circumstance that immediately beneath them, for the next 10 to 12 feet, the purest and hardest limestone (from whose strata most of the building stones and flagstones used at Vicksburg have been quarried) is found. The specimen of limestone analyzed (¶305) was taken from a point about 5 feet below the clay seams in question; while the marl (¶278) is derived from the 4 foot stratum immediately *over*lying the clay bands. Another stratum which, from the abundance and character of its shells, may be recognized easily, lies about 16 feet above the clay bands—a reddish, sandy marl, about 3 feet thick. Its shells are white, well preserved and easily washed out by the rains; among them, *Ostrea Vicksburgensis*, *Arca Mississippiensis*, *Cardium diversum*, *Dentalium Miss.*, and numerous species of *Pleurotoma*, are conspicuous. Immediately beneath it lies a 3 foot bed of semi-indurate marl with large nodular masses of limestone, which can also be identified at most points; and the whole character of the strata from this bed upwards to the Orange Sand, shows a close correspondence with No. 6 of the Brandon section (Sec. 30, ¶218).

The various clayey strata and bands of the exposure (from which to the marl there are many insensible transitions) give rise to patches of "prairie soil" on the Vicksburg hills.—At some of the higher points where deep washes have exposed the formation, we find at the base of the Orange Sand or its representatives, blue sandy clays greatly resembling some of those of the Grand Gulf Group.

FOSSILS OF THE VICKSBURG GROUP.

(Mostly occurring at the Vicksburg bluff).

FISH.

Carcharodon angustidens, Ag.
Carcharodon megalodon, Ag.? (may belong only to the Jackson Group.)
Galeocerdo latidens, Ag.
Teeth of several other species of *Squalideae*.
Saurocephalus lanciformis, Harl.
Otolithes.
Ichtyodorulites, scales and other remains of fish. (Wailes).

CRUSTACEA.

In the limestone of Vicksburg Marshall and Stewart's quarries, and Brandon neighborhood, the plates, claws, etc., of a short-tailed crab are quite abundant.

MOLLUSCA.

[T. A. Conrad *in Journ. Acad. Nat. Sc. of Phila.*, 2d series, *Vol. I; Trans.-Ac. Oct.* 1847.]

BIVALVES.

Panopaea oblongata.
Pholas triquetra.
Amphidesma Mississippiensis.
Psammobia papyria.
Psammobia lintea.
Tellina pectorosa.
Tellina serica.
Tellina Vicksburgensis.
Donax funerata.
Cytherea astartiformis.
Cytherea imitabilis.
Cytherea semi-punctata.
Cytherea Miss.
Cytherea sobrina.

Cytherea perbrevis.
Mactra Miss.
Mactra funerata.
Crassatella Miss.
Cardium eversum.
Cardium globosum.
Cardium diversum.
Cardium Vicksburgense.
Corbula intastriata.
Corbula engonata.
Corbula alta.
Corbis staminea.
Lucina Miss.
Lucina perlevis.
Loripes ? turgida.
Loripes ? eburnea.
Kellia oblonga.
Chama Miss.
Pectunculus arctatus.
Leda serica.
Nucula Vicksburgensis.
Arca Miss.
Navicula lima.
Navicula Miss.
Navicula protracta.
Avicula argentea.
Modiola Miss.
Pinna argentea,
Pinna n. sp., nearly a foot long; Marshall's quarry.
Lima staminea.
Pecten Poulsoni.
Pecten calvatus, MORT.
Ostrea Vicksburgensis.
Ostrea gigantea.

UNIVALVES.

Dentalium Miss.
Fissurella Miss.
Trochita trochiformis.
Bulla cassiplica.
Architectonica trilirata.
Phorus humilis.
Sigaretus Miss.
Natica Miss.
Natica Vicksburgensis.
Narica Miss.
Actaeon Andersoni.
Ringicula Miss.
Cypraea sphaeroides.
Cypraea lintea.
Conus sauridens.
Oliva Miss.
Cancellaria Miss.
Cancellaria funerata.
Scalaria trigintanaria.
Turritella Miss.
Terebra divisurum.
Terebra tantula.
Buccinum Miss.
Cassidaria lintea.
Cassis caelatura.
Cassis Miss.
Oniscia harpula.
Fulgoraria Miss.
Mitra conquisita.
Mitra Miss.
Mitra cellulifera.
Chenopus liratus.
Mitra staminea.
Mitra Vicksburgensis.
Caricella dlemissa.
Turbinella Wilsoni.
Turbinella protracta.
Turbinella perexilis.
Scobinella caelata.
Triton crassidens.
Triton abbreviatus.
Triton subalveatus
Triton Miss.
Murex Miss.
Melongena crassicornuta.
Typhis curvirostris.
Busycon spiniger.
Fulgur nodulatum.
Clavella Vicksburgensis.
Fusus Miss.
Fusus Vicksburgensis.
Ficus Miss.
Pleurotoma porcellana.
Pleurotoma Miss.
Pleurotoma servata.
Pleurotoma congesta.
Pleurotoma cristata.
Pleurotoma tantula.
Pleurotoma tenella.
Pleurotoma cochlearis.
Pleurotoma eboroides.
Pleurotoma abundans.
Pleurotoma rotaedens.
Pleurotoma decliva.

RADIATA.

Scutella Lyelli.
Mortonia Rogersi ?
Schizaster, n. sp.
Salenia ? n. sp.

CORALS.

Madrepora Miss., Cox.
Madrepora Vicksburgensis, Cox.
Turbinolia caulifera, Cox
Lunulites Vicksburgensis, Cox.
Lunulites sp.
Orbitoides Mantelli.

221. Further than at Vicksburg itself, I have not as yet examined the formations of Warren county, and can state only what I have heard.—N. E. of Vicksburg, on the Yazoo bluff, as well as in ravines (which are deeply cut into the Bluff formation), the Vicksburg strata frequently appear up to Haynes' Bluff on the Yazoo, according to Prof. Wailes. I am not aware, however, that they appear anywhere S. of Vicksburg, nor on the line of the Southern R. R., west of Big Black River. Outcrops exist on the latter stream, above the railroad crossing, in Hinds county; of these, however, I have no personal knowledge. A specimen of very sandy, greenish marl, containing Vicksburg fossils, was collected by Prof. Wailes near Amsterdam, on the Big Black. At Brownsville, the Vicksburg strata crop out in the town, where a spring issues from beneath a ledge of blue limestone containing *Arca Mississippiensis*, *Orbitoides*, *Pecten Poulsoni*, and others; it is overlaid by calcareous glauconitic sand with *Pecten Poulsoni*, *Ostrea Vicksburgensis*, and casts, the whole obviously corresponding to adjacent portions of beds Nos. 5 and 6 of the Brandon profile.

222. The blue limestone crops out on Baker's Creek a few miles below Bolton's Depot; at Steward's quarry, 3 miles W. of Clinton, where specimens of *Panopaea oblongata*, *Clypeaster*, and *Serpula*, were procured by Prof. Wailes; also a specimen of sandy marl containing *Arca Mississippiensis* and *Conus sauridens*. It is found moreover at Marshall's quarry near Mississippi Springs, where impressions of *Crassatella Mississippiensis*, *Cardium diversum*, *Panopaea oblongata*, *Pinna argentea*, *Turritella Mississippiensis*, a large *Phorus*, and *Schizaster*, as well as a small lenticular mass of fossil resin were collected by the same. Two specimens of a very large *Pinna*, not seen elsewhere, have been found by Mr. Marshall.

It is also found about nine miles S. of Jackson, on Pearl River; and about 3 miles S. of Byram Station, near the R. R., where it occurs in disjointed, cavernous blocks rather than in a solid stratum.

223. The banks of Pearl River at and above Byram Station, as well as the bed of the creek close by, exhibit fine outcrops of bluish marls with finely preserved shells, for obtaining which this is a very eligible locality. A section of this outcrop, and an analysis of one of the marls occurring there, will be found further on (¶280).

About half a mile further up, instead of the uniform strata of marl seen in the bluff at Byram, we obtain the following section—corresponding, no doubt, to strata somewhat lower than those at Byram.

(Sec. 32.)

SECTION OF VICKSBURG STRATA, ABOVE BYRAM STATION, RANKIN COUNTY.

FEET	CHARACTER OF STRATA.	NO
1	Gray calcareous sandstone, very hard.	6
2½	Blue marl with shells, and small grains of glauconite.	5
2 to 3	Gray, or variegated blue and yellow, sandy limestone, with numerous shells, of slaty cleavage.	4
2½ to 3	Sandy marl with shells and large grains of glauconite. . . . . Clayey marl, bluish, with fewer shells than upper layer	3
2	Gray or variegated, sandy limestone.	2
	Blue marl—waters edge.	

Shells of the Vicksburg Group, but more especially *Orbitoides Mantelli* and *Pecten Poulsoni*, occur in all these strata.

224. At Mr. German Berry's, S. 11, T. 4, R. 2 E., (Monterey P. O.), Rankin county, we find a blue, sandy glauconitic marl containing *Orbitoides*, *Arca Mississippiensis*, *Pecten Poulsoni*, *Cytherea imitabilis*, etc., cropping out on the banks of Richland Creek. It is overlaid by brown, laminated, gypseous clays, which form the main body of the hills.

The chief outcrops near Brandon have already been noticed in the general profile, so that a few generalities only require to be added. The town of Brandon itself is situated on a high ridge composed partly of Orange Sand, partly of the lignitic strata, which are struck in wells in the S. part of the town, furnishing water strongly impregnated with sulphuretted hydrogen, gypsum, and, usually, magnesian salts; in some instances, sulphate of alumina. Crystals, rosettes and laminæ of gypsum, are very abundant in the lignitic strata of the Brandon neighborhood; in connection with the gypsum, either incrusting it, or intimately mixed with crystals of the same, there occurs a mineral of a sulphur-yellow color, apparently amorphous, but minutely crystalline under the microscope, which consists essentially of hydrated persulphate of iron and sulphate of potash; probably the *Misy*, or Yellow Iron Ore. The same occurs at Shongalo (¶183).

In Mr. Ware's well, S. of town, at a depth of 38 feet, Orbitoides limestone was struck, after passing through the lignito-gypseous strata; and it appears on three sides at the foot of the ridge. Thus, due S. of the town, on S. 34, T. 5, R. 3 E., on Richland Creek; near Dr. Parker's, S. 27, where it appears in ledges 2 to 3 feet thick, but not, apparently, continuous for any great distance. The character of the outcrops in A. P. Miller's field, N. W. of Brandon—SS. 17 and 20, T. 5, R. 3 E., has been given in the general section (¶218); the strata comprehended in No. 2 form hills or low ridges, with a general bearing E. N. E. to W. S. W., and which, according to elevation, are capped with the limestone strata Nos. 3 and 4. An analysis of the rock from No. 3, taken at Yost's lime-kiln, is given below.

225. Similar hills capped with limestone or whitish marl appear, further on in a N. E. direction, at Mr. Jos. Jayne's plantation, and at Rev. D. A. Campbell's place, S. 2, T. 5, R. 3 E. At the latter locality we find, included between two

ledges of limestone (the uppermost of which is rather cavernous), a lenticular mass of calcareous spar, 18 inches to 2 feet in thickness, possessing a drusy surface, and composed of many layers which, when struck, cleave into acicular prisms of irregular form, disposed as usual at right angles to the surfaces or nuclei on which the layers have been formed. A few stalactites which we find imbedded in the upper surface show this mass to have been formed in what was originally a small cave, by means of calcareous solutions infiltrated from above. —Beyond the usual fossils, a *Scutella?*—is very common here; it is always converted into brown calcareous spar.

226. At Dr. I. M. Quin's, 4 miles S. E. of Brandon, we find limestone underlaid by whitish marls, a profile of which, as well as analysis of the latter, will be found below (¶285). I have not explored personally the country on the Brandon and Raleigh road, but according to reliable information, outcrops similar to those at Dr. Quin's and a country resembling that N. and E. of Brandon, continue on to Polkville and beyond, where, on the waters of the Okahey, the calcareous as well as the gypseous prairie are well developed; *e. g.* in the neighborhood, and N. of, Mr. L. E. Crook's place, S. 14, T. 3, R. 7 E.

227. Due N. of Raleigh, at Mr. Austin's mill, S. 18, T. 3, R. 8 E., we find, in the bed of a creek, blue marl with well preserved Vicksburg fossils; the material being, however, very changeable, and sometimes containing large indurate lumps. On the ridges E. of Raleigh, in descending to Shongalo Creek, we find at a level considerably above the marl at Austin's mill, outcrops of Orbitoides limestone; on the summits of these ridges, we find the Orange Sand underlaid by white friable sandstone of the Grand Gulf Group, and in wells on the ridge (as at Mr. Craft's) lignito-gypseous strata are struck. Between Shongalo and Bowland's Creek, on the Garlandsville road, the lignito-gypseous strata, as well as the sandstone, are wanting, while at the level at which these are found on the ridges near Raleigh, the Orbitoides limestone appears—forming ridges with flat backs, on which round knolls of Orange Sand are perched, while on the hillsides, we find prairie soil.—After crossing Bowland's Creek, on the Garlandsville road, no more limy strata appear until we reach the Nichols neighborhood, where the *Zeuglodon* bones are found (¶207).

228. I have not personally explored the territory of the Vicksburg Group in S. Jasper; it is described, however, as being entirely similar to that in Smith county, even as, still further S. E., I have found it in Wayne. Observations made by Prof. W. D. Moore, on the Paulding and Williamsburg road, show fine outcrops of the strata of this group to exist near Judge McCollum's, at a point about 3 miles S. W. of Paulding, where there appear on the hillsides, strata characterized by great numbers of the *Schizaster*, occurring with *Pecten Poulsoni*; and at a lower level, the Vicksburg bed containing *Ostrea gigantea*, crops out. As in the territory of the Jackson Group, N. of this, the appearance of outcrops is very much dependent upon accidental circumstances, since the ridges consist of Orange Sand, and it is only in the deeper channels that the eocene strata are exposed at all.

229. In Wayne county, W. of the Chickasawhay River, in T. 9, R. 7 W., the ridges are also to a great extent composed of Orange Sand; yet we frequently find strata of sandy marls with *Orbitoides* and *Pecten Poulsoni*, cropping out on the hillsides, and sometimes on the hilltops also.

On the Chickasawhay, between Red Bluff and the latitude of Waynesboro', both marls and limestones crop out with frequency; the same is the case on the creeks on the E. side, as on Cakchey's Mill-creek, and Limestone Creek; especially near the mouth of the latter, at the foot of the hill on which Dr. E. A. Miller lives—the most southerly outcrop of the calcareous Eocene on the Chickasawhay. The sections exhibited here in the river banks and cuts of the R. R., correspond so closely to those between Yost's Lime-kiln and Brandon Depot (¶218), that the specimens can hardly be distinguished from each other when placed side by side; the only difference being the great abundance of

Orbitoides in the soft white marl intervening between the strata of rock. The ledges of hard limestone (Nos. 3 and 4, Sec. 33) are not so well defined—the rock being softer and whitish; as it appears on the hillside, where the plow touches it. The sandy strata (No. 6) are the same in every respect. Near the top of the hill, Dr. Miller found in his well a stratum of blue shell marl 3 or 4 feet in thickness, underlaid by a stratum 3 or 4 feet thick, of green laminated clay.—The aggregate thickness of the calcareous Vicksburg strata, as observed here, also corresponds very nearly to that deduced at Brandon from the R. R. levelings.

According to information given me by Dr. Miller, the same strata appear on the Buckatunna, E. and S. E. of his place. Between the two streams, there extends a belt of calcareous prairie—or rather, a succession of prairie spots on the ridges, where the limestone frequently crops out—characterized always by *Orbitoides* and *Pecten Poulsoni*, and not unfrequently, by a very large *Salenia?* —Between this prairie belt and those extending eastward from Trotter's Plantation and Ogburn's (¶209), there intervenes a belt of "hogbed soil"—formed perhaps, from the clayey strata interposed between the Jackson and Vicksburg Groups.

V. THE GRAND GULF GROUP.

230. Notwithstanding the large extent of territory represented on the map as occupied by this formation, it is of less importance to the district of its occurrence, than most of the formations heretofore mentioned, are to theirs. Not only is it comparatively poor in useful materials, but on the whole, it takes but a limited and unimportant part in the surface conformation of the region, which is chiefly due to the deposits of the Orange Sand age. Its greatest development takes place on the waters of Pearl River, and on the tributaries of the Mississippi; while on the waters of Leaf, Chickasawhay, and Pascagoula Rivers, it often requires a diligent search to detect it at all under the heavy covering of the Orange Sand.

231. Its materials are, essentially, clays and sandstones, the latter generally rather aluminous and soft, and of white, gray and yellowish-gray tints; the sand being very sharp. Beds of loose sand are unusual; but the clays are oftentimes quite meagre, though the sand contained in them (as is the case in the sandstones) is usually quite fine.

Beds of pure, highly tenacious clay are quite abundant, however, and there is on the whole, little tendency to lamination; so that, while in the Northern Lignitic formation, massy clays are the exception, they are the rule in the Grand Gulf stage. It is owing to this circumstance, no doubt, that the fossil remains of plants, which are far less common in this than in the lower stages of the Lignitic, are so rarely well preserved. The colors of these clays, also, are generally much lighter than these we see in the Northern Lignitic, being rarely other than gray, grayish white, blue and green—the latter colors often reaching a high degree of intensity; though on their surface, they often appear yellow from oxidation.

N. W. of a line drawn from Fort Adams, Wilkinson county, to Raleigh, Smith county, sandstones are quite abundant in this formation—rather the prevalent material. S. E. of that line, however, I know of none, the several kinds of clay forming the exclusive material.

So far as I know, the whole formation from Grand Gulf and Raymond to Dwyer's Ferry on the Pascagoula River, is characterized by the presence, more or less, of *gypsum and common salt,* and generally also of *magnesian salts.* This is the case even with many of the solid sandstones, which on exposure to the weather become covered with efflorescences of salts; and it is to this peculiarity, no doubt, that their want of durability is to a great extent to be attributed. Moreover, these sandstones frequently contain small concretions of iron pyrites, which vitriolesce when the rock is exposed, and thus rend even large blocks.

The carbonate of lime is a rare ingredient, and the deposits containing it are always quite limited. Even in these, I have never detected even a trace of marine fossils.

232. *Localities of the Grand Gulf Group.*—No outcrop, perhaps, is more characteristic, and represents within a small space so many peculiarities of the formation, as that from which it has taken its name—that forming the Bluff at Grand Gulf, on the Mississippi River, where it is overlaid by the calcareous silt of the Bluff formation. The following is a detailed section obtained by myself, on the spot:

(Sec. 33.)

SECTION OF THE BLUFF AT GRAND GULF, CLAIBORNE COUNTY.

FEET	CHARACTER OF STRATA.	NO.
60 to 70	Calcareous silt of the Bluff formation, forming the hilltops.	12
14	"Grand Gulf Sandstone," in ledges 10 inches to 2 feet in thickness; stratification often discordant and curved.	11
15	Gray sandy material, sometimes soft sandstone, with an argillaceous cement; alternating with harder ledges, 6 to 10 inches thick, of friable, whitish sandstone	10
2½	Solid whitish sandstone, of good quality.	9
2½	Greenish-gray clay, with white veins of carb. of lime.	8
1	Soft white sandstone.	7
½	Grayish-yellow pipeclay.	6
1	Dark gray, brittle sandstone.	5
3	Gray, semi-indurate, clayey sand.	4
17	Gray and yellowish sands and clays, semi-indurate, interstratified.	[illegible]
3	Semi-indurate, gray sand.	2
2	Greenish gray clay, with veins of carbonate of lime.	1

233. The character of the minor ledges of this section is very changeable, so that, fifty yards from the precise point where these data were taken, the aspect of the lower portion of the profile especially, may vary greatly. It is only the upper ledge (No. 11) which possesses the peculiar structure which characterizes the "Grand Gulf Sandstone" proper, viz: Grains of pellucid quartz, constituting rather a coarse sand, imbedded in an opaque, white, enamel-like mass of silex,

which forms quite half of the bulk of the rock. It is not of common occurrence, except near the latitude of Grand Gulf. It appears in a ledge about 15 inches thick, on hillsides at a branch about 2 miles S. W. of Port Gibson, underlaid by massy blue clay; an outcrop N. of Port Gibson, on Mr. J. C. Humphreys' land, does not exhibit the peculiar structure of the "Grand Gulf rock." At Rocky Spring, in a profile of 30 feet, we find only 2 or 3 feet of the peculiar rock, and then rather in lenticular masses than in continuous strata, the rest being soft sandstones, clays, etc., which form the usual material of the numerous outcrops in Claiborne and S. Hinds; and to describe which would be endless repetition, the only rule being, that near to the edge of the calcareous (Vicksburg) strata, the materials generally resemble more nearly those of the lignito-gypseous formation near Brandon (¶218 ff.) There are, however, in several localities, strata of considerable thickness, of solid sandstone, hard enough to answer for architectural purposes; thus at the Grindstone Ford, where the Raymond and Port Gibson road crosses the Bayou Pierre, a solid stratum at least 15 feet in thickness, crops out on the bluff, and similar ledges occur near the Mississippi Springs; the rock being, however, ordinary siliceous sandstone. Between Terry and Crystal Springs, ledges of white sandstone are exhibited in several cuts—generally soft, and alternating with materials still softer; the true "Grand Gulf rock" is found there also, however. It is said to be very abundant in the heads of the Bayou Pierre in Copiah county generally.

234 Silicified wood is very abundant in S. Hinds and E. Claiborne, as well as in Copiah; trunks of trees with roots still visible, are said to occur S. of Rocky Spring. It is in this region, on the Bayou Pierre, that silicified palm wood is often found; numerous specimens of it have been picked up near Rocky Spring. It also occurs, however, in Hinds county; a very fine specimen, found near Spring Ridge P. O., has lately been presented by Dr. W. Thompson; and in Mrs. Oakley's collection, at Jackson, there are specimens found by Governor Matthews in the bank of Pearl River, close to the town.

Beds of lignite appear to occur in several localities, near Big Black River, W. and N. W. of Rocky Spring. One 2 feet thick is mentioned by Prof. Wailes, as being inclosed between two ledges of sandstone, and impressions of aquatic plants are mentioned as occurring in it. Another is said to have been struck in a well on S. 11, T. 4, R. 3 W., Hinds county, at thirty-five feet; and another still is mentioned as existing on Pearl River at Partin's Ferry, Hinds county.

235¹ In Jefferson county the materials of the formation appear to be generally soft (or at least brittle) sandstones, and clays. The strata underlying the town of Fayette, which crop out a short distance from the place, on the Port Gibson road, seem to correspond to strata No's 3, 4 & 5 of the Grand Gulf profile; the fine grained, dark gray, brittle sandstone, on the exposed surfaces of which efflorescences of salts occasionally appear, is sometimes quite cellular; wells dug in this formation yield fetid, undrinkable water. In the ridges S. of Fayette, towards Hamburg, we find chiefly gray clays, which sometimes appear even on the summits of the ridges, but usually crop out on the hillsides and in gullies. In several spots they contain veins and concretions of carbonate of lime, but no fossils.

235² In Franklin county, near Hamburg, we find only blue clays in the beds of the streams, but urther S. & S. W., on the Homochitto and Wells' Creek, sandstone is found in abundance—associated, however, with clayey strata, to the mud formed by the disintegration of which, the ridge between the Homochitto and Wells' Creek owes its sonorous name of "Devils Backbone." In some localities in this region, ledges of considerable thickness and uniformity occur; the rock from Dixon's Quarry, S. 40, T. 6, R. 2 E., which is of fine quality, is scarcely to be distinguished from that of Grindstone Ford, mentioned above; it is almost perfectly white.

236. According to Prof. Wailes, the ledges forming the Devils Backbone are traceable in S. W. course, with little interruption, to Loftus' Heights, near Fort

Adams, on the Mississippi River, where for several miles down the river, outcrops of soft sandy materials interstratified with ledges of rough variegated sandstone, are to be seen; but here, as elsewhere, notwithstanding the good opportunity afforded for examination, I have been unable to detect even a trace of fossils.—The Block-house Hill, at Fort Adams, affords the following section:

(Sec. 34.)

SECTION AT LOFTUS' HEIGHTS, FORT ADAMS, WILKINSON CO.

	FEET	CHARACTER OF STRATA.	NO
	73	Yellowish-gray calcareous silt of Bluff Formation.	3
	87	Orange Sand.—Yellow, orange and white sands.	2
	170	Argillaceous sandstone, yellowish-gray in its mass, variegated with ferruginous spots and veins, and of different degrees of hardness, so as to weather into rough, jagged surfaces. Traceable to waters edge.	1

The sandstone of stratum No 1, besides being of unequal hardness within its mass, is interstratified, at from 6 to 15 feet, with softer, sandy strata, which often wash away so as to cause the ledges of rock to tumble down.

Sandstone of better quality occurs in N. E. Wilkinson, on the waters of Buffalo River, and on Homochitto. Near Meadville sandstone crops out in several localities on the Homochitto, interstratified with gray clay, and with all degrees of transition from clay to sandstone, as well as, in one and the same block, from the Fort Adams rock to that of Grindstone Ford. Such is the case at a bluff on Judge Cassedy's land, S. 32, T. 6, R. 5 E., where about 20 feet of these materials are exhibited; about a mile lower down, according to Judge Cassedy, a deposit of lignite underlies these strata, in the bed of the river. On a hilltop about ½ mile due S of the outcrop mentioned, there occurs a singular deposit of orange-colored calcareous clay, a special discription of which is given further on (¶296). A few miles W. of this point, there is a quarry of rock very similar to that of Dixon's quarry and Grindstone Ford, and S. of it we find, for several miles, gray clays appearing on the hillsides.

237. With the development of the formation in Amite county, I am not aquainted. In W. Pike county, I have seen it only at the N. end of Magee's cut on the N. O, J. & G. N. R R., S. of Bogue Chitto Station, where a stratum of gray laminated clay interstratified with sand, appears, 15 feet thick at first, but disappearing with a southward dip. At Holmesville, wells of a greater depth than 20 to 25 feet strike blue or black fetid clays, in which lignitized trunks, and other vegetable remains are said to be found. In E. Pike county, "blue dirt" is frequently struck in wells—thus at 5 to 10 feet on S. 24, T. 3, R. 11 E. (Mr. Conerly's). Further E we find a deep blue, meagre clay cropping out on the banks of Pearl River, at Pope's Ferry, below Columbia, Marion county. The

same material is said to be frequently exhibited on Pearl River below the Ferry; the only one I have examined is Burnett's Bluff, near Spring Cottage P. O., Marion county (about S. 18, T. 1, R. 17 W.), a section of which is given further on (¶302). It consists essentially of green and blue clays, of various degrees of meagreness, of which about 32 feet are exhibited, overlaid, on the hills, by about 50 feet of gravelly Orange Sand strata. The same materials crop out on the creeks inland; an analysis of one of them is given in the place above referred to.

238. Between Columbia and Monticello, outcrops similar to those just referred to, occur with frequency, and high bluffs of the same appear about 10 miles above Columbia, near Mr. Ben. Barnes', whose interest in the use of the materials of these bluffs as fertilizers has given them some note in the State. A special profile of one of them is given in another place (¶299); its chief interest is derived from the fact that one of the strata is strongly impregnated with carbonate of lime, which occurs in layers and veins, and at one point seemed to contain chelonian bones—but the most diligent search could not detect any other fossil remains.—An analysis of this material is given further on (¶300).

On the banks of Pearl River at Monticello, we find a few feet of the clays in question—the lowest stratum visible being heavy blue clay, gradually becoming more sandy further upwards, and finally passing into yellowish and gray laminated clays. Fragments of lignitized wood, with iron pyrites, occur in this bluff. In the latter, strong mineral waters are obtained. Westward of Monticello, a ledge of grayish-yellow calcareous sandstone about two feet in thickness, is seen in beds of the creeks, overlying these clays; and in its turn overlaid by similar materials, which further inland, form numerous bald, gray clay hilltops. The same occurs in the ridges opposite Monticello, in E. Lawrence, where strata of lignite are said to be found, and on the Monticello and Westville road, we find the gray clay interstratified with small sandstone ledges at two or three different levels.

239. On the portion of Pearl River embraced in Simpson and Copiah, both gray or blue clays, and sandstone ledges, appear in several localities, both on the river banks and on the confluents. Thus on S. 27, T. 9, R. 21 W., on Pearl River, where gray and reddish gray clay occurs interstratified with sandstone ledges, some of which exhibit a dip of about 45 deg. S. E.—owing no doubt, to a local fault, since dips in various incompatible directions are repeatedly met with in Simpson county.—Higher up, at Rockport, a jagged ledge of sandstone resembling the Fort Adams rock, runs out into the river from both sides, for 30 to 50 feet on each, so as to narrow the channel considerably—the surface of the ledge being about 3 feet above low water, and overlaid as well as underlaid by gray clays, which also appear in streams on the Copiah side.

240. On Strong River, so far as it passes through Simpson county, there are numerous outcrops of the clays and clayey sands of the Grand Gulf Group. One occurs at the bridge on the Westville and Brandon road—another, and the best exposure in the region, is on S. 10, T. 6, R. 20 W., near Banks' bridge, and in Mr. Barber's field. Near the bridge, strata of whitish materials, varying from soft sand and clay, to sandstone, crops out, with a dip varying from 15 to 20 deg. W.; taking this dip into account, about 110 feet are exposed vertically, although the outcrop is nowhere higher than 40 feet. The materials here contain abundant vestiges of leaves, but so poorly preserved as to be generally irrecognizable; the only form made out with certainty, was a fragment of a fan-shaped palm-leaf. Half a mile W. of this spot, in Mr. Barber's field, the strata are horizontal, lignitic and very fetid, their surface being covered with a yellow efflorescence of salts.

241. The materials of the formation in S. Rankin are prevalently sandy, generally white "rotten" sandstones, but yet frequently interstratified with lignitic, and generally very fetid and saline, clays. Outcrops of this kind are very common on the waters of Steen's Creek, where the saltiness of the clays gives rise to numerous cattle-licks; in some instances, the cattle have eaten

caves into the hill-sides; and I have found a crust of white salt, 1/4 inch thick, formed by evaporation on a ledge of clay in the bed of Steen's Creek. Very nearly the same phenomena obtain on Campbell's Creek waters; a good outcrop occurs at Tucker's mill, S. 14, T. 3, R. 3 E.

In one well near Cato (Cox's), a solid ledge of gypsum 10 to 12 inches thick, imbedded in gray clay, was passed through; most wells have saline and gypseous water.

242. It has been stated that most of the sandstones of this group, when exposed to the weather, show a tendency to cleave at right angles to the plane of stratification; hence such blocks frequently appear in the shape of short angular prisms, often of great regularity. This peculiarity, which may be observed in almost any outcrop from Grand Gulf eastward, has in several instances led to the belief that these forms were the result of human agency, and this has more especially been the case with a hard cherty ledge of sandstone which crops out on the banks of a branch some distance E. of Cato, at Mr. J. Morrison's (about S. 13, T. 3, R. 2 E.) This ledge underlies the entire hill at the foot of which it crops out, as has been demonstrated in digging wells; at one point, however, its surface has been exposed to a considerable extent, forming a "platform" or "pavement," known even beyond the limits of the county of Rankin. At this point, the bed shows the usual regular prismatic cleavage; its upper surface is very level and smooth, its lower jagged and nodular, precisely as would be the case had the indurating (siliceous) solution attained its natural quiet level in a basin of sand. The fragments of rock fit each other closely on the uneven and obviously cleaved surface, in a manner which no amount of human labor could possibly effect, unless on polished surfaces; besides, a stroke of the hammer produces similar forms on a smaller scale in any one of the supposed flagstones. It is quite likely that the spot may at some time have been a resort for the aborigines; since relics of human art are said to have been found in its surroundings, and tracings on the surface of the rock; but the ledge itself is clearly the work of nature.

243. In E. Simpson, and S. Smith, the Orange Sand covers the surface so thickly that it is only occasionally we find any of the materials of the Grand Gulf Group. At Jaynesville, fetid black clays were struck in a well 30 feet deep, dug by Mr. Magee in a bottom; generally, the Orange Sand is not passed through. The sandstone occurring near Raleigh, and the gypseous clays found in a well, have already been mentioned (¶227); the strata found are a mere repetition of those on Steen's Creek. On Leaf River, at Kees' bridge, S. 8, T. 1, R. 8 E., we find a stratum of deep blue clay, covered with saline efflorescences. In one well, near at hand, on S. 2, same T. & R., the clay was bored into for 30 feet, some lignite being struck in it. White sandstone, also is said to be found in S. W. Smith county.

I have not, as yet, examined the counties of Covington, Jones and Perry; so far as I have heard, Orange Sand alone prevails there; it is likely, however, that in the deeper channels, the materials of the Grand Gulf Group may be exhibited.

244. On the Chickasawhay and Pascagoula River, I have found these materials outcropping in four localities. The most northerly is at Col. Sam. Powe's, 2 miles S. of Winchester, Wayne county; a locality of the highest interest in the study of this formation, on account of the well preserved lignitized trunks of trees found there; not only *in situ* in the bank, but absolutely on the spot on which they grew, with their stumps standing and roots imbedded in the ancient soil, on the surface of which we find the vestiges of numerous successive layers of leaves, separated by thin sheets of whitish sandy clay—the results of the autumnal fall of leaves, and winter overflows. The whole of this remarkable deposit is covered by about twenty feet of Orange Sand strata, as exhibited in the following section:

(Sec. 35.)

SECTION OF FOSSILIFEROUS STRATA AT SAM. POWE'S, NEAR WINCHESTER, WAYNE COUNTY.

	FEET.	INCHES	CHARACTER OF STRATA.	NO.
. . . . .	18		Yellow sand, with pebbles in its lower portions—Orange Sand.	5
. o .		18	White sand with nodules of pipeclay.	4
— — —		1	Black clay with leaves.	3
. . .	3		Grayish white sand, with vestiges of leaves on stratification lines.	2
. —— .	5		Bluish sandy clay, with roots and trunks of *Cupuliferae*, *Coniferae* and *Palmae*.	1

The trunks are prostrate, many of them washed out of their matrix by the river, and resemble common "old logs." They retain their roundness, are quite light and porous when dry, but absorb water like a sponge, allowing of its being squeezed out. Two cuts of a common saw will readily sever a trunk 12 inches in diameter. Most of them are dicotyledons, a smaller portion Conifers; and next to these, tree palms, one trunk of which was about 8 inches in diameter, its fibres pulling out of the soft lignitic mass, like those of a corn-stalk out of its pith. I also found, and followed up, a scaly palm root for about 4 feet. The dicotyledonous woods found resembled mostly those of oaks and beeches.

245. Descending the Chickasawhay, we next find a long outcrop of compact, bright blue clay, in a bluff at Mr. W. P. Avera's place, SS. 25 and 36, T. 5, R. 6 W., Greene county. About 15 feet of this material are visible above water, overlaid by the same amount of yellow sand, in which silicified wood is common. Chalybeate and saline waters flow from the stratum in several places, and according to Mr. A., brilliant metallic lumps—of iron pyrites—are found in the mass. At Venson Williams', 7 miles below Averas', we also find blue clayey sand in the bed of the river.

Gray clay is seen outcropping on the hillside at Judge Fairley's Ferry, not far from Cross Roads P. O, Jackson county; and similar clays appear in the hills E. of the P. O, where they contribute essentially to the formation of the soil.

246. At Dwyer's Ferry on the Pascagoula River, S. 11, T. 5, R. 7 W., we find the following section, on the river bluff:

(Sec. 36.)

SECTION OF BLUFF AT DWYER'S FERRY, JACKSON COUNTY.

FEET.	CHARACTER OF STRATA.	NO.
2	Yellowish, indurate clay—"Flatwoods Clay."	5
4	Gray sand with yellow dots, containing particles of lignite, and crystals of gypsum.	4
7	Gray sandy clay with lignitic layers, traces of leaves, and crystals of gypsum.	3
1	Blue massy clay, with crystals of gypsum.	2
12	Stratified, gray clayey sands, cleaving into layers 1 to 6 inches thick.	1

This is the last outcrop observed in this direction, bearing the character of the Grand Gulf Group.

NEWER TERTIARY ? OF THE COAST.

247. It has been mentioned, when speaking of the Orange Sand Group, that its characteristic strata extend, in several points, to within a few miles of the Gulf Coast. It overlies there a formation partly marine, partly fresh-water, consisting chiefly of gray or black, fetid, ill stratified, massy clay, which forms the impervious stratum to which the "Pine Meadows" of the coast region owe their peculiar features (see "Sea Coast Counties"), and extends seaward into the Mississippi Sound, where it constitutes the "blue clay bottom" of the deeper channels, beyond the sands of the beach. It is reached at moderate depths along the whole coast, and renders the water of wells undrinkable, whenever it comes in contact with the "black mud." Notwithstanding that at Pass Christian, for instance, the stratum is reached at 7 feet, it is but rarely so exposed as to afford good opportunities for observation, and the brief space of time which I have spent on the coast, has not allowed me to search for them systematically. I shall simply give, therefore, the data I have thus far succeeded in obtaining, without attempting to fix the precise epoch which these strata may represent.

248. On the Bayou Bernard, near Mr. Bell's, on S. 15, T. 7, R. 11 W., there is an outcrop some 300 yards long, of about 8 feet of dark, bluish-black clay, which is very tenacious, fetid, and irregularly stratified. In this there occurs a lenticular mass, about 10 yards long and 2 to 2½ feet thick, of white shells imbedded in clay similar to that which surrounds it. These shells are very much decayed; we can nevertheless recognize the common living oyster, *O. Virginica*, which forms their main mass; adhering to the oysters, we find occasionally the common *Balanus* (*Barnacle* of the Coast, together with *Mytilus hamatus*, which at present, also, is generally found clinging to the oyster. No signs of other fossils were found in the clay surrounding the shelly mass.

Wells in the neighborhood strike this clay at the depth of a few feet, the water being altogether undrinkable.

249. According to information given me by Mr. H. Taylor, of Pass Christian, shells appear imbedded in both banks of Wolf River, about 20 miles (by water) above the Pass. This locality I have not visited.

Lower down, at Mr. J. Saucier's, S. 20, T. 7. R. 12 W., on Wolf River, there is a bluff about 30 feet high, affording the following section:

(Sec. 37.)

SECTION OF NEWER TERTIARY? AT SAUCIER'S, ON WOLF RIVER, HARRISON COUNTY.

	FEET.	CHARACTER OF STRATA.	NO.
	20	Gray and yellow sand, stratified, more or less clayey, especially below.	3
	2 to 3	Yellowish gray, massy clay.	2
	7 to 8	Matrix of dark gray or black clayey sand, or muck, inclosing trunks, stumps, roots and knees of Cypress, with bark and wood preserved. Also a few pine burrs.	1

The whole of stratum No. 1 cannot be better described than as the soil of a cypress swamp, with its muck, fallen trunks, knees, stumps, etc. Of these there are evidently several generations, separated by more clayey layers of muck. The fibrous bark of the cypress is perfectly preserved; the wood is yellowish and soft, but by no means lignitized (cutting very nearly like that of the Tupelo tree), and its structure and shape perfect.

A few hundred yards below this spot, we find a similar deposit, in which, instead of the cypress, the wood, burrs and decayed leaves, apparently of the Short-leaf Pine, prevail. It is said that similar outcrops occur further up on Wolf River. Moreover, Col. J. J. McCaughan, of Rosalie, as well as Mr. H. Taylor, above mentioned, state that similar deposits have been found in numerous wells along the coast; and that about 3 miles E. of the Pass the black clay, with cypress knees, crops out on the sea-shore. It is possible that some of the stumps and roots observed on the sea-beach and attributed to the living trees of the beach, belong to this deposit, especially if, as is stated, many of them should turn out to belong to the Cypress, which at present is not found within many miles of the coast of Mississippi, however abundant on that of Louisiana. In several bluffs of Wolf River and Bayou Delisle, we see layers of dark colored sand, possessing a lignitic odor, which seem to indicate, whenever they occur, the proximity of the black clay formation.

250. At West Pascagoula, in the well at Mrs. McRae's residence, the following section was obtained: Ten or fifteen feet of sand, then about ten feet of blue clay with yellow streaks, then ten feet of sky-blue clay; then a bed of gray, calcareous, water-bearing sand, containing abundance of shells. Of these, the few I saw were identical with species now living on the Coast, and their state of preservation scarcely other than that of the shells imbedded in the sea-beach

sand for a few years. *The water struck rose to within* 15 *feet of the surface;* it is a saline, sulphureous chalybeate, too strong for ordinary use; it is very similar, on the whole, to that of Ocean Springs. The level of the water is probably by several feet above that of the Sound.

251. Near Pearlington, heavy gray clay crops out in washes on the roadside. Thence up to Hobolochitto, similar strata appear near the surface in several points. At the latter point, however, in a well dug by Col. Kimball, 40 feet deep, after passing through some 25 feet of sand and gravel, a deposit of marine shells was struck, in a gray sandy material. I did not see any of the shells found in the well, which was dug 17 years before; but Col. Kimball says they were quite friable.—Thence northward, nothing but Orange Sand is seen, until we reach the neighborhood of Burnett's Bluff, before mentioned (¶237; 302).

USEFUL MATERIALS OF THE TERTIARY FORMATIONS.

252. *Useful materials of the Northern Lignitic.*—These consist chiefly of *Lignite or Brown Coal*, and *clayey materials* of various kinds, some suitable for fire-brick and pottery; others for the manufacture of alum, and doubtless, with proper precautions, for manure also.

The extensive *Lignite beds* of this formation have not as yet received that special attention and study which their great ultimate importance deserves. Although in general inferior, as a fuel, to bituminous, or stone coal, the better qualities of lignite can be, and are made to subserve, most of the purposes to which the former is applicable, the most important exception being, that on account of their softness and tendency to cleave when carbonized, the lignites cannot be successfully converted into coke.

In its heating effect, as well as in other respects, lignite stands intermediate between wood and bituminous coal; being in fact nothing more than an imperfectly formed coal, and showing transitions into true coal as distinctly on one side as it does into wood on the other. Examples of both these transitions occur among the lignites of Mississippi; hence there exists in this material, as may be supposed, a great diversity of aspect as well as of quality, which it is of the highest importance to take into consideration properly, in its exploitation. As a good practical rule (not, however, without exceptions) we may say that the nearer a lignite approaches, in its general aspect and character, to bituminous coals, the higher will be its effective value. Thus far, the eye of any moderately attentive observer will enable him to estimate the quality of the material. There are besides, two other chief points requiring attention, viz: the amount of ash yielded in burning, and the extent to which iron pyrites, or bisulphuret of iron is present; the less there is of both of these, the better.

253. It is but rarely the case, that the whole of a bed of lignite of any considerable thickness, is of uniform quality. Even small fragments often exhibit great diversities within their mass, and hence experiments on a small scale, or mere specimens, may be far from yielding results applicable to the whole bed, unless selected with especial care. The mass of lignites is almost always laminated, *i. e.*, it shows a tendency to cleave into plates of greater or less thickness, and frequently of different kinds of coal—some being of a dull, earthy aspect, others brilliant like true coal. This tendency is often such, as to cause blocks which were quite solid when wet, to exfoliate and crumble into small flat pieces, which cannot generally be used as fuel. It is necessary, therefore, in most cases, to allow the material (which is generally very wet as taken from the mine) to dry slowly, in stacks or piles protected from the immediate rays of the sun.

254. It is in the cracks and fissures corresponding to this horizontal cleavage that we may generally observe best whether or not any unusual amount of ash or pyrites is present. We often find the beds subdivided into several stages, by bands of clay or sand, and the same is often the case with the minor sub-divisions, or the plates into which, when rapidly dried, lignite will generally cleave. Of course the amount of ash may thus be increased to such an extent as to render the material, such as it would be when obtained on the large scale, unfit to serve as fuel. It is not always, however, that the admixture of an excess of mineral matter can be perceived by the eye; it may rise to 50 per cent. and more, and the substance still retain the aspect of lignite; though generally, in such cases, it is less firm, and gradually passes, through many gradations, into soft lignitic shale, or lignitic clay. These can, of course, be readily distinguished from true lignite by trial in the fire, where lignite, available as fuel, ought not to leave more than 30 per cent of ashes at most—not sufficient to allow of the form of the fragments being preserved after combustion. Few lignites used on the large scale, contain less than 2 per cent. of ash; from five to twelve per cent. is, perhaps, the most usual amount. I have thus far examined but few specimens of Mississippi lignite in this respect; the determinations prove it to be very variable, here as elsewhere:

1. Compact, massy lignite, from Mr. Moses Bridges, S. 33, T. 18, R. 10 E., Choctaw county. Black, fracture conchoidal, lustrous. Ash greenish yellow, light.

2. Lignite from Hughes Branch, S. 8, T. 10, R. 2 W., Lafayette county. Brownish black; fracture earthy, cleavage slaty. Ash grayish white.

3. Same as above, from a locality a few hundred yards distant. Ash grayish white.

4. Lignite from Mr. Vineyards, S. 10, T. 10, R 1 W., Lafayette county. Grayish black, fracture earthy, with some shining layers of pitch-coal; cleavage slaty. Ashes faint reddish yellow.

5. Lignite from Spears' Cut on the N. E. & S. W. Alabama R.-R., east of Marion, Lauderdale county. Black, shining; fracture conchoidal, cleavage laminated. Smells strongly of sulphur in burning; ashes reddish brown, heavy.

AMOUNTS OF ASHES IN LIGNITE.

From		Ash.	
1. Moses Bridges, Choctaw county—(¶265),	......	4.38	per cent.
2. Hughes' Branch, Lafayette county—(¶263),—	I..	22.29	"
3. " " " " "	II..	16.22	"
4. Mr. Vineyards, " " (¶263)	.....	24.20	"
5. Spear's Cut, Lauderdale county....(¶179),	.....	17.28	"

255. As to iron pyrites, its presence, to any great extent, is a serious drawback in several respects. It causes the coal, when exposed to the atmosphere, to exfoliate and crumble, on account of the transformation of the pyrites into copperas: in burning it causes it to exhale offensive sulphureous fumes (sulphurous acid), at the same time attacking the grate or furnace to a much greater extent than would be the case with a coal free from this substance; finally, it increases largely the weight of the material and of the ash.—Generally it is not difficult to recognize the presence of this material. It often appears in flattened lumps resembling cast metal, of colors varying from golden yellow to the pale tint of Britannia ware, on the cleavage planes of the coal; or diffused through its mass, in small rounded particles, or angular crystals, of the tints above mentioned. Sometimes, the mass of the coal may be comparatively free from pyrites, even though the latter may be present in plates or layers in some particular portion of the stratum, easily separated from the rest; at others, the mass may be full of minute particles of the mineral, invisible to the eye. In any case, it is easy to determine the point by burning a sample of the lignite, when not only the stinging sulphureous odor of the smoke, but also the red tint of the ash,

may be taken as indicative of the extent to which the sulphureous mineral exists in the mass. In burning the sulphur is driven off, while iron remains behind in that condition (peroxide) in which it exists in red ochre or in Venitian Red. If the ash is white, yellowish-white, greenish, or gray (as is the case in most of the lignites of Mississippi which I have tested in this respect), or only slightly reddish, it may be taken as a proof that there is not enough of the mineral to injure the quality of the fuel, either as to solidity or for other purposes to which it is applicable.

256. I ought to mention, in connection with this subject, a simple method by which Iron Pyrites, or sulphuret of iron, can always be distinguished from any of the metallic ores for which it is so frequently mistaken. Almost all the tales, of mines or minerals discovered in this State, have started from the discovery of lumps of this mineral, which most frequently occurs within the lignitic formations of North Mississippi, both tertiary and cretaceous. The trial usually given it by persons in the country, is melting it down in an iron spoon in a blacksmith's forge—adding to it as "fluxes," not unfrequently, substances which, like blue and white vitriol, sugar of lead, etc., themselves contain other metals; these, uniting with the sulphuret of iron, form metallic looking lumps when melted down in the high heat of a forge. Even the pyrites by itself, however, when melted in this way, will produce a regulus, which is variously claimed as being zinc, brass, tin, silver, etc., according to the fancy of the discoverer. The high heat used in this process, or the addition of fluxes of any kind, or both, serve only as hindrances in arriving at any definite result; but by attending *strictly* to the following directions, a certain, and in this State, an *unvarying* result will be obtained with all the deceptive yellow, metallic-looking ores found in our formations:

257. Let the mineral be powdered, under a hammer or in a mortar, as fine as may be—at least as fine as rifle powder, but finer whenever possible. Then let a *small quantity* of this powder—not more than three or four thimblefuls—be spread thinly on a clean iron shovel, and heat the shovel *to redness—but by no means higher*, in an open fire, without bellows or fan. The mineral will turn black, and then inflame and burn with a blue, sulphur flame, the odor of whose fumes will be readily recognized. Let the flame burn off quietly, *without raising the fire;* when it has nearly or entirely gone—after the lapse of twenty minutes or half an hour—stir the powder about on the shovel with a stick; crush it if it has baked together (which it will do if the heat has been too high at first), for which purpose the shovel may at any time be removed from the fire, without in any manner endangering the result. The powder having been again spread on the shovel after stirring, roast it for a while as before, until every trace of flame is gone. The stirring and roasting may then be repeated, and the heat raised to a full red—though this generally will not be necessary; for if, after the second roasting, the shovel be removed from the fire, the powder will at first appear black, but on cooling will turn red—the shade varying a little according to the purity of the mineral and the heat employed, but always between that of a hard-burnt brick and Venitian Red; if the mineral has not been finely powdered, the tint may be made plainer by crushing the grains with a hammer; and if the roasting has been imperfect, the interior portion of such grains may still be black or brown; but if roasted again, will also turn red.

The red powder is simply red ochre; it contains no metal but iron, which, in the natural mineral, was combined with sulphur.

258. There is another, but somewhat slower process, by which pyrites may readily be recognised by any one. Powder the mineral as before, put the powder on a plate, *moisten* it all over with water, and keep it moist for a few days, in a moderately warm place—say on the mantel. The powder will very soon taste of copperas, which may also be seen on the sides of the plate; and a piece of tan-bark (Black Oak or Black Jack is best) will rapidly turn blue and black, when laid on the powder well wetted.

Even large pieces of the pyrites generally will, in course of time, undergo the same change—will burst open and generally crumble into a powder consisting chiefly of copperas. This change takes place rapidly when the mineral is carried in the pocket, the cloth of which it will soon corrode.

259. I have stated above, that good lignites are applicable to most of the purposes subserved by bituminous coal, except (in most cases at least) coking (¶252). It cannot, however, any more than the latter, be used in the place of *wood charcoal*, unless previously carbonized. It has been usual, in this State, in neighborhoods where lignite was discovered, to test its usefulness by trying it in the *forge, instead* of charcoal, and as might be expected, the results have been unfavorable. But the fault was with the experimenters, for the best bituminous coal is well known to be entirely unsuited to the blacksmith's use, *unless when mixed, in small quantities with charcoal. Thus* applied, good lignite will be found to answer the same purpose; it cannot, however, be expected to perform what even bituminous coal will not. But for boiler fires, grates, stoves, furnaces, etc., good lignite is found to be little inferior to stone coal; compact varieties resembling the latter, are very well suited also to the manufacture of illuminating gas, and yield a coke suitable to all purposes where it is not subject to much pressure, or long transportation.

260. It requires indeed, but very little foresight to appreciate the importance of these deposits for the industrial development of the State. It is true that thus far, *taking it as a whole*, firewood has been abundant, and will be for some time to come, so long at least as manufacturers shall employ, as they do at present, but a very small part of the productive capital of the State. Should this condition of things change, however (towards which there is now a decided tendency), the call for fuel less costly in its transportation—the distance of which, in the case of wood, will rapidly increase—would soon put these beds of brown coal into requisition. But even as it is, fuel is already becoming expensive in some districts, by the increasing distance from the forest, and Western coal, so largely used in the navigation of the Mississippi river, is being bought at enormous rates in our towns, in order to be enabled to replace the open fireplace by iron grates, or coal stoves. There is no reason, save prejudice, why the native lignites should not be used in the same way. It is needless, however, to expatiate on the importance to any State, of possessing inexhaustible beds of a fuel little inferior to bituminous coal. Common sense, as well as the sad experience of older States, teaches plainly how little reliance can be placed on a permanent supply of timber and fire-wood in any well settled district, under the destructive and improvident management of this portion of the national wealth, under which our forests dwindle at an alarming rate, so as even to affect seriously the climates and meteorological phenomena. The increasing floods, not only of the smaller streams, but of the mighty Mississippi itself, tell as plain a tale as statistical data would make it, of the destructive sway of the axe. The forests of Mississippi are fast sharing the fate of their brethren in the older States, and the years may be counted after the lapse of which she must draw for her fuel on the coal-fields of other States, unless she should think it a wiser policy to avail herself of her own.

261. *Localities of Lignite Beds.*—I shall now give in brief a list of the localities where, thus far, lignite beds of practical importance have been observed by myself or others; with such observations as may tend to give some light to the miner, on their quality and availability.

In regard to the manner of working these deposits, I ought to say in general, that the roof of the mines will usually require to be supported, more or less, by wood-work; being rarely formed of materials sufficiently rigid to support themselves when spanning any considerable excavation; in beds of notable thickness and solidity, it will be found advantageous to allow a part of the lignite stratum to remain above, so as to impart additional firmness to the roof—which, with the aid of pillars left standing on the sides, as practiced in coal mining, will often enable us to dispense with a considerable part of the wood-work. In some cases, the outcropping bed may be worked like a quarry, but more generally, galleries and chambers will be necessary—driven either from the hillside or from a shaft. Attention must be given to the ventilation of these mines, for both the explosive "fire-damp," as well as, more frequently, the "choke-damp, (which is very commonly perceived at the bottom of wells sunk in the lignitic formation), are to be looked for in them.

262. In Tippah county, lignite is found on S. 29, T. 3, R. 3 E., at Squire Street's. The bed occurs in a ravine, between two steep hillsides: its thickness and quality, I have had no opportunity of observing. It was said to burn well in the fire-place and forge.

According to Prof. Wailes, a deposit of lignite exists on Snow Creek, S. 7, T. 4, R. 1 E., Tippah county, about 7 miles S. of Salem.

According to L. Harper, lignite exists in Marshall and Lafayette counties, on the Tallahatchie River. I have not, however, myself observed, or seen any specimens from that region, save black lignitic clays, with small seams of lignite. These are abundant in the Cornersville region, and is quite likely that lignite beds may exist there also. Lignite beds probably occur in R. 1 E., TT. 9 and 10, S. W. Pontotoc, as they do in the adjoining portions of Lafayette, but I have no *definite* knowledge of outcrops anywhere in Pontotoc county.

263. Lignite appears, more or less, all along the Yokeney-Patafa River, and on many of its tributaries, in Lafayette county.

According to information given to L. Harper by Mr. W. J. Vineyard, lignite crops out at the spring of Union (Baptist) Church, S. 1, T. 10, R. 1 W. The bed is said to be 8 feet in thickness.—The bulk of the specimen in the Survey collection is grayish black, of a dull fracture, not very hard, easily crushed, and whitish on the cleavage planes; it contains thin layers, however, of black, shining "pitch-coal." Burns with a bright flame, and leaves 24.2 per cent. of ash, of a faint reddish-yellow tint.—The amount of ash is large, and if the whole mass were of the same character (which is not likely) it would not bear transportation to a great distance.

It is the same bed probably, which is met with in numerous localities in townships 10, Ranges 1 and 2 W., Lafayette county, its thickness varying from 5 to 12 feet; there seem to be, however, several minor beds above it, which were observed by Mr. Ward, S. 22, T. 10, R. 2 W.—one 5 inches, another a foot in thickness. The main bed crops out in branches in Mr. Ward's neighborhood; at Mr. Kirkwood's, S. 26 ?, a stratum 8 feet thick was struck in a well at 50 feet; at Mr. Greager's, on S. 14, the thickness of the bed was greater by several feet. It crops out, with a visible thickness of at least three feet, in ravines and in the bed of Hughes' Branch, on the edge of Potlockney bottom, on S. 8, near Mr. S. Ragland's. Its fracture is dull and earthy, structure laminated, but the mass quite solid; it burns easily, with a bright flame.

An air-dried specimen yielded 16.22 per cent. of grayish-white ash; one dried at the boiling point of water, 22.29 per cent. A partial analysis of this ash gave the following result:

ASH OF LIGNITE FROM HUGHES' BRANCH.

Insoluble Matter (Sand and Silex)	59.24
Potash	trace
Soda	2.52
Lime	8 83
Magnesia	0.73
Oxide of Iron, and Alumina	25.79
Chlorine, Carbonic and Sulphuric Acids, and Loss	2,89
	100.00

The lignite at this point could be easily worked.

Lower down, a bed of good lignite (thickness not ascertained) crops out in the bed of the Yockeney River at Price's old mill, S. —, T. 9, R. 3 W., (see Sec. 20, ¶172). Still lower down, on Mr. Isaac Taylor's and Z. P. Dew's land, S. 9, T. 10, R. 3 W., on a branch of the Yockeney River: thickness and position not known.

Also, on Dr. J. Taylor's land, S. 30, T. 9, R. 3 W., in the banks of the Yockeney River: a stratum 2 or 3 feet in thickness, underlaid by blue clay, which forms the bed of the river, and overlaid by blue sand.

264. In E. Yallabusha, lignite is said to occur in numerous localities, none of which I have as yet examined. A fine bed is spoken of as existing on Robt. Thompson's place, 10 miles E. S. E. of Coffeeville; and another is mentioned by Prof. Wailes, at McElroy's mill on Turkey Creek. In N. Calhoun, lignite is very generally struck in wells, at depths from 20 to 40 feet, but I have seen no specimens of it. Beds of variable thickness have been struck in wells, near Sarepta—at Mr. Stacks', S. 19, T. 11, R. 1 W.; at Mr. Hunter's S. 28, T. 11, R. 1 W., and very generally in the country between Cowpen and Lucknuck Creeks; in Mr. Ray's neighborhood, T. 12, R. 2 W; it also crops out in the banks of the Loosha Scoona River, just below Old Town.

At Pittsboro', according to L. Harper, lignite is found in wells at thirty feet, and sometimes as much as thirty feet in thickness; and a stratum of lignite at least six feet in thickness, is said by him to crop out about a mile N. W. of town, which, from his description, would appear to be similar in quality to that at Moses Bridges', Choctaw county.

265. In S. Calhoun generally, lignite appears to be quite abundant, according to accounts I have received from inhabitants. The same appears to be the case in N. E. Choctaw, where the formation resembles closely that on the Potlockney and Yockeney; a bed of lignite has been observed in the neighborhood of Bellefontaine. At Bankston, dark lignitic clay, with a vein of lignite, crops out on a bluff half a mile S. W. of the place; it seems likely that by bor-

ing, heavier beds of the same might be struck, since they are very common further east. Thus, at Moses Bridges' place, S. 33, T. 18, R. 10 E, a stratum of fine compact lignite crops out in the bed of a branch, the thickness exhibited being about 4 feet. The material is thickly laminated, does not crumble in drying; its fracture, on which some woody structure is still perceptible, is of a fine, glossy black, and will barely make a streak on paper. It inflames less easily than the coals of Lafayette county, burns with a bright flame, and leaves only 4.28 per cent. of light, greenish-yellow ash. This lignite will serve well most purposes of stone coal; even coking.

At Mr. Henry Wood's, on S. 2, T. 17, R. 10 E, there is an outcrop of a stratum of inferior lignite, about 3 feet thick, composed, it appears, chiefly of small aquatic plants; it therefore crumbles in drying, and seems also to contain a large amount of ash.

At Black's Wells, S. 23, T. 17, R. 10 E., Choctaw county, a stratum of lignite of better quality than that at Wood's, and 4 feet in thickness, was struck in a well at about 45 feet.

266. N. Winston abounds in lignite. It is found in a stratum 4 feet in thickness, in wells near New Prospect P. O., and E. of the same on the headwaters of Noxubee where it crops out abundantly in gullies, and is struck in wells N. of Webster. I have had no opportunity of observing these beds personally, but from the description given, the lignite appears to be of excellent quality. Between Sun Creek and Trim Cane Creek, in Mr. Dillon's neighborhood; on Mr. R. L. Johnson's plantation, on the Houston and Starkville road, and in S. E. Ocktibbeha, W. of the Flatwoods, generally, lignite beds seem to exist. Near Louisville, Winston county, lignite has been struck in numerous wells, at depths between 20 and 40 feet; it also crops out at a spring in the neighborhood. The thickness of the stratum varies from 2 to 10 feet. In some portions of this bed the woody structure is pretty well preserved, in others, almost entirely obliterated.

In the eastern counties of the lignite formation, the latter is popularly termed "black dirt," while the accompanying clays are usually denominated "blue dirt." If this designation is to be relied on, lignite must be abundant in S. W. Winston and N. Neshoba, which regions I have not personally examined. Prof. Wailes, however, mentions a lignite bed on S. 30, T. 11, R. 12 E., Neshoba county.

267. In Kemper county, a lignite bed at least 4 feet thick is mentioned by L. Harper as occurring a few miles N. W. of DeKalb.

Whether the "black mud" found in wells at Daleville, Lauderdale county, is lignite or black clay, I have been unable to determine. True lignite, however, is found at Marion, in wells, and the section at Spear's Cut (¶179) renders it obvious that a number of successive strata of lignite exist in the formation of that region.

Those exhibited in the cut are too thin to be worked profitably. Since, however, it is likely that workable deposits will still be found in this region, I have bestowed some attention on the quality, and determined the amount of ash contained in a specimen from Spear's Cut. When dry it resembles stone coal rather than the lignites of Lafayette, burns with a brighter flame, and with a strong odor of sulphur; the ash, reddish brown, amounts to 17.28 per cent. It contains therefore a certain amount of iron pyrites, which is finely diffused through the mass, but does not cause it to crumble.

268. I have not heard of the occurrence of lignite in Attala, or Leake; in Madison county, however, though not outcropping, lignite beds of great thickness have been struck in wells bored by order of the Rev. J. R. Lambuth, both at Canton and at his residence, S. 2, T. 7, R. 2 E., near Calhoun Station. At a depth of 375 feet a ledge of rock was penetrated, beneath which, for 46 feet, the auger brought up lignite, with only an occasional band of clay (¶322).

In Holmes county, and generally along the bluff, from Yazoo to Tunica, lignite beds seem to appear with frequency; with these, however, I am acquainted only from hearsay. A bed of lignite, 14 feet thick, inclosed between strata of green clay, is mentioned by L. Harper as occurring on S. 27, T. 9, R. 4 W., Yazoo county, and he states that outcrops of the same occur frequently on the bluff in Holmes county. In the latter county, there are several deposits which have been currently spoken of as being of fine quality. One, according to Prof. Wailes, is on S. 7, T. 14, R. 1E., near Tchula Lake; another "on Funnigusha Creek, to the east of the crossing of the old road near Coconover's old stand." Other deposits in the same region have been mentioned to me; the stratum probably underlying an extensive area.

269. I have received specimens of iron pyrites, evidently derived from a lignite bed, from Carroll county, but have been unable to ascertain the locality, or particulars.—I am not aware, thus far, of the existence of any lignite beds in W. Yallabusha, although such probably exist on the Yockeney River.

In Panola county, lignite seems to be quite abundant, in the fork of the Tallahatchie and Yockeney Patafa Rivers, its beds being of great thickness and fine quality. L. Harper mentions beds of 15 to 16 feet thickness, and of a glossy conchoidal fracture, as occurring on SS. 8 and 10 (and no doubt on S. 9 also!) T. 10, R. 8 W., and according to information given me by inhabitants, the quality of the lignite as a fuel has already been satisfactorily tested. These beds, occurring as they do, close to the line of the Mississippi and Tennessee R. R., in easy communication with the city of Memphis, afford a fine opportunity for exploitation, if the accounts given of them be correct.

Lignitic clays are mentioned by L. Harper as occurring on Cold Water River, but no beds of Lignite seem to exist there.

270. *Lignite beds of the later Stages of the Lignitic.*—The only available bed of lignite I have observed in the lignitic beds intervening between the *Claiborne* and *Jackson* Group, is that on Suanlovey Creek at Garlandsville, mentioned above (¶197). It is of good quality; about 2 feet of it are visible above the bed of the creek, and it may be of considerable thickness.—The lignitic material occurring at Moody's Branch (¶204, Sec. 29, stratum No. 2) is too earthy to be available. I have found chunks of good lignite at a sandy bluff on Pearl River, about one mile (by land) above Jackson; but

thus far have been unable to ascertain the dimensions of the bed in place. Between the *Jackson* and *Vicksburg* beds, the only deposit I know is that at Vicksburg (¶220). The thickness of the bed, according to Prof. Moore's observations, does not exceed three feet: yet, from its favorable location on the banks of the Mississippi River, it might be made available, if it should prove of good and uniform quality. Of this, not having examined the bed, I am unable to judge.—On the whole, lignite is not to be looked for in extensive deposits, on the territory embraced by the marine calcareous formations, indicated on the map, by the several shades of blue.

271. *Upper or Southern Lignitic.*—Lignite deposits are much less common on the territory of this formation, than on that of North Mississippi.

I have had no opportunity of examining outcrops or even specimens of lignite from these strata. The localities mentioned in ¶234, in Hinds and Claiborne; a bed occurring near Judge Cassedy's, Franklin county (¶296 and ff.) and another in W. Lawrence, whose precise location I have been unable to ascertain—are the only instances I know of the occurrence of lignite on the territory of the Grand Gulf Group.

272. Of the useful *Clays* of the Lignitic formations, I have already spoken, as far as may at present be necessary or useful, in connection with those of the Orange Sand. The variety and abundance of these materials is very great, and they will no doubt be appreciated hereafter.

273. It may be proper to mention in this place, some local occurrences of useful deposits of the indurate clay or siliceous claystone, which sometimes, as has been mentioned (¶165), is found associated with, or rather subordinate to, the Flatwoods Clay. Generally, this rock forms small, irregular, lenticular masses, or veins, and is often very hard. It seems that in S. E. Tippah, large masses of this rock have been found, in a locality which I have not ascertained precisely, by a relative of S. R. Spight, Esq., of Ripley, The rock somewhat resembles, in color and appearance, lithographic stone, for which it was at first mistaken; it will not, of course, serve the purpose, since it is not attacked by acids. It assumes a good polish, however, and as it is somewhat variegated, it might subserve ornamental purposes, if found in sufficient quantity.

A similar rock, but a good deal softer, so as to absorb water greedily, has been found in Choctaw county, on S. 23, T. 18, R. 10 E., by Mr. A. J. Worsham. It attracted attention by the adaptedness of its powder for polishing metals without scratching, even when it had only been scraped off with a knife, without further pulverization. The rock would be admirably adapted to hones, but for its absorbent power, which renders it necessary to saturate the whole slab with water or oil before using. Varieties of this rock not possessing this fault, may perhaps be found in the region. It occurs in small slabs or plates, strewed on the hillsides, where its stratum is, according to description, overlaid by about twenty feet of sand.

MINERAL FERTILIZERS OF THE TERTIARY FORMATIONS.

274. *Ferruginous Greensand of the Claiborne Group—Shongalo Greensand.*—The highly ferruginous sand occurring in the railroad cut at Vaiden Station, near Shongalo, Carroll county, and

also in cuts between that place and Rockport, contains a considerable percentage of green-sand grains, sufficient to render it highly efficacious as a manure.

In the two small cuts N. of the deep one exhibiting gray and brown clay (¶183 ff.), several different materials are exhibited; partly coarse sand, forming a soft sandstone, *containing impressions of sea-shells,* partly clay—all deeply tinged with iron. The greensand grains are apparent throughout the mass, but most so in the sandy portion, and may be readily observed, especially when the mass is crushed and washed with water.

The grains are generally about the size of small bird-shot, but flattened, and of a dark green, in part also of a yellowish-green tint. *The value of the mass as a manure is precisely in proportion to the amount of these green grains which it may contain.*

An analysis of the soft sandstone in the most southerly of the small cuts gave the following result:

SHONGALO GREENSAND.

Coarse sand, and insoluble Silica	36.707
Soluble (in NaO, CO^2) Silica	18.298
Potash	1.601
Soda	0.045
Lime	0.166
Magnesia	1.630
Peroxide of Iron, with little Alumina	34.377
Phosphoric Acid	trace.
Carbonic Acid	0.129
Water	7.012
	99.948

275. *Potash* and *soluble silica* are the ingredients which render this material of value as a manure, and as such, it would probably be suited more especially to small grain—oats and wheat, and to corn. It will be found beneficial, however, to almost any crop, and the only precaution which it might be necessary to observe in its use, would be to avoid applying it to land badly drained, where the large amount of iron which this material contains might prove injurious in wet seasons; and for the same reason, it is not well suited to being composted with farmyard manure, but ought to be spread on the land either by itself, or mixed with other *mineral* manures only. The quantity to be used will vary greatly with the amount of greensand grains present. In the mass analyzed, they constitute about one-third by bulk, and of such, dressings of 70 to 100 bushels per acre would no doubt produce an effect lasting for several years; while mass still richer, such as occurs occasionally, might even be used in the drill. No overdressing need be feared, so long as the soil to which it is applied is well drained. The admixture of some lime, or calcareous marl, would serve to heighten the effect greatly, and would be likely to prevent, to a considerable extent, injury which might otherwise happen in ill drained land.

The material may be found, no doubt, in other hills in the neighborhood of Shongalo; when near the surface, it may be recognized by the dark orange, or rust color which it imparts to the surface material, while the common surface loam of the country is of rather a pale yellow tint. The same may be said of N. E. Holmes, where, between Vaiden and Rockport Station, the ferruginous greensand appears in the cuts of the railroad.

276. The same material exists in N. Attala, not only in the "Red Hills" themselves, whose soil appears to be formed, to a large

extent of the clayey materials of these strata, but also in the high hills bordering the Big Black on the south, where it crops out both on hillsides, as at Kirkwood's Ferry, and in the bluffs of streams—always containing more or less of the *greensand grains* (and impressions of sea-shells—both of which serve to distinguish this material from the common red sand and brown sandstone of the hilltops), which are sometimes washed out and accumulated by the streams in their sand-bars, forming a very eligible manure—as may be observed on Zilfa and Poukta Creeks.

I have not, as yet, specially examined the deposits of Attala, nor am I aware how far they extend westward of Shongalo—as they probably do; they may generally be looked for wherever the "red hill" soil prevails. N. E. of Shongalo, in S. W. Choctaw, these greensand deposits seem to exist likewise; since it is said that brown sandstone with sea-shells occurs there, and these, so far as I have seen, are always associated with greensand. The purple tint on the map, in this region, indicates the probable extent of territory in which these deposits may be looked for; it is quite likely that they may extend through E. Attala into S. W. Winston, N. E. Leake, and Neshoba.

277. *Calcareous marls of the Tertiary.*—These may be looked for, more or less, in the whole of the territory covered on the map by the various shades of blue.

Among the great variety of materials of this kind, forming all degrees of transitions imaginable, from the one to the other, we may nevertheless distinguish two chief classes, in an agricultural point of view; to-wit:

1st. The *white marls*, which consist mainly of carbonate of lime mixed, mostly with clay, but often also with sand, and containing but small quantities of other nutritive ingredients of plants; 2d. the *greensand marls*, in which the carbonate of lime is accompanied by more or less greensand grains, and more usually by sand than by clay. The former are to be regarded rather more in the light of stimulants, the latter, as true, nutritive manures. [See Agricultural Report, General Part.] Both classes of marls appear in each of the three principal stages of the marine calcareous Tertiary, and it would seem that one and the same stratum is sometimes developed in one character, at others, in the other; or portions of one and the same stratum, in one and the same locality, may contain these different marls in its several layers. It may be said in general, nevertheless, that greensand marls are more abundant in the Jackson Group, than in either of the others. On account of the great general similarity of these materials in the several stages, I shall not, however, attempt to describe those of each separately.

278. Of the character of the marls of the *Jackson* Group in its territory between the Bluff and Big Black River, I have no knowledge thus far, not having visited the localities or seen any specimens. It seems likely, however, from what I have heard of the character of the country, that they are similar to those of Madison and N. Hinds.

At *Vicksburg* (¶220) we find strata of bluish or greenish greensand marl between the ledges of limestone which are quarried in the N. part of the city; and sometimes, we find the same stratum composed of soft marl in one locality, and of limestone in another.

The uppermost shell stratum, which appears in the washed gullies near the summit of the hill S. of the creek, is very sandy, though overlaid by a heavy yellow loam of a "prairie" character; lower down, however, as in the gully by the roadside close to the bridge, the blue marl appears rather clayey, its shells being somewhat less numerous than in the upper stratum. An analysis of a specimen from this spot, which seemed to be about an average of the Vicksburg marl, gave the following result:

VICKSBURG MARL.

Coarse Sand	3.700
Clay and fine Sand	17.267
Potash	0.758
Soda	0.293
Lime	37.513
Magnesia	2.063
Peroxide of Iron, and Alumina	4.722
Phosphoric Acid	0.135
Carbonic Acid (and Loss)	30.838
Water	2.657
	100.000

The ¾ per cent. of Potash which this analysis shows, are present chiefly in the shape of greensand grains. It contains, also, a variable amount of iron pyrites in minute crystals, for which reason it would be advisable to expose the marl to the action of the air for some time before plowing it under, whereby a certain amount of Sulphuric Acid will be added to the above ingredients. Judging by its aspect and fossils, this marl represents correctly that of numerous other localities, and will be found a highly efficacious manure for almost any soil. Its low percentage of inert ingredients renders it suitable for transportation, inasmuch as but a small dressing will be required of this, in comparison with other marls, in order to secure a fine effect. On light sandy soils, especially when poor in vegetable matter, 250 to 300 bushels of this marl per acre are as much, probably, as could be used without fear of overdressing. Being, to a considerable extent, however, a true manure and not a mere stimulant, much smaller dressings will be found beneficial.

279. Most of the marls found in the ravines of the Walnut Hills in Warren county, are probably similar to that of Vicksburg; as a general thing, it appears that those occurring highest up are more sandy than those from the lower portion of the stratum, and hence, heavier dressings of these would be required. The shell marl cropping out at Amsterdam, on the Big Black River; that overlying the ledge of rock from beneath which, at Brownsville, Hinds county, the spring issues; the marl found on Jackson's Creek, S. 11, T. 5. R. 4 W., that at Stewart's quarry, and the upper strata at Marshall's quarry, are examples. It is probable that in all these localities, a richer marl could be found at a lower level, in deep ravines or on the banks of the creeks; and exposures of these materials may be looked for, more or less, on the whole territory colored *bluish-gray* on the map. Their great efficiency in the improvement of the soils of this region, has been shown by an experiment made by Mr. Marshall, who has dressed a portion of his land with a mixture of the (rather inferior) marl occurring between the ledges of stone at his quarry, and offall from his lime-kiln.

The blue limestone at Vicksburg would also, when burnt, form a valuable manure (¶205).

280. A marl greatly resembling that at Vicksburg, and containing still less inert matter than the former, though not quite so rich in greensand grains, occurs in the banks of Pearl River, at Byram Station, on the N. O., J. & G. N. R. R.; and I know of no locality

better suited to the shipment of these mineral fertilizers, of which several varieties occur here. The following section will illustrate the condition of things at and below the ferry landing, on the W. bank:

(Sec. 38.)

SECTION OF MARL STRATA AT BYRAM STATION (COOK'S FERRY).

	FEET	CHARACTER OF STRATA.	NO
	6	Calcareous glauconitic sand, bluish, with numerous shells (Vicksburg age).	3
	1½	Gray calcareous clay with detritus of shells.	2
		Bluish marl, with *Orbitoides, Navicula lima, Crassatella Mississippiensis, Madrepora Miss., Lunulites, Dental. Miss., Arca Miss.*	1

The following analysis gives the composition of the marl forming the stratum in the bed of the creek emptying into Pearl River at this point, and also exposed, more or less, in the river bank itself. It is bluish when wet, but grayish white when dry; quite soft and easily dug, without hard nodules, and containing a large amount both of entire shells, and of their detritus.

MARL FROM BYRAM STATION.

Insoluble Matter (chiefly sand)	12.308
Potash	0.611
Soda	0.179
Lime	43.932
Magnesia	1.658
Peroxide of Iron, and Alumina	2.696
Iron pyrites	1.266
Phosphoric Acid	0.224
Carbonic Acid, and Loss	34.720
Water and Organic Matter	2.396
	100.000

The amount of Potash in this marl, it will be perceived, is somewhat less than in that from Vicksburg, to which on the whole, it bears a great general resemblance. It contains, however, a large amount of Phosphoric Acid and of Lime; the Iron pyrites will render necessary its exposure to the atmosphere before plowing under.

The middle stratum (No. 2) is of greatly inferior value, although heretofore, it has been taken in preference to the others. No. 3, the uppermost, blue sandy material is similar to the uppermost marl at Vicksburg and Brownsville, and although containing greensand grains also, its large percentage of inert matter would render unprofitable its transportation to any distance; although, near at hand, it might be used with advantage on account of its easy accessibility. It is this stratum which forms the overhanging bank just below the ferry landing.

Stratum No. 1, which at the mouth of the creek is visible only at low water, is found at a higher level some distance above, near the bend, and is there 9 to 12 feet thick.

The profile occurring about half a mile above the ferry, has been given above (¶223.) Most of the marl is of a quality similar to that of stratum No. 1 at the ferry; some portions (as for instance, No. 3) are more sandy, and contain very large and numerous grains of greensand.

The marl could not of course be profitably obtained here unless in quarrying the rock; but other bluffs containing no rock are said to occur above, and may be looked for all the way between Byram and Jackson, on the river banks. I have not as yet specially examined that portion of the river. No marl is found, however, more than three miles below Byram.

The great abundance and fine quality of the Byram marl, together with its easy accessibility both by water and rail, render these beds of much more than local importance.

281. We now turn to the marls of N. Hinds, and Madison, which differ considerably, both in their aspect and chemical composition, from those just described.

The materials mentioned above (¶202 and ff.) as occurring in the cuts near Canton and Calhoun Station, represent pretty correctly all those I have seen N. of Jackson. They are generally very clayey—so much so, that they are commonly styled "soapstone" by the people. In many instances, these clays would hardly be distinguished by the eye alone, from the fat, blue or yellowish, laminated clays, or "blue dirt," of the Lignitic formation, further N.; yet generally, whitish specks, either of carbonate or sulphate of lime, or both, can be detected in them, and where they touch the surface loam, its peculiar greenish, waxen tint betrays the limy nature of the material. Besides, a drop of strong vinegar, or muriatic acid, will always cause more or less effervescence or "boiling," the greater or less violence of which serves to indicate, in some degree, the amount of lime present.

The *massy* ("joint") clays with only occasional calcareous veins, which generally are nearest the surface and contain no fossils (in cuts N. of Canton, and No. 2 of Sec. 26, ¶203), would rarely be applicable to any useful purpose in agriculture. Not so, however, with those which, though otherwise often greatly resembling the others, possess a laminated structure or cleavage ("*come off in flakes*"), and contain fossils: such as, for instance, No. 1 of Sec. 26, near Calhoun Station, in which the large bones were found; and the material occurring in the washes by the roadside, between Hanging Moss Creek and Jackson, in which numerous oysters occur.

The material is exceedingly variable; at times it is a hard gray clay, difficult to cut with the knife when dry, but exceedingly tenacious when wet; when this is the case, oysters are the only shells to be found in it, and it could serve for agricultural purposes only in exceptional cases, though by no means difficult to pulverize. On the contrary, if a piece be exposed to the sun while wet, it speedily shrinks and cracks in all directions, and is soon reduced to a pile of small crumbs, which the next rain melts down into a plastic mass; and if this happen to take place on a slant, a strong rain brings down torrents of mud. It is in this manner that many of the R. R. cuts between Canton and Jackson give continual trouble, and are rapidly widening (¶203).

282. From these stiff calcareous clays, containing from twelve to 20 per cent. of carbonate of lime, there is every degree of transition into the yellowish marlstone of the McNutt Hills, with 60 to 80 per cent. of the carbonate; the intermediate stages being soft

yellowish marls, somewhat chalky to the touch, without any visible grains of greensand, and with *casts* only of small shells, which are generally of a rust color, and form a very convenient criterion of the quality of the marl ; for the more of these rust-colored casts of shells it contains, the smaller, generally speaking, appears to be its percentage of inert matter, and the better, of course, its adaptation to agricultural purposes—all of which may be studied to advantage in the oft-named cuts S. of Calhoun Station, and in most of the cisterns dug between Canton and Jackson.

The only complete analysis I have as yet made of any marl of this character, refers to a specimen from the outcrop at Moody's Branch, at the foot of the McNutt Hills, N. E. of Jackson (¶201, Sec. 27) ; taken from stratum No. 6 of the section quoted. It is yellowish-white, rather loose and porous, contains little sand and but a few fossils—part of which, however, at this locality, retain their shells.

MARL FROM MOODY'S BRANCH, JACKSON.

Insoluble Matter (white clay and fine silica)	37400
Potash	0.445
Soda	0.208
Lime	28.821
Magnesia	1.407
Peroxide of Iron, and Alumina	5.133
Phosphoric Acid	0.256
Carbonic Acid, and Loss	23.084
Water	3.246
	100.000

The amount of Potash in this marl, it will be perceived, is much smaller than in the greensand marls previously noticed ; but it contains a large amount, comparatively, of Phosphoric Acid, and as it is, is a very eligible fertilizer, though not so much a *nutritive* manure as those before mentioned.

283. I have determined, indirectly, the amount of lime contained in two other specimens, fair representatives of the marls of Madison and N. Hinds. One is a yellowish, calcareous clay, splitting in "flakes," quite hard to cut when dry, containing some large oysters, but no small shells, and occasional crystals of gypsum ; forms a plastic paste when wetted. Taken from a gully in the roadside, 3 miles N. of Jackson. It effervesces weakly with acid, and the determination gave :

Carbonate of Lime..........................17.471 per cent.
(or, pure Lime..............................9.804)

Another specimen, taken from a bluff in Mr. Langley's field, near Jackson. Light yellow, cleaving rather irregularly ; feels chalky, and exhibits rusty casts of small shells ; determination gave :

Carbonate of Lime..........................62.780 per cent.
(or, pure Lime..............................35.230)

This marl is probably quite similar in composition to that of Moody's Branch (see above), but is richer in lime. Similar marls may be looked for all over N. Hinds and S. Madison, and may very generally be selected to suit the soils, according to their lightness or heaviness. As they do not seem to contain iron pyrites, their exposure to the atmosphere previous to plowing under, will only be necessary in so far as it favors their pulverization.

The lower blue strata at Jackson—(Nos. 4 and 5, Sec. 27, ¶201) which contain the perfect shells, and are exposed under the bridge on Pearl River, and on Dry Creek near its mouth, are generally so sandy, and comparatively poor in lime, that their use for agricultural purposes would generally be too expensive, unless they were very near at hand, and it were desired, at the same time, to remedy extreme heaviness of the soil by the admixture of sand. The character of this bed, however, is itself somewhat variable, so that for instance, at its outcrop on the bank of the River near the end of the road embankment, in Rankin, it is so much less sandy, and richer in lime and greensand, as to form an eligible manure, similar in its aspect to the marl of Vicksburg. I have not, however, as yet analyzed it.

284. With the marls of N. Rankin, and Scott, I am not personally acquainted, except through a specimen furnished by Rev. E. B. Sims, from a locality near Morton, which resembles that but just mentioned; and so probably does the marl on Coffeebogue Creek, mentioned by Prof. Wailes. The marl struck in R. R. cuts on the upper Potoe-Chitto, in Newton county, has been mentioned above (¶297). Marls similar to those of Madison and N. Hinds are probably, however, the most prevalent; at least, we find them of precisely the same character on the headwaters of Leaf and Strong Rivers, in S. Scott and N. E. Smith—so much so, that all that has been said regarding the yellow and white marls of Madison and N. Hinds, will apply equally to those of the region just mentioned.

The yellow calcareous clay in which the large (*Zeuglodon*) bones occur, in Mrs. Nichols' field, and neighborhood (¶207), is identical in almost every particular with that occurring on the roadside 3 miles N. of Jackson, which was found to contain 17½ per cent. of carbonate of lime, and some gypsum; materials similar to the marl from Langley's field (see above) occur there also, and may be distinguished by the same criterion from the clays comparatively poor in lime. It is probable that greensand marls resembling the lower beds at Jackson, likewise occur. They should be sought for in the lowest situations (beds of creeks, etc.), underlying the yellow clay marls.

285. The marls occurring near Brandon (belonging to the Vicksburg Group—¶218, 224, ff.) resemble somewhat, at first sight, the yellow clay marls just described. But while they coincide with them in the absence of greensand grains, and consequent poverty in Potash, they differ essentially in this, that the amount of inert matter they contain is either very small, or when present consists of sand instead of clay: besides which, gypsum is entirely absent from them.

The yellowish-white marls of the neighborhood of Brandon contain much less sand than from their grittiness to the touch, one would be led to suppose; the latter circumstance being the effect of the crystalline nature of the calcareous particles. Thus, the rough, yellowish-white, often somewhat indurate marl occurring at the bluffs in Dr. I. M. Quin's field, 4 miles S. of Brandon, shows the following composition:

DR. I. M. QUIN'S MARL, RANKIN COUNTY.

Insoluble Matter (sand and fine silica)	13.074
Potash	0.265
Soda	0.031
Lime	46.222
Magnesia	0.614
Brown Oxide of Manganese	0.067
Peroxide of Iron, and Alumina	2.722
Phosphoric Acid	trace
Sulphuric Acid	0.058
Carbonic Acid	34.751
Water	2.050
	99.857

A determination of the ingredients insoluble in *very dilute* muriatic acid, contained in the yellowish-white, soft marl intervening between two limestone ledges in the "rock cut" of the old R. R. track at Yost's Lime-kiln, gave only 6 per cent. of insoluble matter, 2 of which were sharp black sand, the rest a ferruginous, clayey material. The remaining 94 per cent. may be considered nearly pure carbonate of lime, corresponding to 52.75 per cent. of pure lime.—The marl used by Mr. A. P. Miller, is of this character.

These marls are therefore to be considered essentially as stimulants, whose *continued* application, unaided by other, true manures, would in the end exhaust the soil. On account of the small amount of inert matter contained in them, they are equally well suited to sandy and clayey soils; it being recollected, however, that their great purity renders necessary some caution in their application to light soils, in order to avoid overdressing. Thus, on the sandy ridge soils S. of Brandon, it might hardly be safe to use more than 200 bushels per acre.

286. Besides these pure, white marls, which are to be looked for *wherever, in that neighborhood, ledges of limestone occur (between* the latter), another material may be obtained, in abundance, *above* (*i. e.* always at a higher level than) the limestone, viz: a yellow calcareous sand, containing but few entire shells, but many obscure casts of others; which is seen in the cuts immediately W. and E. of Brandon Depot.

This material is very variable; the firmer, the more lime it generally contains. On account of the large percentage of inert sand contained in it, it would not pay for transportation to any distance: but where it is at hand, it would be a fine material for the improvement of the heavy, cold soils which occur in patches in that neighborhood—*e. g.* at Mr. Jos. Jayne's. For the improvement of hill lands, where transportation is costly, the pure white marls are, of course, to be preferred; so also, for composting, de-odorizing, etc.

Outcrops of limestone occur on Richland Creek in several localities (see below, under Limestones), and they are probably accompanied by marl. The only marl outcrop on Richland Creek which I have as yet examined, is at Mr. German Berry's, S. 11, T. 4, R. 2 E., (Monterey P. O.). The blue calcareous sand, containing entire shells, is very similar to the uppermost marls at Vicksburg, at Brownsville, etc., which see.—Of the *gypseous marls* of the prairies of N. Rankin I shall speak in another place, in connection with the soil of these prairies (see Agricultural Report).

287. With the character of the marls in the Polkville region, I am not acquainted; but from what I have heard, they are similar in general to those near Brandon.

N. of Raleigh, Smith county, at Mr. Austin's mill (¶227), we find marls corresponding in every respect to those at and above Byram, which see (¶280); though on the whole, perhaps, they are a little more sandy; in some places they contain a good many greensand grains. The marl into which the pit for the water wheel is dug, is rather inferior to that which is found a few hundred yards lower down, outcropping on Shongalo Creek. Outcrops of a similar character are said to exist on the Okahay, and on Leaf River; the same marl could no doubt be found under the ledges of limestone which come to the surface on the lower slopes of the ridges falling off towards Shongalo and Bowlands Creek, and may be looked for on Hatchushe and West Tallahala Creeks, E. of Raleigh, and S. of the "Hog wallow prairie" region, in which only the clay marls of the Jackson Group (see above, ¶207 and ff.; 284) are to be looked for.

288. The latter occur, very characteristically, near Garlandsville, and generally on the black prairies, or "shell prairie," on both sides of the Paulding ridge. On the bald prairies S. of Suanlovey Creek, near Garlandsville, we find all the several varieties of the white or yellowish clay marls occurring near Jackson and in the McNutt Hills—heavy calcareous clays with but a small percentage of lime, and some gypsum; and soft, easily crushed marls, with ferruginous casts of shells, resembling those of Moody's Branch and Langley's field (see above, ¶282, 283), and probably of a similar composition also. The great sandiness of the ridge soils of this region would render these clay marls particularly suitable to their improvement.

Of the marls of S. Jasper, I know nothing personally; they are said to resemble partly those of the Brandon neighborhood, partly the sandy varieties of the Vicksburg marl—as do those of the same formation in Wayne county. The country being hilly, they appear only in the deep ravines, and beds of water courses.

289. In Clarke and Wayne counties, we have a great variety of mineral fertilizers.

Beginning at the north, we find in the banks of the Chickasawhay River at Enterprise, strata of shell-bearing, calcareous sand, containing a large amount of greensand grains.

The stratum (Nos. 2 and 3 of Sec. 24, ¶190½) as exhibited in the town of Enterprise, is so rich in greensand grains, that notwithstanding its sandiness, this material would be an eligible manure wherever it is conveniently accessible and does not require to be hauled to any great distance. It is very likely, however, that the river bluff below the town, where a large exposure of stratum No. 3 may be looked for, will be found to contain materials of greater purity, which, for their action as true manures and not mere stimulants, would be of especial value. Portions of this bed greatly resemble that near Shongalo (¶274 and ff.) and it is quite likely that the two deposits are connected, in which case, similar materials might be looked for in N. Newton, Leake, and E. Attala. Similar beds probably exist on the headwaters of Buckatunna, in N. E Clarke county.

290. In the S. W. corner of T. 4, R. 17 W., we find, on Suanlovey Creek, at a bridge, a bed of bluish marl resembling that of Byram. The thickness of this marl stratum I have not ascertained — it probably crops out on the creek below this spot also; and the same marl is found near Quitman; and east of the same, on the waters of the Buckatunna.

At Quitman, it does not appear in the bluffs of the river, where only a bluish-black, clayey sand is to be seen; it occurs at a higher level, in the wells at Quitman, and at Smith's Sulphur Spring, south of the town, where it very closely resembles the Byram marl, save in that it does not contain (excepting oysters) any well-preserved shells. It is further seen in branches for several miles south of Quitman, where it also appears in the banks of the Chickasawhay River. Thus far the marl closely resembles the *blue marls* of the Vicksburg strata, containing a considerable amount of greensand grains.

Further south, at the crossing of Falling Creek, four and a half miles from Quitman, we find it associated with white, sandy marls without greensand grains, resembling in general those of the Brandon neighborhood (¶218, Sec. 30). Of the marls occurring at this point, the blue (No. 3 of the section) is of course preferable as a manure. On this creek, and on the Chickasawhay River above the mouth of the same, marl may be looked for. On Coonupy Creek, however, and on the Chickasawhay near its mouth, we find brown clays containing no shells, and of no value as a manure

291. Southward of Coonupy Creek, we once more come to the territory of the yellowish-white clay marls of the Jackson Group. Here, however, I have not met with so much of the stiff clays seen elsewhere; the marl is more generally of the character of that from Langley's field, like which it contains many ferruginous or rusty casts of shells—as may be seen on many of the prairie hill-sides.

The marl in the banks of the Chickasawhay at Dr. Ogburn's, S. 21, T. 1, R. 16 E, is scarcely to be distinguished from that of stratum No. 6, at Moody's branch (Sec. 29, ¶201), an analysis of which is given above (¶282). At Dr. Ogburn's, the marl is so near to the surface of the ground that it can readily be reached in pits dug in the field itself; and its effects on the productiveness of the soil are much praised by Dr. O. The stratum as exhibited on the river banks, underlaid by brown and red clays, is about thirty feet in thickness.

292. South of Dr. Ogburn's, on Garlands Creek, we find exhibited two strata of greensand marl, corresponding, apparently, to the blue marl at Jackson, like which, they are overlaid by white marls.

The strata occurring in this locality have been mentioned above (¶210); the upper stratum consists of greensand grains imbedded in gray calcareous clay, together with many entire shells. An average specimen of this marl (air-dried) lost 11.914 per cent. of water by ignition, and was composed as follows:

GREENSAND MARL FROM GARLAND'S CREEK.

Insoluble Matter (Silica and Sand)	21.657
Soluble (in $NaO\,CO^2$) Silica	24.224
Potash	1.717
Soda	0.465
Lime	14.785
Magnesia	2.476
Brown Oxide of Magnesia	0.403
Peroxide of Iron	13.020
Alumina	7.751
Phosphoric Acid	0.327
Sulphuric Acid	0.566
Carbonic Acid	12.492
	99.556

This marl is quite remarkable for its completeness as a mineral manure in all respects, containing as it does, large amounts of every essential ingredient (excepting chlorine, which may, however, be present also); being so constituted as to be equally well adapted to light and heavy soils, and without any danger of over-dressing. It is, thus far, the most complete mineral fertilizer I have found in the State.

It constitutes about two feet of the bluff at the bridge, being the highest stratum visible below the soil; the lowest five feet consist of a sandy material, also rich in greensand, yet not as much so as the upper stratum. Both probably crop out on the Chickasawhay near or above the mouth of Garland's Creek, and it is possible that the upper stratum may there be found of greater thickness. It would pay well for transportion even to a distance.

I have received, through the hands of Gov. Pettus, a specimen of marl nearly resembling that of the upper stratum at Garland's Creek, found near De Soto Station, Clarke county, on the M. & O. R. R.

294. In the upland prairies between Garland's Creek and Suck Creek, we again find materials somewhat similar to those of the McNutt Hills near Jackson (¶204); Suck Creek itself has excavated its channel in a solid bed of bluish-white marl, which contains only fine sand and bears no small resemblance, at first sight, to the freshly dug "Rotten Limestone" of the prairies of Monroe, etc. I have not as yet analyzed this marl—it contains small grains of greensand, and while it is certainly very rich in lime, it may contain notable amounts of other useful ingredients.

Similar materials occur all along on the road to Gen. Trotter's plantation. At the latter place, there is quite a variety of marly materials, but on the whole they are poor in greensand grains and consequently in potash; consisting chiefly of lime and sand.

The marl in the deep gullies, and the lower portion of the bluff on the Chickasawhay River, is most sandy, bluish, and greatly resembles the material seen on Suck Creek; while higher up on the hillsides, we find outcropping ledges of soft, yellowish white limestone (precisely similar to that of the McNutt Hills), alternating with soft strata which appear to be the less sandy and richer in lime and clay the higher up they occur; none of them, however, containing any notable amount of greensand.

295. For several miles above and below the plantation, these and similar marls crop out on the Chickasawhay River. The further southward, however, the more clayey and compact they seem to

become, the upper strata gradually descending to the water level and finally disappearing beneath it, until, at the bluffs above Red Bluff Station, a material altogether different takes their place, as is shown in the profile (Sec. 28, ¶212.)

Here we have 50 to 60 feet of a bluish clay marl, almost uniform above and below, and containing chiefly minute, imperfect shells; no ledges of rock appear within it, and traces only of greensand grains. Judging from its effervesence with acids, this marl is limey enough to serve as a strong stimulant dressing, especially on light soils; it is not so well suited, however, to the heavy "hog-wallow soil" which occupies the top of the bluff.

294. Lower down the river, the heavy green clay which appears at the top of the profile (Sec. 28, ¶212) descends lower, and itself forms the bluff; it is unfit to serve any purpose in agriculture, and and shows neither shells, nor effervesence ("boiling") with acids. Gradually, however, it also descends to the water, and overlying it appear the white marls of the Vicksburg Group, so closely resembling those occurring near Brandon, that it is difficult to distinguish specimens of the two, one from the rock cut on the Southern R. R. at Yost's Lime-kiln, Rankin county (¶285), and the other from the bluff of the Chickasawhay at Dr. E. A. Miller's, near Waynesboro', Wayne county; their chemical nature also being, no doubt, essentially the same.

At the latter place also, the yellowish-white marl generally occurs between ledges of limestone; nor are even the calcareous sands wanting, which we see in the cuts near Brandon Depot (¶218). The latter also appear with frequency on hilltops on the west side of the Chickasawhay, in T. 9, R. 7 W.; and in the streams—as for instance, on Yellow Creek—blue marls resembling those at and above Byram, appear, inclosed as usual, between ledges of rock. Specimens of similar marls have been furnished me from Mr. Waldron's place on the Chickasawhay, near Waynesboro'.

As a manure proper, the *blue* marls, which generally contain greensand grains, are preferable, of course, to the *white*, which furnish only lime to the soil. The variety of materials occurring in this region is so great, however, as to deserve a more special examination than, thus far, I have been able to bestow on them; especially in view of the equally great variety of soils, itself owing more or less, no doubt, to the variability of the materials in question.

295[1] No marls are found on the Chickasawhay, so far as I am aware, much below Dr. E. A. Miller's, near Waynesboro', Wayne county. I have not myself visited the waters of the Buckatunna, but from what information I have obtained, the beds corresponding to those on the Chickasawhay from Quitman in Clarke county, to Waynesboro' in Wayne, appear again on the Buckatunna, in a direction south of east, as indicated on the map, and in the intervening tract of country, the marl, together with the limestones associated with it, is found in the ravines and water-courses, and also, where there is prairie, on the hills and hillsides. A growth of Crab-Apple, Wild Plum, Poplar, Red-Bud, etc., in the hollows, will generally indicate the presence of some of these calcareous materials, near to the surface.

The clayey, *gypseous marls* of some parts of Hinds, Rankin and Scott, which are intimately connected, in most cases, with the bald prairies of that region, will be mentioned in connection with the latter, under the head of the Central Prairie Region, as well as below (¶303²).

295². *Calcareous Marls of the Fresh-Water Tertiary of South Mississippi, or Southern Lignitic.*—Calcareous marls, void of shells, and very clayey, occur in limited patches on the territory of the Grand Gulf Group. These deposits are local phenomena—the strata containing them either run out beyond a limited space, or more generally, the material changes its character - loses its calcareous constituent, and becomes a simple gray clay. It is not possible therefore to trace out such deposits from place to place, as we have done in describing the marls of the marine Tertiary: they turn up occasionally, any where on the territory of the Grand Gulf Group.

At Grand Gulf, as the section shows, (Section 33, ¶232), we have calcareous clays at two different levels, in strata Nos. 1 and 8; the latter especially, in some portions of the bed, would no doubt make an effectual manure. But it is not to be traced at other points of the outcrop, and the same is the case with No. 1, which is visible as such only at the lower end of the bluff. The material might form a good dressing for light soils, buts its quality would not entitle it to more than local importance. The amount of lime contained in the mass may be judged of by the eye, since it forms whitish specks in a green mass.

296. The only other deposit of this character and of any importance, which I know of, W. of Pearl River, is a bed of brown clay marl occurring at Judge Hiram Cassedy's, S. 1 T. 6, R. 3 E., on the hills bordering on the S., the S. fork of the Homochitto, in Franklin county.

It forms a "prairie" spot on a hilltop, about an acre in extent, and consists of a stratum some 8 feet in thickness, of a stiff, dark orange-colored clay, interspersed with specks of white, limy concretions, which are largest and most abundant in the lower portion (the lowest 3 feet) of the deposit, where they occur of the size of a hen's egg, and sometimes larger. The whole of the clayey mass, hower, effervesces with acids. The spot bears the usual evidence of a calcareous soil in its vegetation, which consists chiefly of Crab-Apple and a species of Red Haw (or Hawthorn), and on its outskirts, where the soil is not excessively heavy, Wild Plum and Honey Locust also; while the other timber is thin and much stunted. The whole was probably once covered with dark colored prairie soil, which is now found only in patches; and it is stated that when the country was first settled, the spot was entirely overgrown with strawberry bushes.

297. The specimen analyzed represents about the average (exclusive of the large lumps of lime) of the lowest four feet. It is a hard, reddish-brown clay, with numerous white specks and veins.

CLAY MARL FROM JUDGE HIRAM CASSEDY'S, FRANKLIN CO.

The airdried substance lost 6.818 per cent. of moisture at 212 deg. F., dried at which temperature it consisted of:

Insoluble Matter	49.475
Potash	1.242
Soda	0.152
Lime	13.190
Magnesia	1.829
Brown Oxide of Manganese	0.266
Peroxide of Iron	5.538
Alumina	12.587
Sulphuric Acid	0.033
Phosphoric Acid	0.132
Carbonic Acid	9.555
Water	5.876
	99.871

The most remarkable feature exhibited in this analysis, is the large amount of Potash contained in the substance, in the absence of any visible trace of greensand grains. It is highly probable, however, that in consequence of the long continued action of lime on the mass, a large part of this potash, as well as of the other ingredients present, is in an available condition, and that this material will prove a valuable fertilizer, more especially as most of the soils in the neighborhood of its place of occurrence, are very light, and in the case of the bottom soils, extremely so. The large amount of clay contained in the material itself, as compared with its percentage of lime, obviates any danger of overdressing; except in rendering the soil too heavy where it is not naturally very light, by using a very great excess.

The most calcareous portions of the mass ought, of course, to be selected, as they will pay best for transportation. Experiments on the efficacy of the material must decide how far the 22½ per cent. of carbonate of lime and 1¼ of potash will pay for the transportation of the inert clay.

298. It is very likely that similar deposits occur in other portions of the Homochitto Hills. *All* bald hilltops having a clay soil do not, however, necessarily indicate the presence of similar materials: I have observed many, both in the Homochitto Hills, in those S. of Fayette, and in other localities between the Mississippi and the waters of Leaf River, in which a heavy gray potters clay, which does not effervesce, forms the soil and supports a stunted forest growth, and generally some long grass. It is only when the Crab Apple, Red Haw and Honey Locust are present in such spots, that the existence of calcareous marls is indicated. Such indications are found in the hills three to five miles south of Fayette, where the trees mentioned, accompanied by the Wild Plum and Poplar, may be observed in several points on the ridge; and I have found calcareous veins in an outcrop of gray clay in the roads on a hillside about three miles south of Fayette.

For use on the small scale, in the improvement of gardens, where the expense need not be considered, the clay marl at Judge Cassedy's might, no doubt, be greatly improved by a gentle calcination, which would render most of the ingredients available to a much greater extent than is the case in the raw material. In composting manure, it will be found valuable in either case.

299. I have no personal knowledge of the existence of any

similar materials between the localities just mentioned, and Pearl River. On the latter, as stated before, blue, green and white clays usually form the material of the strata of the Grand Gulf Group, which appear to be very generally rich in Potash, Soda and Magnesia, and often in Gypsum; but it is only in one point that I know them to contain a notable amount of carbonate of lime; viz: near Mr. Ben Barnes' place, SS. 2 and 35, TT. 4 and 5, R. 12 E., Marion county.

A high ridge here comes up to the river, and has been washed off into a steep bluff about 110 feet high from the water's edge. It continues along the river for four or five miles below, sometimes coming up close to the bank, but generally at a distance of 200 to 300 yards from the latter, on the west side; its upper portion being formed by deposits of gravel and sand of the Orange Sand Group, the lower, by the gray or variously colored clays and loams of the Grand Gulf Group.

The following is the profile afforded by the strata at the "White Bluff," on the sections above given:

(Sec. 39.)

SECTION OF "BARNES' WHITE BLUFF," MARION COUNTY.

	FEET.	CHARACTER OF STRATA.	NO.
	25 to 30	Yellow and red sand, and pebbles. (Orange Sand).	8
	40	Gray or yellowish, fine sand, somewhat clayey, and indurate, washing into perpendicular, rounded masses. In some portions quite cellular, the cavities rusty.	7
	3	Reddish-gray, clayey sand.	6
c	6	Yellowish-gray clay, almost white when dry, with veins, specks and nodules of carbonate of lime—"*Marl.*"	5
	20	Sandy clay variegated with pale red and gray—same as No. 6.	6
	2	White indurate sand, fine-grained.	3
	6	Solid gray clay, with massy cleavage, very fat; contains rounded masses, several inches thick, of light green clay, with white laminæ.	2
	1	Blue sandy clay, as at Pope's Ferry, and Monticello.	1

300. Of the several materials occurring at this outcrop, stratum No. 5 is the one which at once suggests itself as suitable for use as a fertilizer—more espe-

cially on the very sandy soils of the region, which are pre-eminently poor in lime. An analysis of an average specimen from stratum No. 6, dried at the boiling point, gave the following result:

BARNES' MARL.

Insoluble Matter (clay and silex)	77.438
Potash	0.709
Soda	0.101
Lime	4.800
Magnesia	1.248
Brown Oxide of Manganese	0.316
Peroxide of Iron	2.989
Alumina	6.449
Phosphoric Acid	0.111
Sulphuric Acid	trace
Carbonic Acid	3.372
Water	2.554
	100.197

The large amount of inert matter contained in this material, would prevent its transportation to any considerable distance, on account of the considerable quantity required for an effective dressing. But to the sandy lands of the neighborhood, its application will, no doubt, prove both beneficial and profitable. It crumbles readily on exposure, in a pile, to the atmosphere, but contains no pyrites to render any lengthy exposure necessary. No fears need be entertained of overdressing, unless the application be carried to such an excess as to render the soil too clayey—which is not likely to happen.

301. Here, as elsewhere in this formation, the calcareous character of the stratum does not appear to be continued to any great distance. About half a mile below the bluff, we find at the water's edge a gray clay similar to that of stratum No. 5 of the section, but instead of containing the lime in minute specks and streaks, the latter occurs in solid veins or plates $\frac{1}{8}$ to $\frac{1}{2}$ inch thick, while the mass of the clay contains none and is not, therefore, suitable as a fertilizer. Lower down still, at the "Red Bluff," on S. 12, T. 4, R. 12 E. (which is considerably higher than the "White Bluff," the Orange Sand strata superimposed upon those of the Grand Gulf Group beiug 140 to 150 feet in thickness), we find no trace of calcareous veins in the gray clays into which the creek has cut its channel in the lower portion of its course.

It is stated, however, by Mr. Barnes, that singularly favorable effects were produced, in experiments made by him on a small scale, by the use, as a fertilizer, of a grayish, sandy material obtained at the "Red Bluff," and resembling, in its aspect, that of stratum No. 7 of the "White Bluff." I have not myself seen this material in place; specimens handed me by Mr. Barnes do not effervesce with acid, but a qualitative analysis showed it to contain an unusual amount of Potash, for the presence of which I cannot account satisfactorily, since there is no trace of greensand in the mass. Future examinations must decide this point. It is to be regretted, that Mr. Barnes' experiments with these fertilizers were not made on a larger scale; but the analysis shows good reason to expect the favorable results reported by him.

It seems very likely, that other deposits of calcareous marls may be found in this region, and in the Lenoir Settlement, lower down.

302. It is stated that bald hilltops, overgrown with Red Haw, Crab Apple, Locust, etc., exist in east Lawrence county, but I have had no opportunity of verifying the fact.

There can be no doubt that locally, a good many of the materials of this formation might be employed in the improvement of soils, even where they cannot properly be considered as marls in the usual acceptation of the term: provided only, they be convenient to the tract where they are to be used. The soils of S. E Mississippi show very generally extremes of heaviness and lightness; and whenever the increased facilities of communication shall be such as to render practicable the more costly methods of improvement in the soils of particular localities, the materials of this formation will be called in requisition in preference to others which would not serve the double purpose of a chemical and mechanical manure. [See Agr. Rept., Gen. Pt.] As an example of a material which, though not suitable for transportation to a distance, would form an eminently useful addition to any soil to which it could be conveniently applied, I subjoin the analysis of a green loam forming part of an outcrop, a section of which is given below.

(Sec. 40.)

SECTION AT BURNETT'S BLUFF, MARION COUNTY.

FEET.	CHARACTER OF STRATA.	NO.
4	Orange Sand with pebbles; hilltops about 50 feet more.	5
7	Gray massy clay, very fat.	4
4	Greenish-gray, clayey sand.	3
15	Bluish-gray, fat, massy clay.	2
5	Loose green loam, without coarse sand.	1

The air-dried material of the lowest stratum (No. 1) lost, on ignition, 4.967 per cent. of moisture, and gave the following result:

GREEN LOAM FROM BURNETT'S BLUFF, MARION COUNTY.

Insoluble Matter (clay and silex)	83.691
Potash	0.827
Soda	0.268
Lime	0.793
Magnesia	1.053
Brown Oxide of Manganese	0.223
Peroxide of Iron	4.394
Alumina	8.347
Phosphoric Acid	0.148
Sulphuric Acid	0.022
	99.761

This loam (which was instinctively, from its aspect, considered "rich" by the inhabitants), would from its physical, no less than its chemical constitution, form an acceptable addition to any soil; while the upper strata, which seem to differ from it mainly in the amount of clay which they contain, could be profitably employed, where convenient, for the improvement of very light soils. And under similar circumstances, no doubt such materials as those at Monticello, Pope's Ferry, Avera's, etc. (¶ 237, 238, 245) would be equally useful.

303[1]. At Dwyer's Ferry, S. 11, T. 5, R. 7 W., Jackson county, materials occur which no doubt could be used with great advantage on the poor soils of that region (¶246, Sec. 39). They contain large amounts of gypsum, and probably other fertilizing substances—I have not, however, had time to give them a special examination.

The fertilizers occurring in the formations near the sea-coast, are mentioned in the special description of that region, as well as above (¶¶ 248, 249).

303[2]. Gypsum, or *Plaster of Paris.*—The occurrence of this substance on the territory of the several lignitic stages of the Tertiary, as well as that on the Jackson and Vicksburg Groups, has been repeatedly mentioned. It is usually found in crystalline plates, rosettes, or lenticular masses, 1-20 of an inch to 2 inches in thickness; but I have not thus far seen it in independent deposits sufficiently large to warrant exploitation of the plaster *as such*; although it is very likely that such deposits do exist, and if so, they would be of high value in agriculture. In most cases, the mineral is intermixed in small crystals or thin sheets, with clayey materials, so as to be available only in connection with these; forming *gypseous marls*, whose agricultural value is only thus far inferior to that of pure plaster, as they will not bear transportation so well. Some of them, however, undoubtedly contain other valuable ingredients besides gypsum, and it is possible that not a few of the lignito-gypseous materials found in S. Carroll, Attala, Leake, Holmes and N. Madison (180, 183, 187), as well as in Hinds, Rankin and Scott, will prove valuable fertilizers.

I have not, however, thus far given as much attention to their investigation as to that of the more generally important "calcareous" marls, and greensands; an analysis of one of them will be found in the Agricultural Report, under the head of the "Central Prairie Region," whose gypseous prairies owe their existence to the gypseous clay marls. Other data concerning their occurrence are given in ¶¶ 215 to 219, 231, 233, 241, 246. The largest masses of *pure gypsum* on selenite, of whose occurrence I am aware, have been found in wells near Cato, Rankin county (¶241—a ledge from ten to twelve inches thick); in the railroad cut near Clinton (crystalline masses one to two inches thick and of a square-foot surface); on the gypseous prairies of W. Hinds (Wailes); in Dr. Galloway's well, near Kosciusko (187), and on the Pelahatchie near Mr. J. Parker's (125).

304. Limestones of the Marine Tertiary.—Limestones suitable for lime-burning, as well as for building purposes, are chiefly found on the territory of the Vicksburg Group. The limestones, or rather, indurate marls occasionally found within the two other groups, are generally too soft for building purposes, and not nearly as pure as the hard blue limestones of the Vicksburg Group.

The only locality known to me on the territory of the Claiborne Group, where any solid limestone occurs, is that on Falling Creek, 4½ miles S. of Quitman, Clarke county; so far as I have seen it, however (¶195, Sec. 26), it is very sandy, and would make lime suitable only for mortar, and for agricultural purposes. It may be found of greater purity at other localities on that stream. Nor are the marls of this group of sufficient purity to serve as materials for lime-burning.

The same is true of the limestones of the Jackson Group. The indurate marl of the McNutt Hills does not resist the weather, and would make very inferior lime for all except agricultural purposes; and the same holds true of the limestones occurring on the Chickasawhay near Trotter's Plantation, Clarke county. It is probable, however, that not a few of these materials will be found, when properly burnt, to possess hydraulic properties—a point I have not as yet investigated, but which, from the frequency with which cisterns are used on the territory of this group, possesses a special interest. Marls like those at Moody's Branch (¶204), Langley's field, and many of those of Madison, N. Smith, N. Jasper, and S. Clarke, approach very nearly in their composition, to hydraulic limestones; and the same is true of the marl of Vicksburg, and those resembling it.

305. Some of the limestones of the Vicksburg Group are of considerable purity; thus, that at Yost's lime-kiln, Rankin connty, contains only about five per cent. of impurities (see below) which are the less injurious to the quality of the product, as they consist of sand rather than clay. The limestone ledges always occur interstratified (alternating) with marl strata, the thickness of both varying from 1 to 6 feet; the limestone ledges are generally the thickest, ordinarily 2 or 4 feet. The limestone at Vicksburg, (220) whose quality as a building stone and flagstone has been sufficiently tested,* is less pure than that found in Hinds and Rankin; yet it will, if not overburnt, yield a lime suitable for all ordinary purposes, except, perhaps, whitewashing. A partial analysis of the rock as obtained from the quarry in the northern part of the town of Vicksburg, gave the following result:

VICKSBURG LIMESTONE.

Carbonate of Lime	87.808
Sharp Sand	0.207
Other Impurities	11.985
	100.000

1 cwt. of limestone will, according to this analysis, yield about 61 pounds of burnt lime, containing between 11 and 12 lbs. of impurities. Among the latter,

*The durability of the rock is greatly increased, if care be taken to place it *in its natural position*, so as to place the stratification lines *horizontally* and not *vertically*; in other words, if the slabs be placed "flat" and not "on edge." In many of the stone walls and paving stones of Vicksburg, it will be noted that wherever the rock has been placed on edge, it has split up and crumbled off ("exfoliated") to a much greater extent, than is the case where it was placed on the broad side. In old walls especially, the rocks placed on edge might be distinguished at a distance, by their forming recesses, as it were, below the surface of the others.—The greater permeability of the rock to water in the direction of its cleavage, than at right angles to the latter, explains this phenomenon.

however, the eye, and still better the lens, detects a considerable amount of greensand grains, which will render the product especially valuable for agricultural purposes.

306. Whether or not the limestone occurring at Old Fort St. Peters, above Vicksburg, on the Yazoo, resembles the Vicksburg rock in this respect, I am not informed. It appears that in this locality, the ledges are heavier than at Vicksburg, so that blocks of considerable size can be obtained.—The clay seams mentioned as overlying the best of the rock at Vicksburg (¶220), seem to accompany the same pretty generally, and may serve as a convenient landmark in opening quarries. It would seem that lime might be manufactured to great advantage at several points in the Walnut Hills, on the Yazoo River, where timber is so abundant; and so near to the great highway of the West, at all whose ports are annually landed immense quantities of lime, transported at enormous expense from Portland, Maine, to be distributed and consumed in the valley of the Mississippi.

I am not aware that any limestone appears on the Big Black, in Warren or Hinds counties; it would seem that such must be the case at some point E. and N. E. of Vicksburg, although it might be covered at present by the surface materials.

307. The rock occurring in the town of Brownsville (¶221) is rather impure, but would yield lime suitable for mortar, and agricultural purposes.

Of the limestone occurring on Baker's Creek, below Bolton's Depot, I have not seen any specimen, nor am I aware of the thickness or character of the strata, which are, no doubt, a continuation of those at Steward's quarry, 3 miles W. of Clinton, and could probably be found at corresponding depths in other localities. The rock at Steward's quarry is purer than that at Vicksburg, and well suited for building purposes, as well as for lime burning, being very similar to that of Yost's Lime-kiln. The same is true of most of the rock at Marshall's Quarry; that occurring near the former residence of Mr. Long; and 3 miles S. of Byram, on the R. R. At the latter place, it does not, however, form solid ledges, but strata of disjointed, cavernous blocks; which circumstance, while rendering it less valuable as a building stone, in no way impairs its quality for lime-burning. The stratum can no doubt be found in many other localities, and with the exception of N. E. Tishomingo, I know of no region in the State so well supplied with this useful material, and so accessible on all sides, as that lying S. of the Southern R. R., between Brandon and Bolton, and indicated on the map by the pale bluish gray.

308. At Byram Station itself, as shown in the profile (¶280), no limestone occurs, but only soft marls. But within a mile above, the ledges of rock represented in Sec. 32 (¶223), cropping out on the banks of the river, offer a fine opportunity of obtaining, not only good limestone, but also very durable building stones, at the same time with the first quality of marls.

The smooth, water-worn surfaces of the rock in ledges Nos. 2, 4 and 6, plainly show that it is not likely to give way under atmospheric influences alone. Considering in general, the great resistance of these limestones to decay, which may be seen abundantly illustrated at their outcrops, it is much to be regretted that the soft, easily decaying sandstone of S. Hinds should have altogether superseded it in the erection of public buildings at Jackson.

309. From Byram, the limestone may be traced in occasional outcrops to the neighborhood of Brandon, where it appears at numerous localities, generally capping the hills (as on A. P. Miller's. Jos. Jayne's and Rev. D. A. Campbell's land,) forming a belt running N. E. and S. W.

There are here also, however, several ledges of hard limestone, separated from each other by strata of white marl (¶218). The heaviest stratum, which appears at the same level in several localities in the neighborhood, occurs at Yost's lime-kiln. This stratum is composed of two ledges, separated only by a thin sheet of soft material; the upper ledge, about two feet in thickness, consists of disjointed blocks, very jagged and rough, and its cavities filled with red clay from the surface. The lower ledge is solid, and 2½ to 3 feet thick; it is blue internally, but yellowish on the outside, there being, however, no essential difference between the portions so colored. An analysis of a specimen of this rock, taken from the lower ledge, gave the following result:

LIMESTONE FROM YOST'S LIME-KILN, RANKIN COUNTY.

Insoluble Matter (chiefly fine Sand	2.029
Lime	52.474
Magnesia	0.667
Peroxide of Iron, and Alumina	2.125
Phosphoric Acid	0.075
Carbonic Acid	41.529
Water	1.100
	99.924

One cwt. of this limestone will therefore yield about 57 pounds of lime, of which about 4½ lbs. are impurities.

310. The lime made from this rock, when properly burnt, slakes well, and is suitable for all purposes. It has, nevertheless, been thought to be greatly inferior to the imported—to make the mortar less firm, and not to admit of as large an admixture of sand. There is not, in the nature of the material, any reason why this should be so; but I have perceived abundant cause for these effects, in the manner in which the burnt product is often managed. It has been allowed, after burning, to lie on the ground in piles, in open sheds, and has thus been sold in small quantities, after having lain for weeks and even months. Under such circumstances, the purest and strongest lime will rapidly become useless, for it is thus afforded an opportunity of returning to the same condition from which it was originally changed by burning, and in consequence, it loses its property of hardening when used as mortar. When burnt lime is thus allowed to become airslaked, it increases considerably both in weight (more than one third) and volume; so that the purchaser not only buys a worthless article, but also pays for it higher by giving the same price which he would have paid for the freshly burnt product.

Burnt lime, in order to preserve its fitness for use in mortar, must be kept from contact with the air as much as possible. It ought therefore to be barrelled or boxed immediately, if destined for sale or transportation; and not as apples or oranges are, simply in order to keep them together, but *tightly*, like flour, etc. When, however, a kiln of lime has been burnt for use on the spot, and it be inconvenient to use it at once, it may be kept with perfect security and without danger of deterioration, by slaking it in the same manner as though it were to be converted into mortar at once, but afterwards letting it off from the slaking-pan into a pit in the ground. After a time the lime settles, leaving the superfluous water on top, which as far as practicable may be drawn off; after which, the pasty lime is covered over with sand to the depth of several inches.—Pure lime even improves by being thus kept for a time; but the process is not advisable with very impure lime, such as that made of the Rotten Limestone (¶149).

311. Most of the hard limestone occurring in the Brandon neighborhood is of the same character as that of which the analysis is given above.

Besides being found on the belt mentioned above (¶309), it occurs also due S. of Brandon, near Dr. Parker's, in a little branch on S. 27, T. 5, R. 3 E.; the ledge is not, however, as thick as the one at Yost's kiln, and belongs to a lower level. At a lower level still, on Richland Creek, S. 34, T. 5, R. 3 E., there is an outcrop similar to the one mentioned. These strata do not, however, appear to be always continuous, so that the rock is not necessarily found in one hill at the same level at which it occurs in the one opposite. Limestone precisely similar to that at Yost's kiln, was found in Mr. Ware's well, E. of Brandon, at about 40 feet: and again, we find it overlying the marl at Dr. Quin's (see above, ¶285). Dr. Q. has used the rock for lime-burning, and finds it to produce an excellent article.

312. The same limestone occurs, no doubt, further on in a S. E. direction, about Polkville. It is found again in the neighborhood of Raleigh, and crops out on the slopes of the ridges, towards Shongalo Creek, N. E. of Raleigh; the ledges so far as I have seen, are of less thickness than in Rankin, and on the whole, less pure—the marl character prevailing over that of the limestone. On the ridge between Shongalo and Bowland's Creek, the rock also crops out, giving rise to terraces on the hills; that which I have seen there, is very rich in greensand grains, and would probably answer better for agricultural, than for architectural purposes.

313¹. I am not aware whether or not any hard limestone occurs on the territory of the Vicksburg Group in S. Jasper, but it is very likely that such is the case, for we see it in Wayne county, if not as abundantly, or generally speaking, of equal purity with that of Rankin and Hinds, nevertheless affording abundant opportunity for the manufacture of quicklime, of good quality. Here as elsewhere, the hard blue or gray limestone is to be preferred to any of the softer and yellowish materials; nevertheless, the pure white marls (¶294) might, if necessary, be used for the purpose. Blue limestone is found on the Chickasawhay River, at, and for some distance above, Dr. E. A. Miller's place, near Waynesboro'; on Limestone Creek, both at its mouth and further up; on Yellow Creek, in ledges of inconsiderable thickness, interstratified with blue marl; on Cakchey's mill Creek, and others. It is also found on the Buckatunna, S. E. of the localities mentioned. The soft yellowish limestone underlying the prairies and forming bald hilltops, in this region, is generally better suited to agricultural, than to architectural purposes.

313². Building Stones.—With the exception of the limited deposits of variegated aluminous sandstone occurring at Reeve's, and on Muddy Creek, in Tippah (¶168), no hard rocks but those belonging to the Orange Sand (¶11, 56) occur in quantities useful for building purposes, on the territory of the *Northern Lignitic* formation.

The localities thus far observed of the sandstones and claystones of the *Siliceous Claiborne* stage, have been mentioned above (¶ 188, 190[2]).

These rocks are generally very durable, where they are not too soft from the first.

The *limestones* of the calcareous Tertiary, some of which are of excellent quality as building stones, have been spoken of above (¶304 to 414).

The gray and white sandstones of the Grand Gulf Group, whose chief localities of occurrence have already been given, (232 to 236; 242), would, so far as their obvious physical properties, their frequency of occurrence, and their mass is concerned, form a very eligible and highly valuable building material, but for the drawbacks already referred to (¶ 231), viz: their want of durability when exposed above ground.

In numerous instances their gradual softening has been owing, no doubt, to the amount of salts they contain, which in some regions (Campbell's Creek, Steen's Creek, Rankin county, ¶241), continually effloresce on their surface, and finally reduce them to powder. In others, however (and particularly at the Capitol at Jackson), the chief cause of their decay has been the presence of small concretions of iron pyrites, whose oxidation or vitriolescence causes partly rusty spots, which, though softer than the rest of the mass, serve mainly to mar the appearance of the surface; partly, by the swelling consequent upon this process, breaks out fragments, and rends open large sized blocks; thus seriously endangering the security of buildings. The acrid, inky taste of the spots where this process is going on, will readily show to any palate the presence of copperas.

Two simple practical rules to be observed in the use of this rock, result from the above considerations. Firstly, the use of any rock or portions of rock, where the brilliant, golden-yellow particles or lumps of the iron pyrites may be observed, or where on surfaces naturally exposed, the rust spots indicate its presence, ought to be strictly avoided. Secondly, the rock when used ought to be protected against the action of air and moisture, by a good coating of linseed oil, soluble glass, varnish or the like; and the same means may be employed to arrest the process of decay where it has already commenced.—It also follows, that when the rock is used in works little exposed to the action of the atmosphere, and changes from wet to dry (as in foundations, etc.), there is less danger of a change in its mass.

314. Waters of the Tertiary Formations.—a. *Waters of the Lignitic Groups.*—It is but rarely that waters derived essentially from the strata of any of the lignitic stages of the Tertiary, possess that degree of purity which would characterize them as "freestone waters." Those derived from the materials of the Grand Gulf Group are almost without exception, mineral waters proper; *i. e.* sufficiently strong to be recognized at once by the taste, and in the majority of cases, unfit for constant and daily use. In a less degree in general, this is the case also with those derived from the Lower or Northern Lignitic Group, and from the minor lignitic stages of the Tertiary generally. It is, ordinarily, only where yellow sands enter largely into the composition of the strata of the Northern Lignitic Group (as is the case most frequently where

lignite beds occur) that we find in them springs or wells whose water is but so slightly contaminated with the salts which characterize all more or less, as not to interfere with the ordinary uses of well and spring water.

315. It cannot, therefore, be surprising, in view of the extensive territory occupied, more or less, by these formations, that mineral springs and wells should be reported from all quarters of the State: their inconvenient abundance being such, that in extensive regions a draught of pure water can be obtained only from cisterns and streams, and that the former are of necessity used, notwithstanding the abundance of water to be found in wells. Were it not for the superincumbent beds of the Orange Sand formation, whose very general distribution over the surface has so often been noticed, and which afford the purest of water, even though often at inconvenient depths, the State of Mississippi would find itself in great straits as regards the quality of its waters.

For however acceptable may be the presence of mineral waters here and there, yet their *universal* prevalence, to the exclusion of pure water, is scarcely less undesirable on the land than it is to the mariner at sea, when he finds himself deprived of all but the ocean brine wherewith to slake his thirst. We might as well attempt to substitute the drugstore for the provision market; and it is not a little singular, that such a vast number of persons, who religiously eschew to the last extremity the help of a physician, through distrust of medicines, should not only willingly, but eagerly, be dosing themselves, day after day, with natural solutions of the very substances which, if coming from the drugstore, they would not admit within their gates. It would, probably, be difficnlt to find, on either continent, any region where the abuse of mineral waters is carried to a greater extreme, than is the case in some portions of the State of Mississippi—on the ground, very generally, that these waters are supposed to be "Natures own remedy;" though on precisely the same principle, it would be competent to the house-wife to use poison hemlock instead of celery, or the natural white arsenic in the place of salt.

316. I shall give specially, in the Agricultural Report, the numerous localities at which mineral waters occur, and the analyses I have made; a few general remarks on their character ought, however, to find their place here.

Sulphuretted hydrogen, and a certain amount of *Carbonic Acid*, are very generally present. An ingredient common to all the waters of the lignitic formation which I have examined, is *common salt* or *Chloride of Sodium*, *Glaubers salt;* or *Sulphate of Soda*, is also very common. *Potash*, in the form of *Carbonate* or *Sulphate*, is rarely wanting. But the universally prevalent characteristic of these waters, to which they most frequently owe their injurious effects on health by causeless and constant use, is *Magnesia* in some form—the Sulphate or Chloride, or both. Next to this, the salts of Lime—commonly the Sulphate, but often the Chloride; with more or less of the Bicarbonates of both Lime and Magnesia, form the usual ingredients. A trace of Iron is always present; in numerous instances, strong chalybeates are formed, both by the Bicarbonate, and by the Sulphate of that metal. Sulphate of Alumina, though not a usual ingredient, is often present, and in several cases forms strong alum waters, mostly saturated, at the same time, with gypsum.

These waters occur especially, wherever the Selenite is found accompanied by crusts of Yellow Iron Ore; which is more commonly the case near to the line of the marine fossiliferous strata, than at the more distant points. Very frequently, the waters of the lignitic formations contain organic matter, which imparts to them dark tints, and a variety of tastes, which are more particularly unpleasant in the presence of sulphuretted hydrogen. I have occasionally seen waters, whose color and smell could readily have caused them to be mistaken for the drainings of a manure-pile: and I have repeatedly heard waters of a similar character extolled by enthusiastic persons as particularly "healthy," on that very account.

317. It is not unfrequently the case, that mineral waters, especially chalybeates derived from the Orange Sand formation (and containing their iron as bicarbonate) are partially impregnated with the constituents of the lignitic waters, by contact with the strata, or intermixture of the waters themselves (¶75). Mineral waters thus produced are among the best of the State.

In the absence of deep borings in the Northern Lignitic formation, I have been unable to settle definitely the question whether there is any constant dip of the strata, sufficient to afford a useful rise of water in deep wells. While it is highly probable that such is the case on the whole of the formation, it has been proved with certainty only near to, or on the territory of the marine Tertiary, in Madison and Hinds counties, where wells, although begun in the latter strata, yet obtain their rising waters from the Lignitic formation. Special data with reference to bores of this kind, will be found below (319, ff.)

318. In the Southern Lignitic, or Grand Gulf Group, also, data bearing on the question of the general dip are scarce. Several instances have been mentioned (¶239, 240) where the strata showed a strong dip for a short distance, but then again became horizontal, which is the position in which, apparently at least, they are usually seen. The fact that there is a general correspondence of the materials of this formation in an E. and W., or S. E. and N. W. direction, while there is a much greater variation at right angles to such lines, would seem to make a general dip south-westward probable.

I know only one instance, however, in which a notable rise was obtained in a well dug in this formation, viz: at Mr. P. H. Hale's, S. 2, T. 3, R. 2 E., Rankin county, where at 86 feet, dug chiefly in soft, whitish sandstone, a stream of water was struck, rising 36 feet; the water impregnated, as usual (though not apparently, to an injurious extent), with different salts. This single instance might possibly be owing to one of the faults of stratification above referred to; yet in view of the fact that there are very few cases in which the strata of this formation have been penetrated to a similar depth, the hope of success in the boring of artesian wells is sufficiently justified to induce experiments. It is particularly so when it is remembered, that the water, such as it occurs in the water-bearing strata themselves, is often of good quality, and only *becomes contaminated with salts by standing in the wells.* Hence, the continuous stream of an artesian fountain might be expected to be comparatively pure, even when the water of stagnant wells would be undrinkable.

To the Southern River Counties, which in the absence of the Orange Sand, can obtain no drinkable water in shallow wells (that of the Bluff formation being too limy, and that of the Grand Gulf strata too magnesian and salty), this consideration is of especial importance, and well worth a trial: more especially as the boring is generally very easy.

It is difficult, thus far, to say, to what depth boring might require to be carried; but a few hundred feet would suffice to show what might be expected within the Grand Gulf strata. So soon as, in passing through these (at Port Gibson, for instance, at a depth from 500 to 800 feet) the upper, sandy strata of the marine Tertiary (of the Vicksburg Group) should be reached, water would be obtained almost beyond a doubt; it would probably be somewhat limy, but much less so than that of the Bluff formation, and infinitely preferable to the magnesian waters in ordinary wells, of the Grand Gulf Group. It might be necessary, in order to prevent the strata of the latter from contaminating the water, to tube them out. The practicability of artesian wells further S., *should no rise of water be obtained in the strata of the Grand Gulf Group*, will be simply a question of depth; in this case, the first chances at Natchez, for instance, would lie between 1200 and 2000 feet; while at greater depths, the probability of obtaining artesian water would be a very strong one. But if, as is most likely, water having a considerable rise should be found *within* the Grand Gulf strata, the depth required might fall considerably short even of a thousand feet.

319. c. *Waters of the calcareous marine Tertiary.*—All these are, of course, more or less impregnated with carbonate of lime; yet not generally to such a degree as to seriously impair their fitness for the ordinary household uses, nor even as strongly as those of the Rotten Limestone of the Cretaceous formation. On the territory of the Vicksburg Group, there is generally little difficulty in regard to water: the region is hilly and much interspersed with Orange Sand ridges, yielding pure water above the tertiary rocks; the latter themselves contain many water-bearing strata, especially in their upper portion; and the same is true of the lignitic stages intervening between the several calcareous ones. The waters derived from the latter are, in general, much purer than those originating from either of the two principal Lignitic groups.

320. Within the Jackson Group, water-bearing strata are generally scarce, though not entirely absent. In commencing a bore on the territory of the Jackson Group, we must ordinarily expect to pass through their whole thickness before reaching water.

Since, however, the dip of these strata is quite considerable, we may expect the water of deep wells to possess a corresponding rise; and from such experiments as have been made, there can be little doubt that *artesian wells* are practicable on a considerable part, at least, of the territory of these formations; and especially on its eastern portion, at very moderate depths.

321. The boring of the well at the Penitentiary at Jackson, possesses great interest, not only for the adjoining country, but for the whole of South Mississippi; since it will give us definite information in regard to the general structure of the formations upon which the success of artesian boring will depend. I subjoin the record of the strata thus far penetrated in the Jackson well.

The data, down to No. 8 inclusive, were furnished by Mr. J. Murray,* after whose death the work remained stationary until, very lately, it has been recommenced in a more effectual manner, by the aid of a steam engine, under the direction of Mr. W. B. Blake, who so successfully conducted the boring of the celebrated Louisville artesian well. Strata 9 to 13 are given according to Mr. Blake's accurate record; the greatest depth reached being, by his measurement, 460 feet. In consequence of the failure of the supply of water for the machinery at the Penitentiary, from the ponds heretofore used, the boring of the well has been discontinued at present (July, 1860), in order to allow of its water being used. It has since been reapeatedly drawn upon at the rate of 14,000 gallons per day, without a sensible diminution of the supply—saving about $18 per day (after deducting the cost of pumping), otherwise spent in hauling water. At present the water carries with it some fine sand, which renders it turbid, and is allowed to subside in a tank, before being fed to the boilers. This is owing, no doubt, to the spasmodic action of the pump, and would soon subside in a regular flow. The water is now being used for all ordinary purposes; it is somewhat mineral, the prevalent ingredient being Bi-carbonate of Soda, with some other salts—contained to the extent of about 20 to 25 grains per gallon.

Record of the Bored Well at the State Penitentiary.

1.	Surface materials and clay marl - - - - -	20 feet.
2.	Blue sandy shell marl - - - - - -	11 "
3.	Day sand, with streaks of whitish or gray clay, containing impressions of leaves - - - - - -	80 "
4.	Wet quicksand, caving very badly - - - - - (Here water rose to within 70 feet of the surface.)	70 "
5.	Black clays, mostly laminated, interstratified with layers of sand. Fragments of impressions of leaves, and, at 400 feet, a catkin of a willow?, were bored up - - - . -	268 "
6.	Greensand, with shells, and streaks of gray and red clay -	30 "
7.	Water-bearing sand, caving badly - - - - - (Here water rose to within 50 feet of the surface.)	20 "
8.	Greensand, with shells; same as above - - -	?
9.	Ledge of gray, fossiliferous limestone - - - - -	1 "
10.	Blue clay, with calcareous nodules, and some layers of greensand marl - - - - - - - - -	12 "
11.	Shell marl, with layers of black clay - - -	10 "
12.	Quicksand, with a great deal of mica - - - - -	5 "
13.	White, indurate clay, with iron pyrites. Not yet passed. -	?

The material of bed No. 6 of this profile is richer in greensand than any I have seen in the State; it consists of little else than glauconite and broken shells, and would be of the highest value as a manure, could its outcrop be found. I suppose it to be a continuation of the Shongalo bed; and if so, there is reason to expect, that materials similar to it will be found in other and more accessible portions of that bed.

This profile shows the materials of the formation to be so variable, that water-bearing beds may be expected everywhere at intervals. The water, from which the fetid black clay had been "tubed out," showed no remarkable smell or taste. It will be perceived, that a difference in depth of 368 feet, from the top of the first water-bearing stratum (No. 4) to the second (No. 7) caused a rise of twenty feet; and if the rise increase hereafter at the same ratio, and a water-bearing

*I must observe that the aggregate depth given by Mr. Murray (500 feet) greatly exceeds that since given by Mr. Blake, according to whose measurement, the entire depth, at the time he took the work in charge, did not exceed 425 feet. Not knowing where the error may be, I give this part of the record as I received it.

stratum be struck at the proper depth, the water will rise to the surface at a depth 920 feet below the present, or at a total depth of 1400 to 1500 feet.

322. The wells attempted, both at Canton, and at his residence, by Rev. J. R. Lambuth, of Madison, have already been mentioned; and from all appearance their failure has been owing purely to mechanical difficulties and accidents in boring, which the persons in charge did not know how to deal with.

Three wells were attempted, successively, at Mr. Lambuth's residence, S. 2, T. 7, R. 2 E., two of which failed in consequence of caving, the last by the breaking of the auger. In all the phenomena were the same, as represented in the following record, in accordance with Mr. Lambuth's recollection:

Record of wells bored by Rev. J. R. Lambuth, at his residence.

1. Surface materials, and bluish and yellowish clay marls (202, ff.)	40 feet
2. Blue clay marl, poor in shells - - - - -	40 "
3. Blue sandy shell marl, with well preserved shells -	6 to 10 "
4. Dark colored, mostly bluish, laminated clays, interstratified with layers of sand - - - - - -	185 to 190 "
5. Hard, gray sandstone - - - - - -	1 inch
6. Yellow, water-bearing sand - - - - -	10 to 15 feet
[Here water rose to within 75 feet of the surface.]	
7. Dark-colored, sandy clay, with crystals of gypsum - -	80 to 85 "
8. Hard, gray sandstone - - - - - -	1 inch
9. Lignite, interstratified with layers of clay; above it, *a stream of water rising to within* 45 *feet of the surface* (as far as penetrated) - - - - - -	40 feet
Whole depth reached, about - - - -	415 feet

Strata Nos. 1. 2 and 3 correspond, no doubt, to those of the McNutt Hills (¶204, Sec. 29, Nos. 4, 5, 6 and 7,) and Nos. 2 and 3, with Nos. 1 and 2 of the Jackson well. A comparison of the lower strata, however, shows no strict correspondence, save in the general nature of the materials. It is observable also, that in Mr. Lambuth's well, the rise of the water is much more rapid, since a difference of only 100 feet in depth caused the water to rise 30 feet higher. This difference is probably caused by the different nature of the surface at the fountain head.

323. In another well bored by Mr. Lambuth, at Canton, the phenomena were almost precisely the same, down to the first ledge of rock, on penetrating which, water rose to within 25 feet of the surface. Beneath the ledge, however, quicksands kept filling in so fast that it became necessary to tube, in doing which the tube was so twisted and crushed as to render the task hopeless.

It is not a little singular, that at a point ten miles further north, and near the edge of the formation generally dipping S. or S. W., the latter should be found of the same thickness and character—at a point which, according to the railroad levelings, must be between 80 and 100 feet higher than the town of Canton; while again, at Jackson, we find them at about the same absolute level as at Lambuth's, but rapidly dipping southward thence (¶200).

324. I know of no attempt at boring in this formation, between Jackson and N. Smith county. Here, the boring of a well was attempted under the auspices of Mr. A. P. Duke, of Montrose, on S. 34, T. 4, R. 10 E.

No record having been kept, the data, as recollected by Mr. Duke, were somewhat indefinite, yet sufficient for all practical purposes. Mr. D. states that at the place mentioned, on a hillside, the clay marl ("prairie") was struck at twelve feet, and continued with occasional changes from hard to soft and vice versa, to about 100 feet. Then the material grew harder, yet so that it could be slowly bored; its thickness was not recollected. After passing through, a "white shell rock" was struck, interstratified probably with sand, for water was obtained in it which *rose to within eight or ten feet of the surface.* At about 175 feet, they struck a dark brown sand, which gradually grew lighter and finally white; then a coarse white sand. At this point, some of the material above began to cave, and they tried to pump the well, but after working twelve days in vain, it was abandoned. Once, however, the depth of 197 feet was reached. The water when first obtained, was clear and without any unpleasant taste and smell; but by standing in the bore, it has now acquired the taste of the "blue dirt."

It is evident that here, nothing but tubing was wanting for the success of the artesian bore. At the level at which it stood, the water could even then have been made to run out into the valley; and had an additional stream been struck after tubing out the quicksand, the water would doubtless have overflowed.

Another attempt was made by Mr. Foley, about five miles S. E. of Garlandsville; but he broke his auger at a moderate depth and abandoned the work: what his results were I could not learn.

325. These experiments prove conclusively, that deep bored wells, and artesian or flowing wells, are quite as likely to succeed in the prairie region of the Tertiary, as they are on the waters of the Tombigbee; and the importance of this fact will be appreciated by those who are acquainted with the difficulty found heretofore in obtaining an adequate supply of drinkable water, in the region in question. For the tracts known as the "hog wallow" or "post oak prairie," in N. W. Jasper, N. E. Smith, and some parts of Scott and Newton, this circumstance is of the most vital importance, since they are utterly destitute of water during the greater part of the year. The nature of the strata does not admit of the existence of springs, and water cannot be obtained in dug wells at any reasonable depth. Not only the uplands of this region have been neglected, to a great extent, on account of this very difficulty, but even the profusely fertile bottoms of West Tallahala and Leaf River waters have experienced the same fate.

The probable practicability of deep bored wells extends, of course, not only to the region of the calcareous Tertiary, but for some distance, at least, N. and S. of the same, and very probably to that of the Siliceous Claiborne Group (see map).

R—13

THE QUATERNARY FORMATIONS.

326. The quaternary, or post-tertiary formations of Mississippi, seem to subdivide very naturally into five successive stages or periods, viz: Lowest, immediately overlying the latest Tertiary, the *Orange Sand formation*, corresponding, probably, to the drift of the Northern States. Next above, the *Bluff formation* of the Mississippi River; a calcareous silt deposit containing, in Mississippi, chiefly or only terrestrial fossils. Succeeding this, we find the *Yellow Loam* deposits, which form the basis, as it were, of the agricultural wealth of the upland portion of the State. Still more modern are the *Second Bottom* or *Hommock* deposits, which, while they show a very obvious relation to the water-courses as at present existing, still must have required a state of things different from the present, to produce them; and latest of all are the *Alluvial* deposits, whose formation is referable to causes still in action, including all the soils, first-bottom deposits, sand drifts, etc., now in progress of formation.

I. THE ORANGE SAND FORMATION

Has been treated of at the beginning of this volume, out of its proper geological order, for reasons there explained (¶5, ff.)

II. THE BLUFF FORMATION.

327. The deposits of this formation, whose characters seem to be identical, in almost all respects, with those of the beds so named by Prof. Swallow, in Missouri, occupy a narrow belt, along the borders of the Mississippi Bottom in N. Mississippi, and along the river itself in the southern portion of the State. In the whole of this territory, so far as I am aware, it exhibits a remarkable uniformity of character; consisting of a fine silt, almost too siliceous to be called a loam, of a grayish or yellowish buff tint; which effervesces throughout its mass in consequence of a certain percentage of the carbonates of lime and magnesia, and contains, besides, irregularly shaped, often tubular, concretions, from the size of sand-grains to the weight of several pounds, consisting of the carbonates just mentioned, with some of the silt intermixed. The whole mass is lightly cemented by these salts, so far as to impart to it a certain degree of firmness, which it loses when once broken up. Although profiles of as much as seventy feet are sometimes seen, consisting altogether of this material, it is in most cases extremely difficult to find any definite marks of stratification, which I have

observed only in a few places where the terraced form of slowly denuded hillsides showed the existence of a certain horizontal structure.

Wherever these beds occur associated with the Orange Sand strata, they overlie the latter; being in their turn as uniformly overlaid by the yellow or brown surface loam, which in the rest of the State, reposes directly upon the Orange Sand (¶332). The thickness of the Bluff formation is very variable, its materials having, apparently, filled up the valleys, resulting from denudation in the older formations—the Tertiary, and Orange Sand. Its fossils, so far as known, are exclusively terrestrial.

328. In the Southern River Counties, below Vicksburg, the deposits of this formation are found on a belt ten to fifteen miles in width, running parallel, in general, to the Mississippi River; the surface is very much broken by deep and steep valleys and ravines, which always result from the denudation of these deposits. Intimately connected as these are with the agricultural features of this region, I shall refer the reader, for further details on the subject, to the description of the Southern River Counties, in the Agricultural portion of this Report. As to its region of occurrence north of Vicksburg, along the Mississippi Bottom, I cannot speak *from* personal knowledge. It appears from scattered observations recorded in Harper's Report, that the silt of the Bluff formation appears in patches or limited belts, along the border of the hills, from Satartia on the Yazoo to the Tennessee Line; not extending back into the interior, for more than a few miles at most. The character of the deposit is described as being in all respects the same as that exhibited in the Southern River Counties, save in that it is overlaid here by a yellow loam containing calcareous concretions; which is not the case below Vicksburg, where the loam (see analysis under Southern River Counties, Agr. Rept.) contains no more lime than is necessary to constitute a good soil. Possibly this calcareous loam may be a distinct facies of the Bluff formation itself, or the link of connection between it and the common brown surface loam, which is elsewhere wanting.

329. Fossils of the Bluff Formation.—These, as has been mentioned, are altogether terrestrial, so far as ascertained. I have given but little attention to their study as yet; but the shells have been collected by Prof. Wailes, and studied by him; they, as well as the mammals, having received the attention of Conrad and Leidy, in part through specimens furnished by Prof. Wailes. The snails occur singly, imbedded in loose silt, or not unfrequently, in the calcareous concretions above mentioned; at times they appear in bands or strings, disposed, however, without any apparent regard to stratification. Their substance, although softer and more friable than in the living individuals, sometimes preserves the stripes or markings of the surface very distinctly.

The bones, as well as the ivory of the Mastodon's tusks, are mostly soft and friable, having lost the greater part, or all of their organic substance; so that on drying they crumble or exfoliate, unless previously imbued with a solution of glue. It seems that these bones have in most cases been much scattered, so that they are generally found singly. Considerable portions of the skeleton have, however, been found together in spots where ponds would seem to have existed, as though the animal had perished there; and in such cases the bones are frequently in contact with considerable masses of black, fatty earth, which may reasonably be supposed to have resulted from the decomposition of the viscera, and other perishable animal matter. (Wailes).

330[1] The snails all seem to belong to living species, though, according to Prof. Wailes, some of them are not at present living in the region where they occur in a fossil state. Among the specimens obtained, Prof. W. mentions the following (First Rept., p. 283):

Helix albolabris.
" *alternata.*
" *concava.*
" *elevata.*
" *fraterna.*
Helix perspectiva.
" *profunda.*
" *thyroides.*
" *tridentata.*

To which I may add *Helix monodon*, and a large *Achatina*, found in Wilkinson county.

The following list of the mammals found in a solid blue clay, said to belong to this formation, was furnished to Prof. Wailes by Dr. Leidy:

Felis atrox, LEIDY.
Ursus Americanus, foss.
Ursus amplidens, LEIDY.
Megalonyx Jeffersonii, HARLAN.
Megalonyx dissimilis, LEIDY.
Mylodon Harlani, OWEN.
Ereptodon priscus, LEIDY.
Tapirus Americanus, foss.
Tapirus Haysii, LEIDY.
Equus Americanus, LEIDY.
Bootherium cavifrons, LEIDY.
Cervus Virginianus, foss.
Bison latifrons, LEIDY.
Elephas primigenius.
Mastodon giganteus.

Of these, the last named is by far the most common. The following localities are mentioned by Prof. Wailes: Bayou Sara; Pinkneyville, Wilkinson county; various localities in Adams county; near the former town of Greenville, Jefferson county; in Warren county, in the deep cut of the railroad at Vicksburg, and in the vicinity of Big Black River, near the east line of the county. In a ravine on Pine Ridge, Adams county, in TT. 7. and 8, R. 3 W., about six miles north of Natchez, these remains are very abundant. They are found about twenty feet below the surface, and the bones of other animals are here found associated with them; *e. g.* the *Megalonyx*, *Tapirus Americanus*, the fossil horse, and ox. (Wailes.)

330. USEFUL MATERIALS, AND WATERS OF THE BLUFF FORMATION.—The calcareous silt of this formation is often a *marl* properly speaking, when it contains a large amount of white specks of carbonate of lime. Usually, its percentage of lime is too small to pay for its transportation to any distance, forming simply a calcareous soil or subsoil; but on account of its general and convenient accessibility, and its highly beneficial effects on the brown loam soil, it may often be mixed with the latter to great advantage. An analysis of this material, and other specialities concerning the same, will be found in the Agricultural Report.

Small, local deposits of a soft limestone or tufa are sometimes formed by the highly calcareous waters of this formation. The rock is generally of a yellowish tint, very porous, and occurs in irregular masses, in which shapes resembling icicles, or stalactites, are frequently seen. Sticks, leaves, etc., may sometimes be found imbedded in it, while the cavities are usually filled with soil. These deposits may be looked for in the heads of hollows, or in the beds of branches, wherever the water drips, in the Cane Hill region; but their extent, as before observed, is too limited to render them of any great practical importance; they lie on the surface and do not extend into the mass of the formation. The impure lime which might be burnt from this material, would be applicable mainly to agricultural purposes.—The largest deposit of this kind which I have seen, occurs on Mr. J. C. Humphrey's land, near Port Gibson.

331². Owing to the great uniformity of the material of this formation, *springs* are very scarce on the territory occupied by it, except where it is underlaid at the proper elevation by impervious clay or sandstone strata of the Grand Gulf Group. The water issuing from the calcareous silt is very "hard," of a flattish taste, and contains the bicarbonates of lime and magnesia to such an extent, as to be disagreeably perceptible even in the streams of the region. For this reason, cisterns, or wells deep enough to penetrate the Grand Gulf strata, are very generally preferred to the natural waters. It is questionable, however, whether even these are not preferable, as far as health is concerned, to many of the strongly saline and magnesian waters sometimes found in deep wells, which contain the sulphates and chlorides, instead of the carbonates, of the above earths (¶316).

III. THE YELLOW LOAM DEPOSITS.

332. The yellow, brown, or reddish loams, which have been repeatedly mentioned as forming the surface, and therefore, essentially, the *soils* of the greater portion of the State of Mississippi, constitute, to all appearance, an independent aqueous deposit, posterior to the Orange Sand and Bluff formation, and anterior to the alluvial formations of the present epoch. The great thickness which this loam stratum attains in some regions, its distinct definition, as well as its comparative independence, as to its character, of the formations immediately underlying, preclude its being claimed as a mere surface disintegration of the older formations. The nature of its materials, and the entire absence of stratification lines distinguish it sufficiently from the Orange Sand, where it immediately overlies the latter; while the absence of any large amount of lime (except where it is in immediate contact with strongly calcareous formations), the presence of a considerable amount of hydrated peroxide of Iron, as well as the want of proper fossils, as distinctly separate it from the Bluff formation of the Mississippi River.

I have stated that it is to some extent independent as to its character, of the underlying formations; *i. e.* it is not so uniformly dependent upon them as to allow of its being considered (as has been attempted) as a mere surface disintegration, *in loco*, in the absence of a more *general* distributive agency, than those which we find at work at the present time. Yet nevertheless, there is a very obvious *general* correspondence of variation in character, between the older formations and the surface loam, more especially so where the stratum of the latter is thin; a circumstance which cannot fail to force itself upon the attention of every one in the study of the soils of the State. In view of the intimate connection existing between the latter and the loam stratum, I shall leave the special description of its variations in different districts, for the Agricultural portion of the present Report, where these will necessarily be mentioned; and will only give in this place some generalities concerning its geological relations.

333. From the appearance of the loam stratum even on high ridges and elevated uplands, it is obvious that its deposition took place, in part at least, anterior to the great denudations which have produced the present surface configuration; nevertheless, its increasing thickness as we approach the immediate valley of the Mississippi, shows, as in the case of the Bluff formation, that this great channel was already in existence. On the Tombigbee, and on the *lower* Tallahatchie, Yallabusha, and Big Black, a similar increase in the thickness of the loam stratum may be observed. But on the smaller watercourse, this is the case only to a very limited extent, showing that although at the time

of the deposition of this loam, the larger channels were already more or less impressed upon the surface, and high ridges existed which remained above the level of the water which deposited the loam : the minor denudations which have caused the present undulating surface, had as yet exerted but little influence. The lines of contact between the Orange Sand and loam, where the latter is decidedly *in situ*, are generally much less undulating, than are those between the Orange Sand and the older formations.

334. Under the present configuration of the surface, however, we find precisely the same stratigraphical relations to exist between the Orange Sand and the loam stratum, as those which we see between the latter and the calcareous silt of the Bluff formation, as exemplified in Diagram No. 6 (see "Southern River Counties") ; that is to say, the loam has to a great extent been removed from the level hilltops or plateaux where it was originally deposited, to the hillsides and valleys, leaving the higher portions of the ridges more thinly covered or altogether bare. The same agencies which are at work at present, carrying away the arable soils from our uplands, will explain the *hillside* position in which, in the more hilly uplands of Mississippi, this loam is prevalently found at the present time ; while, whenever extensive level or slightly undulating tracts exist, it may be seen to rest conformably upon the Orange Sand strata.

335. Its prevalent character in what I have termed the Yellow Loam Region of the State, is that of a mellow clay or loam, without any definite structure or cleavage, variously tinged with iron; containing from 10 to 25 per cent., usually, of siliceous sand, the rest being clay mixed with finely divided silex, and forming, therefore, rather loose, mellow soils, and good brick-clays. It almost invariably contains some irregular whitish veins of sand, especially in its lower portions, where it overlies the Orange Sand ; and sometimes, but not most frequently, passes into the materials of the latter by degrees of transition, through a sandy "hardpan," which in some localities attains a considerable thickness (10 to 15 feet) and may correspond to the "altered drift" of Prof. Swallow (Report of the Geological Survey of Missouri, p. 76). Where, however, the loam overlies clayey strata, it becomes heavier as we proceed downwards ; and if they be rich in lime, this ingredient is also found in increased quantity in its lower layers. In the latter case, the fair yellow or brown color of the loam almost invariably acquires a greenish hue, even where full exposure to the atmosphere places a reduction of the peroxide to the protoxide out of question. Such is very generally the case in the prairie regions of the State, whose loam stratum (overlying the Rotten Limestone in the cretaceous, and sometimes the clay marls of the tertiary region), I believe to be essentially contemporaneous with that of the hills, since, so far as comparable, its geological characters are very similar.

336. That forming the surface stratum in the "Northeastern Prairie Region," is certainly not cretaceous (as has been, with some doubt, suggested by Tuomey) ; for it contains none of the fossils of that formation, except where it is in immediate contact with the rock ; and no proper fossils whatsoever, (except in the alluvium immediately bordering on the streams*) ; while on the edge of the prairies, the greenish-yellow underclay of the prairie soil is often distinctly seen overlying the Orange Sand, and passing insensibly into the common loam. It is but very indistinctly stratified, and very nearly the same in appearance, from the top to the bottom of the stratum, which is sometimes 10 to 15 feet in thickness (on the prairies of Monroe), viz : a heavy, massy clay, containing but little sand (and that coarse), and a large number of smooth, hard, round concretions of Brown Iron Ore, from the size of sand-grains to that of buckshot,

*The "prairie fossils" mentioned in L. Harper's Report (p. 109, ff.) were, to my personal knowledge, collected in the neighborhood of streams in the prairie region.

usually to the extent of 2 to 3 per cent. These concretions are of a concentric structure, consisting of thin, variously colored layers of hydrated peroxide of iron; they are sometimes hollow and filled with a soft, olive-green ferruginous mass (phosphate ?). Similar concretions occur in the yellow loam subsoils of the hills, wherever a calcareous formation underlies; as in the case on the Pontotoc Ridge, and especially in the Tippah (and Chickasaw) "Buncombes," where these concretions are so numerous and acquire so large a size (*e. g* that of a fist, with a weight of several pounds) as to be somewhat of an obstruction in tillage. Most of the "Red Lands" of the Pontotoc Ridge (¶129) contain these concretions, of about the same size and frequency of occurrence, as the prairie soils.

337. The great resistence which, on account of their clayey character, the soil and subsoil of the prairies oppose to washing or denudation, readily accounts for the levelness of the prairie region, which, immediately after the deposition of the loam, it probably shared with the immediately adjoining country, with whose hilltops it is now generally on a level. The subsequent denudations, which wore deep gullies and valleys into the surface occupied by light, sandy materials, would leave the heavy surface deposits of the prairie (derived mainly from the clay marls of the underlying formation) comparatively untouched.

The heavy soil of the Flatwoods (¶164,165) may, in part, have been formed in a manner similar to the prairie soil. It appears as though in the case of the Flatwoods as well as the prairies, the impervious material, which yielded but slightly to denudation, had prevented the deposition, or favored the subsequent removal, of the Orange Sand, so that in both cases, the materials of the more ancient formations themselves essentially have formed the soil. The formation of the Flatwoods soil out of the heavy gray clays of the Lignitic, is constantly in progress, wherever the latter is near enough to the surface to be reached by the action of the atmosphere; but strata 10 to 20 feet in thickness could hardly have been thus produced.

The *light* Flatwoods soil (see Agricultural Report), however, is evidently of a later formation than the red loam, by which it is frequently underlaid; and both this fact, and its peculiar character, seem to place it within the period of the formation of the Second Bottoms (see below, ¶340).

338. While on a large part of the territory of the calcareous formations, the smooth, round pebbles of brown iron ore characterize the loam, we often find, elsewhere, a part of the iron contained in the loam, secreted in the form of Bog Ore (commonly called "black pebble"), whose concretions possess no definite form, nor, indeed, are always distinctly separable from the surrounding loam; into which, from the dark-brown nucleus, there are many shades of transition. Where these black pebbles appear on the uplands, in the absence of any obvious defect of drainage, they are generally considered a sign of an inferior soil (as in some portions of Rankin, and in S. W. Winston counties;) but the best soils of the Yellow Loam character will secrete their iron in this manner, and become white in their mass, when the drainage is insufficient; and hence, bog iron ore, though most common in the soils and subsoils of the bottoms and second bottoms, occasionally occurs even in the best upland soils.

339. The loam of the hillsides, which has been removed from its original position on the ridges, differs in no essential particular from the original material, except where either denudation has progressed so far as to penetrate into the Orange Sand, or else, where the washings of high Orange Sand ridges, not originally covered with loam, mixed with the latter when washed down the hillsides. The soils thus produced are, of course, lighter than those derived from the loam alone, and resemble the Hommock or Second Bottom soils, the main mass of which, formed at a period subsequent to the deposition of the loam, seems to constitute the formation immediately preceding our present era.

340. USES OF THE YELLOW LOAM.—Its most important office, unquestionably, is that of forming the best *upland soils and subsoils*

of the State; but in this point of view, it will be discussed in the agricultural portion of the Report (see especially "Yellow Loam Region"). It subserves, however, another purpose, which to a State so poor in building stones, is of no small importance; viz: that of brick-making, to which purpose it is in general admirably adapted.

Yet while few States, perhaps, possess so great an abundance of good brick-clays as does Mississippi, in few probably is the *average* quality of the article manufactured a poorer one. The claim generally conceded to brick, of having their material seasoned and tempered in a moderate degree at least, before moulding, is most flagrantly disregarded by many brick-makers in Mississippi: the consequence being that oftentimes, among ten bricks in a kiln, we will scarcely find more than one or two that will bear being taken up by one corner, without breaking by their own weight. Yet in consideration of the fact, that the clay as dug from the pit, after receiving a dash of water, is almost instantly transferred to the clay-mill, where it experiences a merely nominal kneading; and that, when we break a newly made brick as it comes from the mould, we shall frequently find it to consist of a conglomerate of dry lumps and slush: too much cannot be said in commendation of the brick-clays which, under similar treatment, will still yield brick of moderately good quality. Yet not unfrequently, the inroads of the weather, and more especially, of *frost*, render the duration of buildings constructed of such brick, a matter of calculation; and all know that the duration of brick pavements is most unwarrantably brief, in most of our towns. Were brick used here as largely as it is in some commonwealths, and were buildings of such enormous dimensions as we often see them elsewhere, constructed of this material, experience would soon teach the necessity of greater care in its manufacture, than is bestowed at present. I have seen but very few cases indeed, in which the complaints made against the quality of brick in this State, have been owing to defects in the brick-clay itself.

341. It would be important for brick-makers to remember, that the mechanical working of the clay or loam, which is to effect its thorough mixture with the water, may be replaced to a very great extent, by previous exposure for some time (especially during winter) to the action of the atmosphere—in a locality where it will not get too dry; and that clay thus disintegrated or "seasoned," works much easier, and yields a much better quality of brick, than that which comes fresh from the pit. A great advantage is also gained by allowing the clay to remain in a pit, *wetted with as much water as it may require for working*, as long as possible—even a few hours time would be a great improvement on the present method of simply mixing it with a hoe, for a minute or two, preliminary to its transfer to the clay mill. And since neither the previous digging, nor the pitting of the clay, involves any extra expenditure of any consequence, these simple expedients surely ought to be generally adopted. The *desiderata* for common brick are, on the whole, very nearly the same as those for fire-brick (¶67).

IV. THE SECOND BOTTOM, OR "HOMMOCK" DEPOSITS.

342. Many of the first bottoms (now annually overflowed by the streams), and in many cases, the channels themselves, of the rivers of Mississippi, are bordered by level tracts of land, sometimes several miles in width, which are now rarely reached by the overflows, and whose vegetation is intermediate, as it were, between that of the uplands and of the bottom. The materials composing their soil and subsoil give evidence, in the alternation of sandy

and clayey bands, of their formation in flowing water; yet it is evident that the streams in their present condition could not have formed them. They seem to be a parallel, in many respects, to the "Bottom Prairie" of Missouri (Rep. of the Geol. Surv. of Missouri, p. 66, ff.)

Sometimes (as on the Tombigbee) they slope down gradually into the first bottom; but more commonly (Big Black, Pearl, Pascagoula Rivers) they fall off with rather a sudden descent of 3 to 4 feet, and sometimes more. Their soil is most generally lighter than that of the first bottom of the same stream, and much poorer in vegetable matter. On Yockanookana and Big Black they are usually whitish, as also on upper Pearl River; on Yallabusha, lower Pearl, and on the Tombigbee River, the soil is commonly formed of a yellow loam, somewhat lighter than that of the bordering hills, and of a paler hue; but in general, there is a very obvious correspondence between the material of the *body* of the hills, and that of the second bottom deposits; showing that at the time of their formation, the denudations were cutting deeply into the surface. Not unfrequently, we find the level surface of these "hommocks" interrupted by hillocks or ridges of more ancient formations—especially of the Orange Sand—which, being composed of materials opposing considerable resistance to denudation, were surrounded and partially covered over by the newer deposits. Examples of this kind are of common occurrence in the level region E. of the Tombigbee, in Monroe and Lowndes (¶535), where pebbly hillocks of the Orange Sand age, and others belonging to the Tombigbee Sand Group of the Cretaceous, appear like islands in the plain.

343. Since the Second Bottoms, like the Yellow Loam, are of necessity mentioned in connection with the soils, in the Agricultural portion of the Report, I shall not enter here upon more special descriptions of these deposits, which appear to have been the first result of the more active denudations which succeeded to the deposition of the loam, and scooped out the bulk of the valleys of the minor streams also, in their present place; though none of these ever, at the present time, fill the whole of the space which, as the nature of the deposit proves, they once must have occupied.—How much of the Mississippi Bottom deposits may be referrible to the same period, I am unable to say, not having, as yet, had any opportunity of personal observation. It seems that near the seashore the period here referred to is represented by the sands forming the "Pine Meadows" and part of the "Sand Hommocks;" a specimen of whose stratification is given in Diag. No. 3 (¶51), which see.

V. THE ALLUVIAL DEPOSITS.

344. These include all the soils, first-bottom deposits, sand-bars, etc., now in progress of formation or attributable to causes now in action, and will of necessity be treated of at length and in detail, in the Agricultural portion of the present Report; they need not, therefore, find any lengthy discussion here. Their useful materials are our *arable soils*, greatly surpassing in value and importance the richest mineral deposits of the older formations; and the doctrine which, in treating of these latest formations, corresponds to that of the mining and smelting of the rocks and ores of the former; which teaches us how to utilize in a rational and economical manner, the resources of the important deposits in question, is that which shall next occupy our attention: SCIENTIFIC AGRICULTURE.

PART II.

AGRICULTURAL REPORT.

I. *GENERAL PART; PRINCIPLES OF RATIONAL AGRICULTURE.*

A. SOILS.

345. *What is a soil?*—It might appear superfluous, in speaking to an agricultural public, to give any explanation or definition of the term "soil." Yet the word, is sometimes used in a manner somewhat indefinite, as though it necessarily implied a certain physical condition or "texture" of the material. I have been frequently told of the occurrence of "soils" twenty feet or more below the surface; and more frequently still, it is said that there is "no soil" in some thickly wooded, or grassy region, simply because the surface stratum may not happen to be suitable for cultivation.—Properly speaking, in its most general acceptation, the term *soil* implies the *surface stratum of earthy material, as far as the roots of plants reach;* no matter whether it be sand, or potters clay, or, as in most cases, a mixture of the two.

346. Now, since the roots of the different kinds of plants penetrate to very various depths, and since, moreover, in most cases a rapid change in the character of material takes place, as we proceed from the surface downward; it is evident that according to the above definition of the term soil, it may imply a great many different average materials, according to the plant to whose soil we refer; *even in one and the same spot.* When we speak of the soil with reference to Bermuda Grass, we do not necessarily include anything more than a surface layer 2½ to 3 inches in depth; whereas, in alluding to most forest trees, we necessarily take into consideration a layer of several feet, from the surface downwards. Nay, in the latter case it may happen that the "soil" thus spoken of is quite independent, in its character, of that which in cultivation would form the arable soil of our field; which may be entirely *above* the stratum in which the roots of the trees are fixed.

347[1] *Judging of land by its natural vegetation.*—The distinction just mentioned, so far from being of merely theoretical value, is of the highest practical importance. Agriculturists are accustomed to judge of the quality of lands by the natural vegetation which they find upon it; and they rarely direct their attention to anything but the forest trees. Yet these are, for the most part, indicative rather of what, in the *agricultural* sense, is termed the *subsoil*, than of that of the surface stratum usually turned by the plow, in the shallow tillage prevailing at present—which may be of a totally different character.

As a general thing, the forest growth, when considered not only with regard to the *kind* (species), but also to the *form* and *size* of the trees, is a very safe guide in judging of the quality of land; and the systematic study of the subject, in connection with analyses of soils, promises results of the highest practical importance, which it is intended to communicate more fully in a future Report. But this criterion may not unfrequently lead to grave mistakes, unless a proper examination of the character of the soil and subsoil be made at the same time. Of cases of this kind, it may be well to give a few examples.

347[2] The Black Jack Oak, when forming large, well-shaped trees, with regular, and especially, tall trunks, and closed tops, is justly considered a sign of no inferior soil. As a species, the Black Jack occupies some of the poorest, as well as the richest soils of the State. We see it in the prairies of Monroe, in the rich, mellow Table-lands of Marshall, on the best yellow loam uplands of Yallabusha, Holmes, and Madison; while on the other hand, the hopeless infertility of the sandy "Black Jack ridges" of the hilly counties is familiar. In each of these localities, the tree has its characteristic features peculiar to the soil, and easily recognizable by an attentive observer. In the Long-leaf Pine Region of the South, *e. g.*, in the counties of Pike, Smith, and Simpson, land has frequently been bought on the faith of some large Black Jack Oaks scattered among the Pine; yet the land, on cultivation, yielded no better results than adjoining tracts on which no Black Jack was to be seen. And in truth, there was no perceptible difference between the character of the soils, *such as the shallow tillage exhibited them.* Yet, on examination, I found the tree to have given a correct indication; for at the depth of 8 to 12 inches (to which the plow had never penetrated), the white ashy soil is underlaid by a good yellow loam, which when turned up, proves to be quite fertile. It was, of course, from this stratum, that the tree had derived its nourishment; having little or nothing to do with the surface soil. Had the purchaser noted this fact, or paid more attention to the character of the smaller plants, the roots of which do not extend beyond the arable soil, he could not have been thus misled.

348. Another case in point occurs in the Southern River Counties, in the hilly, fertile loam lands bordering on the Mississippi River. Here the "Poplar" or Tulip Tree (*Liridendron tulipifera*) is quite common among the hills, and knowing the habits of this tree, we should at once conclude the soil of these hills to be very calcareous. Yet it is found that most of these very soils are much improved by the application of lime; analysis, moreover, does not allot to them any unusual percentage of that substance.—A little attention, however, will show the tree to be consistent in its indication nevertheless. The main mass of these hills, as has been elsewhere stated (327), consists of the highly calcareous silt or loam of the Bluff formation; in most cases, however, the latter is overlaid, and the soil is formed, by a brown loam, of a different character and more modern age. It generally caps the hills, and also forms their talus, while on the brow of the hills, where the *level breaks off*, the calcareous loam of the bluff formation is generally *near to*, and sometimes *at*, the surface; the same is the case, of course, in washes and gullies on the hillsides. Now, these are precisely the spots on which the "Poplar" is most frequently seen, viz: on the hill*sides* rather than on the level area on top, which is chiefly cultivated. And when the "Poplar" *is* found on the hilltops, as is frequently the case where the ridges are high and narrow, examination will generally show that the brown

loam stratum is nearly or entirely wanting, while the roots of the trees bury themselves in the calcareous silt. The latter then forms the arable soil, to which an application of lime would be perfectly useless. (See "Southern River Counties.")

349. These examples may suffice to show that while in the forest trees, we possess trustworthy guides to a knowledge of the character of the material in which their roots are buried, it is quite essential to convince ourselves at the same time, by inspection, that it is the arable soil itself, and not merely the subsoil, which is thus characterized; and we should especially make sure that the smaller plants, viz: the *shrubs* and *perennials*, corroborate the evidence of the trees. Annuals are less reliable in their indications, because their development is to a greater extent influenced by the accidental circumstances of the seasons.

350. SUBSOILS.—If the term *soil*, as to its practical import, is dependent on the kind of vegetable under consideration, the same is true, no less, with reference to the *subsoil*, which is necessarily dependent on the first. In the common parlance of the agriculturist, however, who considers them chiefly with reference to the plants he cultivates, and his means of tillage, they assume a definite meaning in that he designates as *soil*, whatsoever he usually turns over with his plow, and as *subsoil* what lies beneath. It is evident that inasmuch as, in this country, the depth of tillage varies, on the same kind of land, from 3 to 12 inches, that to use the term in that sense, would be to deal with an idea absolutely shapeless and intangible, unless referred to the practice of some particular individual.

In collecting specimens of soil for chemical analysis, which is to serve as the basis of a rational treatment of the soils in question, it is evidently of the last importance that these circumstances should be taken into consideration, and that a rational and uniform rule be adhered to in reference to the distinction between the soil and subsoil.

351. *Examination of soils.*—In the large majority of cases we find, in examining soils in their natural place, that a sensible change in the character of the material occurs at a moderate depth, say from three to twelve inches—about the same as the usual range of the plow. If, therefore, as a rule, in speaking of virgin soils, we designate as *soil*, the surface layer down to the point where a perceptible change takes place, and as *subsoil*, what lies beneath, we shall in most cases find these subdivisions to co-incide with what, in a proper system of tillage, becomes the soil and subsoil in the sense of the agriculturist.

In the soils of the Prairies, "Flatwoods," Sea-coast Marshes, as well as in those of many of our larger bottoms, frequently no perceptible change of material occurs at a less depth than from 18 to 30 inches, and sometimes more. In such cases the subsoil *proper* is oftentimes of little importance to the agriculturist; it will be sufficient for him to be made acquainted with the properties of his soil *proper*, and with the fact that it is the same as far as his plow reaches; or in other words, that *his subsoil* (in the agricultural sense) *is the same as his soil.* In such cases, as a rule, I have taken a specimen from the surface to the depth of twelve inches; and mostly also a specimen of the subsoil *proper*, at whatever depth it may occur. The latter specimen is not *necessarily* intended to be analyzed; an examination of its physical properties may be important with reference to drainage, resistance of the land to drouth, etc.

352. On the other hand, when the surface layer is of no greater thickness than a few inches, it would be useless to examine that layer by itself, inasmuch as no one would be likely to restrict himself to such shallow culture; the tillage would necessarily mingle with it a few inches at least of the subsoil.

Presuming that culture to a depth less than *six inches*, can hardly lay claim to being rational, I have adopted as a rule, to take no specimen of soil shallower than the above; save, perhaps, in some particular instances in which a great and important difference between the two layers renders a knowledge of their peculiarities specially desirable. In all these cases, specimens of the *subsoils* have been likewise collected for analysis, viz: from the point where the change takes place (below six inches) to the depth of fifteen to eighteen inches from the surface, according to circumstances. In all cases the depths at which the soils and subsoils have been taken, will be found recorded with the analysis; every one will therefore be able to judge as to which of the two layers analyzed corresponds to the soils and subsoils which his particular practice may have produced.

353. *Soil Analyses.*—It has often been stated, and urged even by high authority against the utility of analyses of soils, that a specimen of a few pounds cannot be made to represent correctly the character of the soil of a whole region, or even of a single field. This difficulty may indeed become a serious one, where the soil has been long in cultivation, so that fundamental differences may have been superinduced in adjoining fields; and also where the geological formations are very various, the face of the country much broken, and the underlying rocks contribute immediately and continually, to the formation of the soil; though even in the latter case, attentive study will generally succeed in reducing the mass of soils to a few principal types (and their intermixtures), recognizable by their physical characters, or position. In Mississippi, most soils are dependent upon continuous deposits extending over considerable areas, within which they are, to a great extent, of a uniform character; or at least, *vary uniformly.*

It is often by no means easy to take correctly specimens of soil intended to represent a district of some extent; it is necessary, in the first instance, to study closely all the general characters, and upon that study, to base the selection of representative specimens. And I am convinced that by conscientious observance of this method, it is practicable in this State at least, to study the essential features of all the soils entitled to such consideration by the extent of their occurrence, from a limited number of specimens; and without an approach to anything as extravagant as the analysis of "the soil of every field," as has been thought necessary.

354. The period during which the soils of Mississippi have been subject to cultivation, has been too short, and the system of cultivation too uniform and simple, to interpose any serious difficulty on the grounds above alluded to. Moreover, the simple history of almost every field, from the time of its clearing to the present, is still fresh in the memory of its occupant; so that, knowing the original character and constitution of the soil, from the investigation of adjoining tracts still uncultivated, we shall not generally be at a loss to conjecture the changes it will have experienced by cultivation. For this reason I have thought it best to restrict myself, for the present, to the investigation of *virgin soils*—unless in exceptional cases, where some important general truth might be expected to be gleaned from the study of cultivated soils; as for instance, with reference to soils which, through cultivation, have acquired the habit of rusting cotton.

The uncultivated lands in this State are still so extensive, that a knowledge of their soils, their intrinsic value and ultimate fitness for cultivation, is of itself an object of great magnitude, even if we abstract from the information simultaneously acquired, as to the character and wants of the land already under cultivation.

355[1] *Origin of Soils.*—It is but rarely the case, that the materials of which the strata of the more ancient formations are composed, are fit to serve as soils to the plants of the present age. Even those in which we find the proofs of their once having sustained a vigorous vegetation, whose relics they contain, have mostly undergone essential physical and chemical changes, which render them unfit to resume their former office, until they have undergone a process of disintegration, under the influence of the atmospheric agencies.

Thus, the soils that bore the luxuriant vegetation which has passed down to our epoch in the shape of bituminous coal, have in the course of ages been converted into shales and claystones, often of considerable hardness, which we find associated with the coal beds; we often discover in them, in a compressed condition, the roots, with parts of the trunks, leaves, etc., of the plants which have furnished the materials for the overlying coal. In the same manner we often find in the Lignitic formations of our own State, dark colored, sandy clays, filled with the vestiges of an ancient vegetation, the roots and parts of the trunks of which are still in their original position. Two beautiful instances of this kind, occurring in this State, have been mentioned in the Geological Report (244; 249). But in both these cases, the materials surrounding the fossil roots would be totally unsuited, in their present condition, to the growth of analagous plants, at present existing. Even though they may still contain the same elements of fertility which enabled them to produce the forests we now find buried, their physical condition has been greatly altered; they have become dense, compact and semi-indurate. Nor are the chemical changes they have undergone of less moment.

355[2] The action of the atmosphere would gradually restore these ancient soils to their original condition. It is to the same agency, slowly but surely disintegrating even the hardest rocks, that we owe the formation of our soils, at the present time; if, therefore, we would understand the nature of soils, we must make ourselves acquainted with the mode of action of the causes just alluded to, among which the following claim our chief attention, viz: 1. The mechanical action of water, by attrition and transportation of materials, or what is technically termed *denudation*. 2. The effects produced by changes of temperature, such as frost, and changes from wet to dry and vice versa; with the effects of both of which, in pulverizing soils, agriculturists are familiar. 3. The chemical action of the constituents of the atmosphere (excepting nitrogen, which is inert), viz: water, carbonic acid, oxygen, and ammonia.

356. Most rocks are composed of several minerals, some of which are more readily decomposed by the action of the atmosphere than others; moreover, small particles of one and the same mineral disintegrate sooner than large ones. Usually, therefore, rocks are softened, and their particles made susceptible of being carried off by the rains, long before the chemical decomposition of the several minerals has been completed. It follows as a consequence, that in soils thus formed we have to distinguish two different portions, viz: that which consists of *minerals undecomposed*, or in process of decomposition; and that which is formed by the *decomposition of the several minerals*.

357. *Fallowing.*—The process of decomposition does not, of course, cease after the particles of the rock have been carried away from their original places. On the contrary, its progress generally becomes more rapid, in consequence of the comminution caused by the transportation; it is constantly active in our soils, and its effects are most strikingly perceived when land is *fallowed*, *i. e.* exposed to the action of the atmosphere for one or several seasons, without cropping. In the fresh, undecomposed portion of the soil, the mineral ingredients which plants require are contained in a condition in which they are not immediately available for absorption into the vegetable economy—*locked up* as it were. In the natural course of things the action of the atmosphere very *gradually* uncloses these hidden treasures; but we can very much accelerate the progress of decomposition by the use of the so-called *stimulant manures*, of which I shall speak hereafter; and the beneficial effects of thorough tillage are also due, to no small extent, to the increased accessibility of the soil, to the decomposing action of the atmosphere.

PRINCIPLES OF AGRICULTURAL CHEMISTRY.

358. Important, and almost indispensable as it is, that any one who would avail himself, to its full extent, of the aid which science can give to the practical agriculturist, should be acquainted with the rudiments at least of chemistry, it would divert me too far from the purpose of the present Report, should I give,

under the above head, any thing more than the merest outline of the doctrine of Agricultural Chemistry. In the final Report, it might be proper to treat of the subject more at length; for the present, I shall confine myself to what is absolutely necessary for the useful understanding of the matter contained in the present pages.

359. *Scientific and Technical Terms.*—It may be justly expected that in writing for the benefit of the mass of the people, the use of technical terms should be avoided as much as possible. On the other hand, it is vain to expect, in entering upon any new field of knowledge whatsoever, to escape the necessity of learning some new words or expressions. This is unavoidable, and in the very nature of things; for whenever we direct our *special* attention to any object, we find it to consist of distinct parts, which a merely general, cursory glance failed to detect. These parts are so many new conceptions or ideas, and *new ideas*, as a matter of course, *require new words for their expression.*

This is quite as true of the arts and crafts of every day, as of the exact sciences. The language which the sailor uses in describing his vessel, is not more intelligible to the uninitiated "landsman," than a chemical formula would be to the sailor himself; the printer, the tailor, the shoemaker, the blacksmith—all have their peculiar *terms of trade.* If the majority of men, while perfectly at ease with reference to what the tailor styles his "goose," stand appalled at the "big words" of chemical or geological terminology, it is not because the former term is more expressive of its object than the latter, but simply because tailors are more numerous than chemists, and their calling more ancient.

In this respect, agriculturists enjoy an advantage over all other occupations; their technical terms are known and understood by an overwhelming majority of mankind, not only because they themselves form so numerous a class, but also because the products of their labor are the prime necessities of life, which all feel deeply interested in, and with which, as well as with the means employed to produce them, all are consequently conversant

360. INGREDIENTS OF SOILS—ELEMENTS.—Anciently, no separate ingredients were distinguished in soils; "earth" was regarded as a simple, an element, which might, to be sure, be slightly modified here and there, yet was essentially the same everywhere. Later researches have gradually resolved soils, rocks and what proceeds from them, into a number of substances, which as yet have resisted all efforts at a further decomposition. These substances, most of which, as well as their combinations, are unknown to common life, have received new names, so far as this was necessary; we call them *elements*, supposing that they are incapable of being resolved into any simpler constituents.

Chemists are, at the present time, acquainted with *sixty-four* elements; but among this multitude, only sixteen or seventeen claim the attention of the agriculturist, as being ingredients of his soils as well as of the products which he draws therefrom. They are the following:

Non-metallic substances.	Metallic bases of the Earths and Alkalies.
Oxygen.	*Potassium.*
Hydrogen.	*Sodium.*
Nitrogen.	*Calcium.*
Carbon.	*Magnesium.*
Silicon.	*Aluminium.*
Sulphur.	
Chlorine.	
Fluorine.	
Phosphorus.	

Heavy Metals. *Manganese.* *Iron.*

To the first class of this list may be added *Iodine*, and to the last, *Copper*; since these substances are found to be very generally present, though in very minute quantities.

361. *Important Combinations.*—These elements, in their combinations amongst themselves, and especially with OXYGEN, compose the vast majority of all material objects that surround us. The human frame ordinarily contains every one of them; and so do most plants (if we except *Fluorine* and *Aluminium*). The first four, in combination, form the great bulk of vegetables, such as wood, starch, albumen, etc. *Oxygen* and *Hydrogen* form WATER; *Oxygen* and *Carbon*, CARBONIC ACID (the gas contained in soda-water); *Hydrogen* and *Nitrogen*, AMMONIA (spirits of hartshorn). AIR is a mixture of four-fifths (by bulk) of *Nitrogen* and one-fifth of *Oxygen*; it always contains, at the same time, variable amounts of Aqueous Vapor, and minute quantities of Carbonic Acid (one three-thousandth) and Ammonia (between one and two millionths).

Small and insignificant as the amounts of the two latter ingredients present in air may appear, they perform most important parts in vegetable economy. All the carbon which plants contain is obtained by them from the atmosphere in the shape of carbonic acid, which they decompose, retaining the carbon and returning the oxygen to the atmosphere. In the same manner, a large portion of the nitrogen contained in plants, is derived from the ammonia present in the air; while their fixed mineral ingredients, which remain behind in the shape of ashes when vegetables are burnt, are derived from the soil.

362. The combinations of other elements with oxygen (which are produced by *burning* the same), are called *Oxides;* a large part of these, generally possessing a sour taste, are called *Acids.* Thus we have Oxide of Iron, of Manganese; Sulphuric, Phosphoric, Carbonic acid, etc. Combinations of Oxides and Acids are called *Salts.*

The combinations of the other elements, most important to the agriculturist are the following:

363. SILICON—with oxygen, forming *Silica*—flint, quartz, rock crystal, the hard grains of almost all *sands;* in the latter form, and in combination with Alumina, it forms the great bulk of most soils. Moreover, it enters largely into the composition of all grasses, of pine straw, and a great number of other plants. It is but seldom that soils are deficient in silica *as such;* but it often happens that it is not present in an *available*, or soluble, condition; a defect promptly remedied by the application of lime.

364. SULPHUR—with ogygen, forming *Sulphuric acid* (in its pure state called oil of vitriol); this in combination with Lime, forms *Gypsum*, or plaster of Paris; with Magnesia, *Epsom Salt;* with protoxide of Iron, *Copperas*, etc.

365. PHOSPHORUS (well-known as the inflaming ingredient of common friction matches) with oxygen forms *Phosphoric acid.* The latter, in combination with Lime, forms the earthy part of bones, or bone-ash, which is, essentially, phosphate, with a little carbonate, of lime. Phosphoric acid is, moreover, contained in all seeds, to a considerable amount; hence, its absence from the soil is fatal to the formation of seed of any kind. The stem and leaves of plants require it also, but in much smaller quantities.

366. POTASSIUM and SODIUM, form with oxygen, repectively, *Potash* (the *potential caustic* of druggists) and *Soda;* the former, in combination with carbonic acid, is the chief ingredient of pearlash, saleratus, etc.; while the combinations of soda with the same acid, are what are familiarly know to our housekeepers as soda, or salsoda. Moreover, sodium in combination with chlorine, forms common salt.—Potash is as universally required by all plants (excepting sea-weeds) as phosphoric acid, and is therefore one of the most important and indispensable ingredients of a good soil; so much so, that the amounts of potash and phosphoric acid contained in a soil, may usually, in practice, be taken as a direct index of its fertility. All other ingredients necessary for the growth of plants are more easily and more cheaply supplied, than these two. Whenever they are wanting, or are present in very minute quantities only, we may consider, for all practical purposes, that the soil has to be *made* before it will produce anything.

Almost all plants require for their full development, more or less *Soda*, also. But while the absence of available potash from a soil is one of the most common causes of infertility, a sufficient amount of soda is rarely wanting.

367. CALCIUM with oxygen, forms *Lime;* the latter, in combination with carbonic acid, constitutes marble, and the prevalent as well as the all-important ingredient of *limestones*, most of which are a mixture of carbonate of lime with earthy matters—sand, clay, etc. Most limestones contain magnesia, also, and a great many contain small amounts of potash, soda and phosphoric acid. In the process of burning lime, the carbonic acid of the carbonate of lime is expelled by heat; in the hardening of common mortar, the lime partially resumes its carbonic acid from the air. Hydraulic cement is burnt out of limestones containing certain proportions of other earthy matters, or out of an artificial mixture of pure limestone and clay.

Of *phosphate of lime* (being the chief ingredient of bones) and *sulphate of lime* (being *gypsum* or *plaster of Paris*) I have spoken above (¶364, 365).

368. *Action of Lime in Soils.*—Most plants require for their growth notable quantities of lime, which must, therefore, be present in the soil. Few soils are infertile for want of lime; the increase of fertility observed after liming, is mostly due, not so much to the direct action of the lime itself on plants, as to its chemical action in rendering *available* to vegetation other ingredients, especially potash and silica, when contained in the soil in a "locked up" condition (357), in the undecomposed part of the minerals.* Lime, especially when applied freshly burnt, greatly accelerates the decomposition both of minerals and of vegetable matter. Hence we see that by means of liming, we can *in a brief period of time*, produce the same effects on the soil, which the unassisted action of the atmosphere, or *fallowing*, would have required centuries to effect.

369. But in so doing, we exhaust the soil very rapidly; what we *gain* in the fullness of crops, we *lose* in the duration of our land; hence the well-known adage, that "Lime enriches the father, but impoverishes the son." When land which has been limed moderately, ceases to produce fallowing will have little effect on it for several years, because all the nutritive matter which was easily accessible, has been already developed by the powerful action of the lime. Yet, after fallowing for a number of years, such land may again become productive, in consequence of the decomposing action of the atmosphere having at last penetrated to that portion of the soil which even the lime had not reached, and thus made available a new supply of nourishing ingredients. Usually, however, after a moderate dressing of lime has ceased to be effective, another and stronger dressing is put on; and thus the process of exhaustion may be continued, until the soil becomes really and utterly exhausted—stripped *completely*, of all, or of some, of the ingredients required by the plants. Henceforth, the crops will depend entirely upon the application of *manures—true* manures (of which stable-manure, or still better, *night-soil*, is the type), not mere *stimulants*, like lime, ammoniacal salts, common salt, Chilian saltpetre, etc.

The use of lime on land to the extent above referred to, is scarcely better policy than that of the drunkard, who, in order to sustain the excitement he desires, finds it necessary to take deeper potations each succeeding day, until at last the energies of life are completely exhausted, and the foundation gives way, before

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*While there can be no doubt that the *greater part* of the favorable effects of liming is due to the indirect action above referred to, experiments made upon the growth of plants in lime water seem to show that lime also exercises a kind of *direct* stimulation on the vegetable functions, which in the experiments mentioned, was manifested in the more vigorous development and deeper green of the seedlings vegetating in lime water, as compared with those placed in pure water. It may be doubted, however, whether the effects are in any manner comparable to those exercised by "stimulants" upon the animal economy.

the expiration of one-half the time during which, with prudent management, it would have held out.

Under the head of Manures, this subject will be more fully considered, in connection with the use of the marls of our State.

370. *Calcareous Soils.*—Limy (or *calcareous*) soils, *i. e.*, soils in which lime, in combination with carbonic acid, forms a prominent ingredient, occur much less frequently than is commonly supposed. The soils of the prairies, which are notoriously limy, have given rise to the supposition that all soils resembling them in their physical characters, and particularly in point of "heaviness" and the property of forming an exceedingly tenacious mud, are limy also. Spots where some tenacious clay, of whatever color, comes to the surface, forming redoubtable obstacles to vehicles in the rainy season, are popularly styled "prairie spots," throughout the State.

371[1] Many purchases and settlements have been made on the strength of this apparent similarity of the soil to that of the prairies; and when it is afterwards found that the soil in question will produce little or nothing, it is very commonly ascribed to an *excess of lime* supposed to be contained in it. Such is commonly the case in the "Flatwoods" region, which skirts the Prairie region on the west, from Tippah Creek, in the county of the same name, through Pontotoc, Chickasaw, Ocktibbeha, part of Winston, and Noxubee, to Kemper and the Alabama line. The same supposition is entertained with reference to the "hog-bed" or "hog-wallow prairie" soil, occurring in Smith, Jasper and some of the adjoining counties. In both these cases, the direct contrary is proved by the analyses of the respective soils, which are given further on; not only is there no *excess* of lime in either, but especially with reference to the Flatwoods soils, even a *deficiency* to such an extent, that the application of lime, as a manure, to these soils, is at once indicated.

371[2] The heaviness and "stickiness" of the prairie soil has nothing whatsoever to do with the lime contained therein; on the contrary, an excess of lime rather tends to *diminish* the tenacity of clays, as may be observed on the "bald prairie" hilltops, as compared with the level prairie with yellow clay subsoil. In the light, almost pulverulent silt which forms the main mass of the hills of the Southern River Counties—(Vicksburg, Grand Gulf, Petit Gulf Hills, etc.)—we have a soil containing much more lime than even the black prairie soils of Smith and Jasper; yet that soil never forms, at the worst seasons, anything that would be called "mud" in the prairie region.

372 The true distinguishing features of limy ("calcareous") soils, which never fail to characterize them plainly enough, may be found in the peculiar growth, large and small, which they bear. Chemical reagents cannot more surely announce the presence, in the soil, of a large supply of lime, than does the prevalence of the Crab Apple, the Wild Plum, the Cottonwood, the Sycamore, the "Poplar," and some others—And we may confidently hope that a diligent comparison of a sufficient number of soil-analyses with the natural growth of the soils, will enable us to judge, in a similar manner, as to the presence or prevalence of other ingredients; so that we may analyze the soils, as it were, by the eye alone.

373. The next element in our list is MAGNESIUM, the combination of which with oxygen is Magnesia. Epsom salt, the combination of magnesia with sulphuric acid, is familiarly known; besides this, the combination of magnesium with chlorine is practically important, as being the cause of the greater pungency of sea-salt, and a common—too common—constituent of spring and well waters, in some regions of the State. Magnesia is scarcely ever wanting in soils, and is remarkably abundant in a large part of those of our State, which are derived from the materials of the several lignitic stages (Geological Report, p. 110, 147, ff.). It may be said that the latter are almost as certainly characterized by *magnesia*, as the marine strata of Jackson, Vicksburg, etc., are by *lime*. Probably the majority of mineral springs in this State are characterized by magnesian salts (¶155; 316).

374. The next succeeding element—ALUMINIUM (which, in its metallic state, has but lately been introduced into the arts, and is distinguished by its extraordinary lightness) is the most abundant ingredient of the earth's crust, next to oxygen and silicon. Its combination with oxygen, *Alumina*, when still further combined with *Silica*, forms the main mass of all *Clays*, and of a great number of rocks, by the decomposition of which, clays are formed.

375. *Clays*.—There are innumerable varieties of clays, which have received numerous names, both popular and scientific. The differences arise partly from the various proportions in which silica and alumina may combine, partly, and most frequently, from the admixture of foreign (*i. e.* not chemically combined) substances. The purest of all clays is *Kaolin* or porcelain earth; next to this, the white pipe-clay, such as those found chiefly in Tishomingo, but also in other counties of this State, in the deposits of the Orange Sand formation (¶60, ff.). In some of these pipeclays, there is a strong mechanical admixture of finely divided silica; in some instances this ingredient gradually becomes so prominent that the material loses its title to the name of clay, and becomes a soft, fine-grained, white, siliceous rock, the transition being so gradual, that it is difficult to say where the pipeclay ceases and the rock begins (¶62, 66).

A similar uncertainty very frequently attaches to the more common mixtures of clay and sand, known as brick-clays, loams, silts, etc., including the majority of soils; there is no definite line of distinction, so that it is often optional with the individual, whether some material he describes shall be called a clayey sand or a sandy clay.

376. The different *colors* of clays are generally owing to either or both of the two last named elements of the list, viz: *Manganese* and *Iron*, and to *Carbon*, or finely divided particles of coaly substance.

Iron (in its two combinations with oxygen, called the *protoxide* and *peroxide*) and *Carbon* are by far the most commonly occurring coloring matters. *Peroxide* of iron imparts yellow, orange and red tints (the two former tints pass into red whenever the substance is heated to redness); *protoxide* of iron, blue and green. The two last mentioned colors pass over into those of the peroxide, whenever the material they color is exposed to the action of the air; hence it is that in the southern portion of the State, where blue and green clays are so very common (in the upper Tertiary, or Grand Gulf Group, ¶230, ff.), we frequently see nothing but yellow or orange surfaces on the exposures, the blue or green portion being found at the depth of several inches at times. The same frequently happens with reference to the blue marls, both of the cretaceous and tertiary formations; they have escaped notice in many cases, simply on account of the surface having undergone the change just referred to, which rendered them similar in aspect to the soil or subsoil.

Clays colored by *Manganese* alone, are of rare occurrence; according to the amounts of oxygen combined with the element, it imparts delicate pink, brown or black tints. But it frequently modifies the tints produced by iron, and is rarely wanting where the other occurs.

Clays colored by *Carbon* alone, which imparts to them a black, gray or sometimes bluish tinge, become white by burning. Such is the case with many clays from the Lignitic formations, which, although very dark at first, on burning yield ware almost equal in whiteness to that made of the Tishomingo pipeclays.

Of course it often happens, that several or all of these coloring matters are present in one and the same specimen, thus producing an endless variety of tints—from the purest white through all shades of gray to almost jet black; from the light and delicate rose tints of the Orange Sand clays frequently found in South Mississippi, to the deep red of the ferruginous clay occurring in Tishomingo county, which has been designated as "Terra sigillata," and comes properly under the head of coloring materials (¶71). Clays of all shades of blue are frequently found associated with our lignite beds in North Mississippi, and are very common in the upper (fresh water) Tertiary of South Mississippi; so also are those of the several shades of green (¶231, 237, 243, etc).

Color, therefore, has nothing to do with characterizing any substance as a *clay*. I have been thus particular in stating this point, because of the difficulty I have so often encountered in arriving at a definite conclusion concerning some material described to me, the party whom I questioned insisting that it was not clay, merely on account of some unusual tint it happened to possess.

377. "*Soapstone*"—It is very usual in this State to hear designated as "soapstone" any clay which, being free from course particles, is smooth to the touch, like soap or *true* soapstone, and which does not readily form a plastic paste with water. The bluish laminated clays of the Eutaw Group of the cretaceous formation (¶101, ff.), as well as similar clays occurring in the Tertiary (¶165, 231), are invariably so designated in the counties in which they occur.

True Soapstone, such as is used for the interior lining of stoves, for hearth-plates and ovens, does not occur within the State; the formations to which it belongs are entirely wanting, and all the "soapstone" commonly so called in Mississippi, belongs to the class of clays above described. When worked up with water, they gradually form a very tenacious mass, which, however, usually contains too little sand to be suited to the purposes of the potter, in its natural state.

378. *Retentive Powers of Clays.*—One of the most important properties of clays, which they impart, in greater or less degree, to all soils, is their capacity of retaining in their mass a certain amount of the ingredients necessary for the growth of plants, even when these are in a condition in which, ordinarily, they are soluble in water. When solutions of potash, lime, phosphoric acid, etc., are filtered through a layer of soil of sufficient thickness, the whole of these ingredients is retained by the soil, so that the water which drains from it contains no more of them. This retentive power, which varies very much in different soils, is of the very highest importance, as it prevents the waste of valuable ingredients by the action of the rain water which continually filters and drains *through* the soil. Hence it is that in the waters which drain from soils pre-eminently rich in soluble ingredients, traces only of these substances can be discovered, unless indeed, the soil should happen to be *saturated* with some of them, so as to be unable to retain an additional supply; as a sponge will not receive, or retain, more than a certain amount of water.

The point of saturation differs for different substances and one an the same soil; and it is remarkable that in regard to the retentive power, there is a marked distinction in favor of those substances most generally needed by the plants in large quantities. Thus potash and phosphoric acid are most pertinaciously retained, while soda, magnesia and soluble vegetable acids are often carried off in large proportions by the drain waters. Light and sandy soils are the least retentive of these substances, as well as of moisture; while clayey soils, and those containing much vegetable matter, are the most retentive of both.

Clays are retentive, not only of solids and liquids, however, but also of gases, and particularly so of *ammonia*; hence they condense the latter from the atmosphere, thus furnishing it to the roots of plants. In this, as in other respects, clays act analogously to humus, concerning which, see below under the head of manures (¶425).

379. "*Alum.*"—Next to the combination of Alumina with *silica*, which is the basis of clays, its combination with *sulphuric acid* deserves mention. This does not often occur in substance, but is not an unfrequent ingredient of the mineral springs issuing from the lignitic clays; which are commonly distinguished as "Alum springs." The name, though not strictly correct (inasmuch as true alum contains sulphate of *potash* beside that of alumina), well expresses the sweetish astringent taste possessed by such waters. In this State, they always issue from the lignitic strata of the tertiary formation, and are most abundant in those which are immediately contiguous to the marine, fossiliferous Tertiary. The strongest alum water in the State of which I have any personal knowledge, is that of Baugh's well, at Brandon, Rankin county; one very

similar to this occurs in a well dug on the plantation of Mr. Holland, S. 35, T. 6, R. 3 E., near Brandon.—The water of the Artesian Springs in Madison, is of the same character; and another alum spring, which has acquired some reputation in the neighboring counties, is situated about two miles south-west of Grenada. In the neighborhood of such springs, a mixture of alum with other salts is frequently seen, as a white covering ("efflorescence") on the surface of the clays (¶181).

380. Of the part taken by Iron and Manganese, the two last elements of our list, in coloring clays and soils, I have already spoken. Manganese, though almost universally present in soils, is generally so in very minute quantities, so as to escape the eye, and leave its presence to be demonstrated by chemical reagents. Occasionally, in this State, Oxide of Manganese may be observed forming curiously ramified designs (*dendrites*), resembling mosses or diminutive trees, on the cleaved surfaces of gray and white sandstones and limestones. These figures are frequently mistaken for fossil plants; but they have no connection with such, being simply strings of crystals, formed somewhat in the manner of the figures on frozen windows.

381. Iron is one of the most widely diffused substances with which we are acquainted. It would be difficult indeed, in common life, to pick up anything whatsoever that should not contain a trace at least of iron—unless, perhaps, it had been purposely purified. The ashes of almost all vegetables contain it; so do all soils, clays, and sands; so do all kinds of glass. Even the metals, copper, tin, zinc, lead, and silver, such as they are known to common life, contain certain amounts of it; often very minute, but still discoverable by chemical means.

382. *Oxide of iron* in combination with water (*hydrated peroxide of iron*), or *iron rust*, is the compound most commonly occurring. It is found almost pure, as yellow ochre (which is usually, however, a mixture of oxide and of clay); it imparts the yellow or orange tints to clays, sands, soils and subsoils; to the "red lands" of Pontotoc, Chickasaw and other counties; to the yellow loam lands of the two ranges of counties bordering the Mississippi bottom, which form the rich agricultural regions of Lafayette, Yallabusha, Carroll, Holmes, Madison, Hinds and other counties. It forms the cement which binds together the grains of sand in our red, brown or "black" sandstone, found more or less all over the State (¶11, ff.); sometimes the cement so far predominates over the sand, that the material would be valuable as iron ore, but for its being too much scattered to allow of profitable smelting (¶74[1]). Nodules of brown iron ore, of various degrees of purity, are the unfailing surface indication of the gray clays of the Lignitic formation of North Mississippi (¶42).

383[1]. *Iron in Soils*.—The presence of a large surplus of the peroxide of iron (or iron rust) in soils (which may generally be pretty correctly judged of by the intensity of the color), does not apper to exert any very characteristic influence on vegetation, save such as may be owing to its powerful attraction for moisture and ammonia (which it shares with clays), and the influence of its color on the absorption of heat from the sun's rays. A small amount of iron seems to be indispensable to the vigorous growth of most cultivated plants, for on soils artificially formed without the addition of iron, these vegetables languished and drooped, and the subsequent addition to the soil of a small amount of iron, seemed to produce effects similar to that which the preparations of iron used as tonics in medical practice, produce on the human system, viz: a general invigoration of the vegetative energies. But such a soil had to be artificially formed, as above stated; for in nature it might be difficult to find any soil not containing a supply of iron sufficiently large for the use of plants.

383[2]. While an excess of iron in the shape of the compound heretofore mentioned (viz: the hydrated peroxide of iron) may be present without any injury to vegetation, the same is not true with reference to the other combination of iron with oxygen (containing *less* of the latter element than the peroxide, or iron rust): the *protoxide*. And since this difference has an important bearing on the subject of draining of swamp lands, as well as plowing, I shall here dwell upon it for a few moments.

I have before observed (¶376), that the blue and green tints of clays, etc, are generally caused by some combination of the protoxide of iron, and also that, when such clays are exposed to the action of the air for some time, the green or blue tint changes to gray, yellow or orange, in consequence of the conversion of the protoxide into common rust. We have a familiar example of this change, in the well-known process of copperas-dying; the fresh, green copperas contains the protoxide in combination with sulphuric acid; when it turns yellow, the *protoxide* passes into *peroxide*; it loses the copperas taste, and becomes insoluble in water. This process, if kept in mind, will explain many phenomena important to the agriculturist.

384. Few persons residing in regions where the soil or subsoil is yellow, can have failed to notice, that the yellow mud, when kept wet for a length of time (especially in the warm season)—as for instance, in a deep mudhole—will assume a blue tint in its lower portions; the wagoner wisely avoids the spots where the wheels of some predecessor have brought up mud of this hue, because it is a sure sign of a "bad place." We have here the opposite of the process which takes place in copperas dying; the iron *yellow* has been transformed into *blue*, by the influence of fermenting vegetable matter, in points where the air had little or no access. It will also be observed, that plants will not grow well where the soil retains this hue—they wither or become rusty. Water flowing from such spots, will deposit iron rust, like copperas water itself Now, every one knows how deleterious copperas water is to plants; and the same is true of the water which collects on such spots; the protoxide of iron which it contains, however, is dissolved in *carbonic* and vegetable acids, instead of sulphuric acid; the former being the product of the decay or fermentation of vegetable matter, and present in all soils.

385. Wherever water remains stagnant *on* or *in* soils for any length of time, this process takes place, and where this happens, plants—at least those we cultivate—will not thrive. And although the corrosive action of the solution of iron thus formed is but rarely the *only* cause which, in such spots, acts injuriously to plants, its formation is an unfailing *symptom* of a *want of proper drainage.* It frequently happens in level branch bottoms, that the whole of the soil has a bluish tint; such soils invariably rust cotton, and are often considered naturally unproductive. The remedy, however, is simple enough: correct the drainage of the land, and then turn up the soil as deep as may be practicable, according to circumstances; but instead of planting it at once, *fallow* it for a season or two. The bluish tint will be found to disappear rapidly under the influence of the air (which transforms the protoxide into peroxide) and when it is gone, the land will often times be found to be more productive even than adjoining tracts in which, originally, no such tint was perceptible. Those who clear and cultivate bottom land, will scarcely fail to recollect having met with instances of this kind in their experience. The beds of sloughs, which in after years generally become the most fertile portions of the fields, will not produce as freely at first; but they will become productive more rapidly in proportion as the soil is loosened and aerated more frequently; they require fallowing at the very outset.

386. It is commonly observed, that even in lands where the subsoil is very deeply tinged with iron, the surface soil is almost always of a lighter tint; hence the conspicuous "red washes" so frequently formed in fields, where the surface soil has been washed away. This difference in color is owing, in some degree, to the presence, in the surface soil, of dark colored vegetable matter, which covers the iron tint; but very generally we also find a smaller *absolute* amount of iron in the surface soil than in the subsoil; as will be seen by the table of analyses, in the Claiborne County Soil, Pine Hill Soil, and Soil from Summit, as compared with their subsoils. It seems, therefore, that this process, which we observe to be going on in all badly drained soils, with a considerable degree of

energy, takes place at times, more or less, in most or all soils, when, in long wet seasons, they are temporarily in an undrained condition. Nevertheless, we find an exception to the rule above referred to, in the case of the soil and subsoil of the Marshall County Table lands (see table No. 2) in which the surface soil is richer in iron than the subsoil; a proof of the perfect natural thorough-drainage of some of these soils.

387. *Bog Ore, or "Black Pebble."*—When light and open soils possessing a porous subsoil, underlaid, in its turn, by denser strata, are placed under conditions like those referred to above, an effect is produced which is very familiar in some regions of this State, and of which examples on a small scale may be found in most neighborhoods. Soils of the character just mentioned, being but very slightly retentive of soluble matters of any kind, will allow any solution of iron formed in it to sink, until it reaches a denser stratum, where it is retained and gradually forms bog ore or "black gravel," while the surface soil, being deprived of its coloring elements (iron, as well as vegetable matter), becomes light gray or almost white, in strong contrast to adjoining bodies of well drained, yellow loam land. It is probable that this process of lixivation extracts from the soil other and more valuable ingredients (*e. g.* phosphoric acid), besides the iron and vegetable matter, and it is, perhaps, for this reason, that these white or "crawfishy" soils are, with few exceptions, less productive than those from which they were formed by the combined action of vegetable matter and stagnant water. The difference is plainly exhibited, in most cases, by their natural vegetation, which, though otherwise widely distinct in different localities, possesses one element of almost constant occurrence, to-wit: stunted Huckleberry bushes. The Flatwoods of N. E. Mississippi, and the bottoms of South Mississippi, often exhibit examples of this kind on the large scale. Some soils of this character are, nevertheless, very productive when properly drained and supplied with vegetable matter; and in many cases which have come to my knowledge, the application of *lime* to them has proved extremely beneficial. As yet, however, no analyses of this class of soils, from which their characteristics could be deduced, have been made.

388. From the foregoing considerations, it will be apparent how great is the importance of thorough drainage in lands strongly charged with peroxide of iron, or iron rust, as are a large portion of the best uplands of the State. Not only are the solutions of iron, so readily formed in such soils when undrained, a positive poison to plants, but, while the partial withdrawal of iron alone would be no disadvantage to the soil, the process upon which its solution depends, drafts largely upon that important ingredient of the soil, its humus or vegetable matter; as well as, probably, upon several other important elements, and among these, especially upon the Phosphoric acid. The "black pebble" or bog ore, which owes its formation to this process, is well known to be particularly rich in the latter substance—for which reason, though unfit for the manufacture of malleable iron, it is preferred for such metal as is to serve for fine castings.

389. *Chalybeate Springs.*—A phenomenon dependent upon the same cause, intrinsically of much less importance, but which has frequently attracted attention and excited curiosity in this State, is found in the diminution or disappearance of the mineral ingredients of chalybeate springs, so soon as the spots on which they were situated were "improved," or the springs themselves cleaned out. The ferruginous sands of the Orange Sand formation (¶10) give rise to a great number of chalybeate springs (¶75), many of which have no other origin than this: that the decaying vegetable matter collected in depressions of the surface, heads of hollows, etc., or even in the basin of the spring, effects the transformation above referred to, *i. e.* of the insoluble iron rust into soluble carbonate of the protoxide, which passes into the spring water, rendering it chalybeate. It follows as a matter of course, that so soon as the vegetable matter which causes this transformation is removed, the water must lose its mineral ingredients. This, however, can only happen to superficial springs,

and never occurs with the springs derived from the lignitic eocene, or the lower cretaceous formation.

390. *Formation of Rock.*—There is another effect, due to the same cause, which is frequently observed in the territory of the Orange Sand formation; I mean the gradual induration, or transformation into rock, of strata of sand (¶11) or sandy loam, which have been quite soft within the memory of the inhabitants. When water charged with the carbonate of iron, formed as above mentioned, percolates through strata of sand or gravel, it may come in contact with so much air, contained in the pores of the mass, that its protoxide is reconverted into the yellow peroxide, which adheres to the grains of sand and gradually cements them together into a rock. This takes place more especially, when the iron solution reaches a seam or layer of clay, which prevents it from sinking deeper; a sheet of ferruginous sandstone is then formed on top of the clay. This process may be seen in progress by an attentive observer in almost any region where the Orange Sand prevails, and from the fact that almost all the ledges of ferruginous sandstone found in this formation, are underlaid by a stratum of clay, we may justly conclude that most, if not all this rock has been formed, originally, in a similar manner (¶11).

391. NOURISHMENT OF PLANTS.—Before entering upon the consideration of the subject of manures, their several kinds and mode of action, it may be well to recapitulate briefly the general, well-established principles of vegetable physiology, without a knowledge of which, it would be impossible to appreciate correctly the bearing of the analyses given below, and to apply to practice in each separate case, the results they contain.

392. *Constituents of Plants.*—Most plants, and all, or nearly all, of those which are the subject of the farmer's care, require the same ingredients to be supplied to them from the soil and the atmosphere, viz: those which have been briefly characterized in the preceding pages, with the sole exception of *Alumina* (¶374), which is not often contained in the ashes of plants (provided they have been thoroughly cleansed of dust, etc., before burning). *Fluorine*, also, is a very subordinate ingredient, and frequently wanting.—From among the rest, Carbon, Hydrogen, Oxygen and Nitrogen, or rather their combinations, may be, and are for the most part, derived from the air, as has been stated (¶361); while the rest of the ingredients required (which are contained in the ashes) are derived from, and must therefore be present in the soil, to support a healthy development of vegetable growth. And experience further proves that if only a *single one* of these ingredients be absent or insufficient in quantity, the presence of all the rest will be unavailing to render the soil productive. To a limited extent, some of these ingredients may be replaced by others of similar chemical character, *e. g.* Potash and Soda by each other and by Lime and Magnesia; Iron by Manganese, etc. Such replacements, however, always cause differences in the mode of development of the plant, and in the quality of the crop. Cultivated plants in particular possess a wider range in this respect, than do those retaining their natural state; and the consequent adaptability of the vegetables constituting our crops, to a great variety of soils, is a feature of the highest importance to the agriculturist.

393. *Rotation.*—While, therefore, all plants require nearly the same ingredients so far as their *kind* is concerned, each one requires its own peculiar *proportion* of each of them—varying, in most cases, between narrow limits only. Hence it is that, when a soil has been apparently exhausted by the frequent repetition *of one and the same crop*, it may still be quite productive of *another*, which finds remaining in the soil a sufficient quantity of available nourishment in the proper relative proportions required for *its* growth. During the season in which the soil has been occupied by the latter crop, the action of the atmosphere may have set free and rendered available, a fresh supply of nourishment heretofore "locked up" in the undecomposed minerals of the soil (¶356), and in the proportions suitable for the first crop; which may now again succeed. This

is the rationale of the good effect of the Rotation of Crops.—But rotation *alone*, as these considerations show, is not in reality an improvement of the soil; on the contrary, it is but a systematic method of *exhausting it to the best advantage*. Eventually, it will cease to be effective; and thereafter, crops will be dependent altogether upon *Manures*—"No manure, no crops"

394. *Order of Rotation—Analyses.*—Experience has, in a great many of the crops long known, demonstrated the proper order of succession for certain kinds of soil. The same will not, however, always hold good in reference to other soils, of a dissimilar, or unusual constitution; and from a disregard, or want of knowledge of this fact, many disappointments, and a great diversity of opinions on this subject has arisen. In many cases of this kind, comparative analyses of the soils as well as of the crops in question, have plainly shown, not only the cause of the anomaly observed, but also the remedy, by indicating the proper order to be followed.

With respect to crops of modern date, Chemical Analysis has done the same thing, or *can* do it where it is not already done. The crops most important to the Southern States, are still in want of a thorough examination in this respect; to give which I consider, not only as one of the legitimate, but also, as one of the most important objects of the Agricultural Survey.

395. Analyses of Soils, Crops and Manures.—Analysis teaches us, what are the *kinds* and respective *quantities* of the ingredients contained in crops, soils and manures. It teaches us, therefore, which of the latter two will be best calculated to promote the successful culture of the former; a knowledge to obtain which by mere experimenting, would require a disproportionate amount of time and labor. It has already been stated, that the absence of a single one of the ingredients necessary for the growth of a plant, renders unavailing the presence of all the rest. Unless we are taught, by analysis, *which* is the ingredient—or ingredients—of which there is a deficiency, we shall be compelled, in order to be safe, to add *all* of them, at great and unnecessary expense; for it will be of no practical advantage to have added an additional supply of those of which there was no lack.

396. *Analyses of Soils.*—The importance of reliable analyses of crops, soils and manures, is, therefore, obvious enough. Yet the mere *presence* of any useful ingredient in a soil, or manure, as demonstrated by analysis, does not yet assure us that it is present in an *available* condition, so as to be ready for absorption by the plant; for the agents which the chemist uses in the laboratory, are much more powerful than those placed at the command of vegetables by nature. In the course of a few hours or days, we can abstract from the soil all those ingredients which, in the ordinary course of fallowing pursued by nature, it would have required centuries to bring into action (¶368); thus far, therefore, mere ultimate analyses are not a direct indication of the producing powers of the soil.

397. This consideration becomes of most serious moment, where the rocks from which the soils are *originally* derived are in close proximity, so that a large amount of undecomposed material may be supposed to be very *unevenly* diffused throughout the soil. It will be less so, when the minerals constituting the several soils have been transported to a great distance and become thoroughly intermingled and comminuted; as is mostly the case in Mississippi.

Yet still, the determination of the available portion of mineral nutriment contained in the several soils, is of great importance, and it is intended that it shall be made in every case of soil-analysis, so far as the means we possess of imitating the operations of nature in this instance, will allow; want of suitable arrangements alone having prevented their being made as yet, with reference to the analyses thus far executed. Yet even without these determinations, the soil-analyses afford us a safe basis for our operations. For since, in all the soils of Mississippi, the component minerals (except quartz) are in a very finely comminuted condition, we know that when ultimate analysis shows the nutritive elements to be present in notable quantities, they can be "brought out," or rendered available to plants, by stimulant manures; and that the soil can be improved by fallowing.

On the other had, when analysis shows one or several ingredients to be scarce or absent, we know that those ingredients require to be added; while the rest, if abundantly contained, may be developed by stimulants, and need not be supplied from without, for the present. And if analysis, finally, shows a soil to be absolutely poor from the outset, in all, or most nutritive ingredients: we shall thereby know that fallowing and stimulants will be of little use, and that we must use stable manure, or its equivalents.

A glance at the table of analyses (No. 2) will show that so far as the analysis of Mississippi soils has progressed, there is a very close and obvious correspondence of their fertility as ascertained by experiment, with the respective amounts of the most important ingredients they contain, as shown by the analyses—which are comparable amongst themselves, inasmuch as the soils were treated, as nearly as possible, in precisely the same manner (see preface).

398. The *analysis of crops*, *i. e.*, the determination of the kind and quantity of the mineral ingredients which they withdraw from the soil, is at least equally important with that of soils themselves. It informs us directly *what* and *how much* the soil has lost in cultivation, and thus enables us to select judiciously the most economical mode of replacing the drain; provided, of course, that the composition of the fertilizers at our command be also known to us. It is not enough, however, in these investigations, to examine single specimens of each crop, for, as has been stated (¶392), there are several ingredients which can, to some extent, replace each other, and it is of the highest interest to determine the extent of these variations, the circumstances under which they occur, and the influence they exercise on the quality and quantity of the crops. And in order to render the results positive and comparable, it is further to be desired that in these analyses, as in those of soils, the *same*, well-devised methods should invariably be employed.

399. *Analyses of Southern Crops.*—The analyses which, thus far, we possess of the different parts of the cotton plant, are so utterly discrepant amongst themselves, as given by different observers, that it is hard to form from them any definite idea concerning the character of the plant—which is either susceptible of variations in an extraordinary degree, or has been sadly misrepresented in results obtained by some analists, without the extreme care requisite to insure correctness in this difficult department of analytical chemistry.—Of corn also, the analyses are thus far few, and widely discrepant; in this case, however, the extraordinary adaptability of the plant to a great variety of soils and climates would seem to render a wide range in chemical composition more likely, than it is with reference to cotton. The other crops usually raised in the South, have received still less attention.

400. Physical Constitution of Soils; Means of Modifying it.—The productiveness of soils is not, however, dependent alone upon the presence and available condition of the substances which form the nourishment of plants. It is also necessary that the soil should have the proper *physical constitution*, viz: that it should be *neither too "heavy" nor too "light;"* and that under all circumstances, it be *properly drained.* In either of the two first mentioned cases, crops growing on it will be liable to injury by *drouth*, and in the case of a "heavy" soil, by excessive *wet* also; while a certain intermediate character of the soil renders the crops comparatively safe with reference to either of these influences. I need hardly mention, that the former fault ("heaviness") is usually caused by an excessive admixture of clay with the soil, while its opposite ("lightness") is due to an excess, either of sand, or of some other substance which breaks up the continuity of the clayey portion, such as undecayed vegetable matter, "black pebble" or bog ore, or the undecomposed detritus of rocks.

It is a matter of the highest importance, that the soil be sufficiently porous or "open" to admit the air freely, in order that the carbonic acid, ammonia and moisture which it contains, should have access to the roots of the plant; yet again not *so* freely as to allow the frequent and rapid changes of moisture, temperature, etc., to affect the roots of plants. All these changes are so tempered by a soil of the proper physical constitution, that only a long continuance of the same condition of the atmosphere will sensibly affect vegetation.

401. *Light or Sandy Soils* —The *clayey* portion of soils is highly attractive and tenaciously retentive of moisture, [rivaling in this respect some of our most powerful chemical agents (¶378)], and of the nutritive ingredients of plants, when in a soluble condition. Vegetable matter, such as is usually present in soils, possesses similar properties; while sand is but very slightly endowed with this quality, even when very fine. This peculiarity is well pronounced in the determinations of the absorbent power of soils, which will be found accompanying the analyses. Compare, in this respect, the amount of moisture absorbed by the sandy soil of the Chickasaw Flatwoods (No. 165, ¶572), and that of the Pine Hills soil (No 206)* (both soils almost destitute of vegetable matter also), with the heavy clay soil of the Pontotoc Flatwoods (No. 230, ¶571) on the one hand. and with the sandy Marsh soil from Pascagoula (No. 215)† on the other. The last named soil is a very sandy one, but it contains nearly 20 per cent. of vegetable matter; the former (No 230) is almost void both of sand and vegetable matter. Both the latter possess a strong attraction for moisture, as shown by the respective percentages of hygroscopic moisture (9½ and 15½ per cent); while both the former will readily surrender to a dry atmosphere all the moisture they may contain (2 and 2½ per cent.), beyond a mere pittance, inadequate to the support of vegetable life.

402[1] *Heavy Clay Soils* —Such is the main disadvantage of soils of excessive lightness. When, on the other hand, there is a great excess of clay in the soil, disadvantages not less serious will arise. In the case of drouth, such a soil will shrink and crack open, thus not only exposing parts of the roots of plants to the dry atmosphere, but even mechanically injuring them.

But perhaps the greatest evil to which such soils are liable in this case, is the circumstance of their substance becoming so dense, that no access of air to the roots can take place, thus excluding from them both the ammonia and the carbonic acid of the air, so necessary to the nourishment of all plants; while at the same time, the stony hardness which the material sometimes acquires, forbids the further development and expansion of the delicate rootlets which the plant sends forth in all directions, in search of nourishment. Thus, of course, the whole organism is paralyzed in its action, languishes and finally dies.—And all these phenomena will take place equally, whether the soils be in themselves fertile or not; save that a strong, healthy plant, grown in a productive soil, will naturally resist longer than another, grown in a medium or poor soil.

Thus, for instance, the physical constitution of some of the Monroe prairie soils is scarcely less objectionable than that of the heavy soil of the Flatwoods; yet the respective average crops are much oftener made in the rich prairie soil than in the second rate (so far as its *chemical* constitution is concerned) soil of the Flatwoods, because the vitality and capacity of resistance of plants grown in the prairie region is much greater than in the other case.

402[2] In case of excessive *wet*. such soils are no less troublesome. The great difficulty encountered in tilling them during seasons of either wet or drouth, is too well understood to require discussion; yet it is precisely in such soils that tillage would be most necessary in such seasons. For if, as has been observed above, excessive *dryness* of the soil closes it effectually against the access of air (except in the *cracks*, where there is too much of it), such is no less the case whenever they are saturated with water. Light and "warm" soils, even when

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*See "Long-leaf Pine Region."

†See "Sea Coast Counties."

wet, still permit some access of air to the roots; but when a heavy soil remains wet for a length of time, the complete exclusion of the air from its lower portion too often becomes evident from the appearance of the fatal blue tint, due to the reduction of the peroxide of iron to the protoxide (see above, ¶384, ff.); in consequence of which, rust and blight soon perform their work.

403. *Cultivation of Heavy Soils.*—It is manifest, from the above considerations, that in heavy clay soils, *deep and frequent tillage* is pre-eminently desirable as tending to temper all of the disadvantages referred to, by approaching their physical condition to those of lighter soils. But not only does the work of plowing naturally require more power in heavy soils, but the number of working days throughout the year is necessarily smaller. The profitable cultivation of such soils, therefore, requires a large laboring force, and "intense culture" on an area comparatively small; for with shallow and insufficent tillage, the frequent failure of crops on heavy soils becomes ruinous; and in no case is the folly of cultivating too much land (¶480) more strikingly exhibited, than when we have to deal with heavy soil.

404. *Heavy Siliceous Soils.*—In some instances, "*stiff*" soils are formed, even in the absence of any considerable quotum of clay, when a very large amount of finely divided siliceous matter is present, which when wet, packs very closely, and renders the soil difficult to work; when dry, it is sometimes almost powdery, at others, when drouth follows a very wet season, it will form a very hard surface crust. Such soils are not very common in the State, though sometimes quite prevalent in bottoms, in the southern portion, and characterized by the prevalence of the Dwarf Palmetto, among a stunted growth of bottom oaks. They are complained of as being "cold," "stiff" and "working like putty;" clogging the plow very much, even when moderately moist.

These soils, notwithstanding their "heaviness," are but very slightly retentive of either moisture or manure, and suffer severely from drouth; and also from long prevailing wet weather, in consequence of the impossibility of tilling them while wet. Thorough drainage is, therefore, a very important step in their reclamation, and next to it, the addition of coarse sand and vegetable matter is indicated, in order to relieve the compactness of the material, and to increase its retentive power. Many of the white soils mentioned (¶387) belong to this class.

405. A great many different classifications of soils have been introduced by different writers, suited, more or less, to the soils of particular districts described by them, and based on differences partly of chemical, partly of physical constitution. But so innumerable are the modifications, and so insensible the transitions which occur, that special classifications, thus far, are necessarily very arbitrary, and useful chiefly with reference to particular regions. I shall not, for the present, refer to more than one other general class of soils frequently mentioned by agricultural writers, viz; that of "*acid soils;*" although, its distinctive feature being really of a chemical nature, it properly belongs under a different head.

406. *Acid Soils.*—This class has often been defined as being characterized by an excessive *amount* of vegetable matter; but this criterion will not hold good; the peculiarly acid soils of the Gallberry Flats of the Coast, for example, are poor in vegetable matter as well as in everything else, except sand. Their peculiarity is to be sought rather in the peculiar *condition* of the vegetable matter they contain, which consists partially or wholly of soluble *Crenic*, *Apocrenic*, or similar acids (such as color the water of marshes, etc.; ¶440, ff.), instead of insoluble humus—in consequence of the decay having taken place in the presence of a large amount of water, and with but little access of air; or sometimes, as in the Pine Barrens, in a soil very poor in "basic" constituents (potash, soda, lime, magnesia). The mode of formation of these soils, their peculiarities, and the remedies of their faults, will be found more fully discussed in another place (¶539, ff).

407. Drainage.—This has been mentioned above as being one of the essentials

of a proper physical constitution, with all kinds of soil. Yet its importance is very much underrated, thus far, by the agriculturists of our State, and even where its intrinsic value is acknowledged, it is very commonly considered as being "too expensive an improvement" for the present condition of things.

This may be a sound objection in the case of the squatter, who intends only to skim off the cream of the soil, and then move westward for more; but it can hardly be considered rational even now, with those who mean, in general, to cast their lot with the community where they reside, and to enjoy the general improvements, and the comforts and blessings of civilization, towards which every individual member of a commonwealth contributes his share of money, labor and trouble—which share he is compelled to contribute over again, each time that he shifts his citizenship to the westward.—There are few chapters in statistics which offer a more curious comment upon human nature, than would an estimate of the three items above mentioned, annually spent in the Southwest in "*moving*," on the plea that the improvement of the old lands will not "pay;" or the money lost in poor crops for want of a little deeper tillage, or drainage, which might have rendered them bountiful. Certainly, of all last expedients in agriculture, that of submitting to poor crops will "pay" least.

408. *Effects of Drainage*.—The advantages of drainage are not confined to land which is absolutely *wet*, in the ordinary acceptation of the term; though in these it is the most needful, and the first step towards rendering them anything more than a lottery, from which the agriculturist draws at least as many blanks as prizes. Its beneficial effects will be experienced in all those soils, in which water can remain stagnant, at any time, at a less depth than three or four feet beneath the surface.

The necessity of access of air to the soil and roots of plants has already been dwelt upon (¶361, 402). Now it is evident that such access cannot take place, and the roots will not penetrate, where the soil is saturated with water. Like shallow tillage, want of drainage compels the roots of plants to remain near the surface of the ground, where they are not only greatly exposed to all the vicissitudes of the weather, but are also compelled to seek their nourishment within very narrow limits. And in this we find the explanation of the fact, which at at first appears to many to involve a contradiction in terms, viz: that while drainage is obviously a safeguard against excessive *wet*, it is so likewise against *drouth*. It loosens and aerates the soil and subsoil, in such a manner that the roots of plants are enabled to penetrate deeper; to strata which are rarely or never sufficiently affected by drouth to allow of injury to vegetation.

409. But it is not moisture alone which the plant seeks and finds in the lower strata; it also receives from them an additional supply of nourishment, which would otherwise have remained inactive--because the roots as well as the fallowing action of the atmosphere (¶357) would not have penetrated there. Hence drainage subserves, in a great degree, the purposes of subsoiling. It even exercises the *mechanical* action of tillage in this, that the more frequent alternations of wet and dry, which are thus effected in the soil and subsoil, serve to break up and pulverize them in the same manner that we see even the hardest clays speedily cracking and falling to crumbs, when exposed to the weather.

410. *Drainage of Clay Soils*.—The observation just referred to will explain the fact, at first disbelieved by many, that even heavy clay soils can be successfully *under*drained, and that their tillage is rendered much easier in consequence of the operation. The water which in their ordinary condition, remains in them and renders them tough and plastic, is afforded an opportunity of escaping through the drains; in consequence, the whole mass of the subsoil shrinks and splits, so as to be traversed by numerous fine fissures, which allow the water to percolate with ease. It is manifest that this must greatly facilitate the deep tillage (¶403) so necessary in such soils.

411. *Drainage Warms Soils*.—The broad statement, however, that draining prevents injury from wet, hardly does justice to the many positive advantages

it affords in this respect, even outside of unusually wet seasons. In the ordinary condition of soils, about one half of the rain water only reaches the water-courses; the rest is returned to the atmosphere by evaporation from the soil. This evaporation consumes an enormous amount of heat, which the solar rays must spend simply to get rid of the surplus water, before they can begin to warm the soil for purposes of vegetation. When, however, this surplus water is carried off by drains, the soil is at once prepared to be warmed, by the first sunshine it may receive. It is very obvious then, why drainage renders soils so much "earlier," "warmer," and "safer."

412. *Advantages of Drainage in Manured Lands.*—There is still another point, which is of considerable importance whenever, in unretentive soils, liquid manures, or such as contain a good deal of easily soluble ingredients, are employed. It is obvious that the higher is the column of soil through which the solution filters, the more effectually will the nutritive ingredients be withdrawn from the latter (¶378, ff.); if the soil is very shallow, the solution which has passed through it will still retain a large portion of its ingredients which are then gradually absorbed by the subsoil. If the latter be hard, or drenched with water, the roots of plants will not penetrate it, and thus a large portion of the manure will be lost, when it would all have been deposited within reach of the roots in a *deep* soil, such as always results from drainage.

Such are the chief advantages which drainage secures *within* the soil, in its relations to the crops; and their importance, as will appear from the foregoing considerations, is such as to render intelligible in some measure, the enormous increase of productiveness which is so often observed after thorough-drainage.

413[1] *Drainage Prevents Washing.*—Among the external effects of this improvement, the most important perhaps is its tendency to *prevent the washing away of the soil*, as well as of manures, by the great diminution of the surface waters which it causes.—The injury produced by the latter does not consist alone in the absolute removal, *in mass*, of the arable stratum, but also in this, that the finest particles of the soil, upon which the fallow exercises its most energetic action (¶357), are thus carried off by preference, forming the fertile bottom soils, greatly at the expense of the uplands. This fine portion of the soil is, of course, retained, when the water, instead of running off from the surface, is filtered through the soil to the drain, from which it issues perfectly clear.

413[2] The improvement in the general health of districts where drainage, and particularly underdraining, has become general, is not among the least noticeable advantages which have followed its introduction in numerous cases.

It could hardly be proper, in this place, to enter into the detail, or to discuss the merits, of the several methods of drainage. I regret that want of space precludes me from appending at the end of this volume, some special considerations of this part of the subject, in accordance with a desire for information which I have frequently heard expressed. For a most thorough, lucid, and pleasantly written treatise, embracing the theory as well as the practice of Drainage, I refer the reader to the work of Maj. H. F. French, lately published.*

414. CONDITIONS OF PRODUCTIVENESS OF SOILS.—We have defined above two classes of conditions required to be fulfilled in order to render a soil productive, to-wit: firstly, the proper *chemical constitution*, or the presence of the mineral ingredients required by plants, in an available condition; secondly, the proper *physical constitution*, *i. e.* not being either too light or too heavy, but of that medium character which the planter terms "warm"—an exact definition of which it would be difficult to give, but which, fortunately, we can abundantly illustrate by examples from our favored State. The bottom soils of North and Central Mississippi; the table-lands of North Marshall and Tippah; the

* "Farm Drainage," by Henry F. French; New York, Saxton, Barker & Co., 1860.

Pontotoc Ridge lands, including the "Buncombes" of Tippah; the yellow loam lands of the two ranges of counties bordering upon the Mississippi bottom; most of the lands of that mighty bottom itself; those of the Southern River Counties, and finally, the hommocks of the Sea-coast, furnish examples familiar to all. The extremes of heavy and light, or clayey and sandy soils, are on the whole much more prevalent in the eastern, than in the western half of the State.

415. When soils are defective in regard to either of the two classes of conditions just mentioned, we must correct them by artificial means. These may consist either in the *operations* of draining, tillage, subsoiling and the like, which we have already discussed; or in the application to the land of *substances* corrective of the defect in question; which may, in a very general sense, be comprehended under the term of MANURES.

B. MANURES.

416, *Classification of Manures.*—Of these, we have two different classes: *Mechanical manures*, or such as correct the *physical constitution* (lightness or heaviness) of the soil; and *Chemical manures*, or such as are intended to correct the *chemical constitution* of soils.—Of the latter again, we must distinguish two kinds, essentially different both in their nature, and their intrinsic value, viz: *Stimulant* manures, or such as merely render *available* the nutritive elements *previously contained in the soil*, and aid in their rapid transfer to vegetable organism; and manures *proper* or *Nutritive* manures, which add to the soil one or all of the ingredients required by the plant for absorption into its fabric.

417. Important and well defined as these distinctions are theoretically, it is, nevertheless, but rarely the case, that in practice we apply materials exclusively with a view to *one* only of these three effects. On the contrary, it ought to be our aim to combine all three together, whenever we can. But it is none the less important to know and distinctly understand, which of the ends is *chiefly* served when we use the several materials offered to us in practice, and more than this, *of which of them our land is most in need.* These are the questions which it belongs to an Agricultural Survey to answer.

1. MECHANICAL MANURES.

418. With reference to the first class, the *mechanical* manures, little need be said, inasmuch as it will but rarely "pay" to haul mere arid sand, to improve clay land, or sterile clay to improve sandy land. It is not unfrequently the case, however, that by a little management, we can make nature perform the work for us, by so regulating the drainage, that it will tend to intermingle the opposite extremes of soil Such is the case with large tracts of bottom land, which may be much improved in their physical conditions by properly diffusing over their surface the washings of the bordering hills. Heavy, cold bottom soils, like those of parts of Pontotoc, Chickasaw, Calhoun, Choctaw, Oektibbeha and Kemper, are very much improved by intermixture with the sand from the hills; provided only, that these sands be not allowed to accumulate in one spot or channel, but be to some extent evenly distributed over the surface, by occasionally changing and distributing the channels of deposition; after which, tillage will complete the mixing.

419. Striking examples of the benefit accruing from this source, may be observed in the small strips of tertiary prairie, occurring in Scott, Smith, Jasper and Wayne counties (¶198, ff.), and bordered by sandy hills, which in themselves are by no means fertile. Here, the prairie soil, as usual, is very heavy and "sobby," and though in favorable seasons it will yield heavy crops, unfavorable circumstances will easily cause a total failure. This evil, however, is found to be corrected, and a safe crop insured, wherever the washings from the hillsides have intermingled, in a moderate proportion, with the heavy prairie

soil. The hills wash very freely, and this circumstance is now complained of by the planters; whereas it might be a real blessing, if, instead of allowing the sand to accumulate, and cover over altogether some of the best lands, they would take the trouble of diverting the water a little from its usual channel, slanting to the right and left, which would spread it evenly over a large surface. In truth, in locations as favorable as these for such a purpose, it might be remunerative for planters to aid nature with a cart or two, during the time when their field hands are almost unoccupied.

2. CHEMICAL MANURES.

420. VEGETABLE MATTER, AND "HUMUS."—Thus far, in speaking of the nourishment of plants, I have alluded only to the fixed mineral ingredients, which they derive from the soil, and to those which, being derived from the atmosphere, return to it in a gaseous condition when vegetables are burnt; while the vegetable matter, contained in most soils, and usually considered not only as a *sign*, but even as the *cause*, of fertility, has only been casually mentioned. As it is indispensable, that we should understand the true value and mode of action of this portion of the soil, if we would use manures correctly, I shall premise what may be necessary in this respect, before speaking of manures specially.

421. Experiments have shown conclusively, that the carbon which plants contain, and which forms the basis, as it were, of their vegetable substance, is derived from the air, and *not* from the soil. It has been shown, that plants *can* grow in soils absolutely void of vegetable matter, provided only that these soils contain the mineral ingredients required by the plant, in a *soluble* state, or at least, in such a condition, that they shall be *accessible* to the vegetable organism (¶357).*

422. The latter condition, however, we do not often find fulfilled in soils in their natural condition. It has been stated above, that only a part of the sum total of nutritive ingredients present in the soil, is usually in an available condition, the greater part being "locked up" in the undecomposed or partially decomposed minerals, and but very gradually set at liberty by the action of the atmosphere.

This very action is due chiefly to the carbonic acid contained in air, and will of course be the more powerful and rapid, the more carbonic acid is present. Now, carbonic acid is continually formed in the process of decay of vegetable matter, such as is constantly in progress in soils containing the same; in such soils, therefore, the nutritive mineral ingredients are being made available more rapidly than would be the case, were no vegetable matter present in them, and were the decomposing process left to be performed by the carbonic acid of the air alone. In this respect, vegetable matter must, therefore, be classed among the *stimulant manures*, as above defined (¶416).

423. *Properties of "Humus."*—There are, however, other highly important offices in vegetable economy, performed by this class of constituents, and more particularly by the (somewhat indefinite) substance, now familiarly known as humus, or vegetable mold. One of these—its retentiveness of moisture—has already been mentioned; it serves as a corrective, in this respect, for light, sandy soils; while on the other hand, it renders heavy clay soils less compact and stiff. Yet there is still another virtue possessed by humus, more important than either of the two just referred to; it is its power of absorbing *ammonia* from the atmosphere, thus fixing in the soil this important stimulant as well as nutritive

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*I have generally, in the text, used the word "available" in preference to "soluble," because the former involves no unproved theory concerning the peculiar condition of the portion of the soil in question; which is certainly not *soluble* in the ordinary acceptation of the term (¶378).

ingredient, ready to be delivered to the roots of plants, whenever called for.

424. When we consider the great importance to vegetable economy, of the properties of humus just referred to, it cannot be surprising that its presence should, as a general rule, exercise an influence so decidedly favorable on the productiveness of soils. Yet it is incontestably true, that humus alone, without mineral matter, will not support vegetable growth; while on the other hand, examples of very fertile land almost destitute of humus are common, and particularly so in our own State. The fertile "red lands" of Pontotoc and Chickasaw, for instance, and some of the best yellow loam lands of Holmes, Madison and Hinds, are so poor in vegetable matter, as to render its amount almost inappreciable; and yet these lands are justly considered as being among the best upland soils in the State. It is nevertheless true, that a perfectly healthy development of cereals or any useful cultivated plant, is rarely attained in soils destitute of humus.

425. *Clay a Substitute for Humus.*—It will be observed, however, that only soils containing a considerable amount of *clay*, can be permanently fertile in the absence of vegetable matter. We must conclude, then, that clays must, to some extent, possess the same properties as humus; and such, in fact, experiment proves to be the case. It has been stated above, that clays are powerfully retentive of moisture; and in like manner we find, that clays will absorb *ammonia* from the atmosphere—not to the same extent as humus, it is true, but still sufficiently for the purposes of vegetation (¶378). The presence of humus or vegetable matter, therefore, is more essential to sandy soils than to those of the opposite character; to both, however, it is highly beneficial; for it must be borne in mind that while clay may replace humus so far as its retentive and absorbent powers are concerned, it does not exercise the stimulant action resulting from the decay of vegetable matter (¶422).

426. *Green Cropping.*—It must be recollected, that inasmuch as all vegetable matters ordinarily at the disposal of the agriculturist, contains fixed mineral ingredients (*i. e.*, ashes), their application to the soil is useful not only with reference to the formation of humus, but also as introducing into the soil important nutritive elements. If the vegetable substance thus used has *not* been obtained on the same soil, we shall thus *add* to the stock of fertility; but when, as in the case of turning down green crops, the material used has *itself been raised on the soil*, then in reality we add nothing to the latter except the vegetable matter itself, which in its decomposition forms humus, and has been derived from the air. At the same time we thus return to the soil *in a more available condition*, the mineral ingredients which the crop *obtained from it*. In both these causes united, we have the rationale of the good effects which follow the procedure in question. We must remember, however, that this is merely a *stimulative* process; and that it can be practiced only at the expense of diminishing the *duration* of fertility—being eminently exhaustive.

427. AMMONIACAL MANURES.—It may be proper to introduce in this place, some considerations on the subject of *ammoniacal* manures, such as now occur in commerce under various denominations, such as "ammoniated guano," "ammoniated marl," etc.; together with the impure sulphate of ammonia, which is now manufactured on the large scale, for agricultural purposes, from the offal of the manufacture of coal gas. For the present, I shall speak of the effects of ammoniacal salts alone, independent of any substances with which they may have been mixed. Ammonia (¶361) is necessary to the *nutrition*, properly speaking, of plants. It is absorbed into the vegetable organism both through the roots and leaves, and serves for the formation of the nitrogenized substances contained in plants, such as gluten, vegetable albumen, casein, etc. Whether plants are capable of assimilating directly the nitrogen of the atmosphere for this purpose, is still an open question; although it appears most likely that they cannot, and are dependent upon ammonia alone for their supply of nitrogen.

428. *Stimulant Action of Ammonia.*—Beyond this, however, ammonia possesses in an eminent degree, the property of *stimulating* soils, or, in other words, of rendering available to plants in a short space of time, a large supply of mineral nourishment. Not only is it powerfully active in the process of decomposition of rocks, in a manner analogous to carbonic acid; but it (or rather its *salts*—combinations with acids; ¶361,—also possesses the property of dissolving a number of substances insoluble in either pure water or carbonic acid, thus rendering them immediately available to plants.

Ammoniacal salts, when applied by themselves, are therefore highly exhaustive of the soil, though, for the time being, they may enable it to produce heavy crops. On the other hand, when applied at the same time with other, *true* manures, ammoniacal salts are to be highly recommended, as rendering the manure most rapidly effective.

429. *Leaf-Producing Powers of Ammonia.*—Experience seems to prove, that as a general thing, the presence of an abundant supply of ammonia in the soil is pre-eminently favorable to the development of the *leafy* portion of plants, and is, therefore, particularly beneficial and important during the period prior to bloom and fructification, in which the development of the leaf and stalk takes place. An abundant supply of ammoniacal manure in the early stages of vegetation, is calculated to insure a good and vigorous "stand;" while on the other hand, an over-supply at a *later* period, may retard blooming and fructification, and cause the plant to "run to weed." It is highly probable that the tendency of cotton to "run to weed" in newly cleared bottom land very rich in vegetable mould, is due to this cause in part at least (¶447). It is well known that the most decidedly favorable effect is produced by this class of manures, on those crops whose surface of leaf is comparatively *small*—such as wheat, and the cereals generally; while their effect is less noticeable with plants naturally very leafy, which possess a large surface for the absorption, from the atmosphere, of the ammonia they require. In coincidence with this rule, we observe that the same land which causes cotton to "run to weed," will produce the most abundant crops of corn.—It appears likewise, that an abundant supply of ammonia is not favorable to the development of bulbs and tubers, such as the turnip, for instance; and it will be observed that the sweet potato, likewise, prefers sandy soils, poor in vegetable matter and ammonia. In rich, black bottom soils, especially when they are heavy, a great deal of leaf is formed, but the patotoes are small and wiry.

430. *Peruvian Guano.*—I may as well mention here, Peruvian Guano, concerning which there has been a good deal of discussion among agriculturists, as to whether it is to be regarded as a mere stimulant, or as a true manure. Some of these differences of opinion have undoubtedly been owing to variations in the material employed; for the greater part, however, they are probably attributable to different conditions of the land to which it was applied.

It must be remembered that whenever the soil contains a sufficient quantity (in an available condition) of any nutritive ingredient, for the wants of the *present* crop, that crop cannot in any way be benefitted by the *further addition of the same ingredient.* The surplus will simply remain idle, until, perhaps, called for by the succeeding crop.

Peruvian Guano contans chiefly ammoniacal salts, and the phosphates of lime and magnesia; also *small* quantities of soda and potash, sulphuric acid, etc. As it is not generally employed in very large quantities, the amount of the latter ingredients which it brings into the soil, will not generally exercise a very perceptible influence, if a soil is in tolerable condition, for the reasons above given; its chief action will be stimulant, due to the ammoniacal salts, which cause a rapid assimulation of nutritive ingredients by the plant, while the rest of the ingredients will remain comparatively inert. Should the soil, however, have been in want of phosphates, the guano will serve still another purpose, and the *difference* between the land thus manured and that which has received nothing, will be still greater than in the first case. If lime, magnesia, etc., were also wanting, the effects of the guano will be still more perceptible.

431. *When is Manure Most Profitable?*—As a matter of course, the application of any kind of manure to land *pays* best, when *all* the ingredients contained in the latter are immediately required by the soil. We do not want to expend money and labor in introducing into the soil, substances which, though useful in the end, will remain inert for years to come; for so long as this is the case, we lose the interest on the capital which they represent. If our soil requires *stimulation* merely, *i. e.*, the rendering available of nutriment it contains, while it is not deficient in any particular ingredient, then guano is too expensive to be used for the purpose; for we *utilize* only the ammonia it contains, while we *pay* for phosphoric acid, lime, magnesia, etc., besides.

It is obvious, therefore, that in the case of two adjoining fields, originally possessing the same soil, the application of guano may be profitable in one, while almost ineffectual in the other—according to the culture each one has received, and the length of time it may have been in cultivation. And what is true of guano, is equally so with reference to all other *partial* manures—*i. e.*, such as do not contain in the proper quantities *all* the ingredients required by plants, but only *one* or *a few* of these. Hence the great practical importance of the analysis of soils, as well as of the manures intended to improve them.

432. *Columbian Guano.*—There is at present imported from South America, under the appellation of "Columbian Guano," a substance very different from the Peruvian article; which consists chiefly of phosphate and carbonate of lime, but contains no ammonia or only traces of it. It may be used in the same cases as ground bones, or superphosphate of lime; it is not, however, as energetic in its action as the latter, being much less soluble. It has been attempted, and apparently with considerable success, to remedy this slowness of action by intermixture of the finely ground mineral with *stimulants*, such as *Peruvian Guano* or *ammoniacal salts.*—Of the effects of a similar mixture (sold in commerce, at present, under the title of "Kettlewells Manipulated Guano" there have been very favorable reports.

433. *Superphosphate of Lime.*—Of late years, the substance now generally known as *Superphosphate of Lime* has attracted the constantly increasing attention of agriculturists. The material sold by this title is, essentially, a mixture in various proportions, of gypsum or sulphate of lime with the true phosphate; which is usually obtained by the action of sulphuric acid or oil of vitriol, on bones, or, latterly, on the article just described under the appellation of Columbian Guano.

The important part which phosphoric acid plays in the vegetable economy, has already been dwelt upon (¶365); it cannot, therefore, be surprising that its addition to the soil should in most cases prove highly beneficial. The energetic action of the commercial article just referred to is not, however, attributable alone of the few nutritive ingredients which it furnishes *directly;* this circumstance alone could not render it so generally beneficial. It is, over and beyond this, a powerful *stimulant.* A discussion of the mode of action of gypsum as such, will be found below (¶436, ff.); that of the superphosphate of lime is quite analogous, for not only does it greedily absorb, and fix in the soil, the ammonia of the air, but its powerful acid (phosphoric) undoubtedly exercises an energetic action on the undecomposed portions of the soil, the nutritive ingredients of which it liberates and renders available to vegetation.

434. Its *exclusive* use is, therefore, necessarily exhaustive, *in the end*, of those ingredients which it does not furnish, and among these especially of potash, which must, therefore, in time be supplied to the soil from other sources, *e. g.*, from ashes, greensand, etc. A mixture of the commercial superphosphate of lime, with natural greensand, and ammoniacal salts obtained from gas-works, is probably the nearest approach to a universal fertilizer, of any artificial compound brought into commerce, and might in most cases successfully replace

stable manure. Among artificial mixtures intended as universal manures, the one known as "Mapes' Nitrogenized Superphosphate of Lime" has acquired some reputation; and new compositions of a similar character are daily coming forward.

The superphosphate of lime, as also bone-dust, is a specific manure for the maintenance of pastures, inasmuch as the largest part of the ingredients withdrawn from them by the stock is thus replaced. It is also specially recommended as a top-dressing for the turnip crop.

435. *Chilian Saltpetre; Common Salt.*—Among the stimulants which may sometimes be used with advantage, both by themselves and in addition to stable manure or to the compost pile, we may mention *Common Salt*, and *Chilian Saltpetre* or nitrate of soda. There are, probably, but few cases in which the action of either of these substances can be attributed to the ingredients they supply *directly;* they act as solvents and decomposing agents, somewhat in the manner of ammoniacal salts, and the farmer ought to understand distinctly, that large crops resulting from the use of these substances, have been produced entirely at the expense of his soil. Both salts, being but slightly absorbed by the soil, are soon removed from it, to a great extent, by the drain waters (¶378).

436. *Plaster of Paris, or Gypsum*, which is brought into commerce for agricultural purposes, under the title of "Land Plaster," occupies a prominent place among stimulant manures. Its constituents—Lime and Sulphuric Acid—are themselves important nutritive ingredients, as before stated. Yet its supplying these ingredients to the soil is but rarely the main cause of its favorable effect upon crops. While exposed to the atmosphere in a moist soil, it undergoes a chemical change, caused by the ammonia and carbonic acid contained in the atmosphere, both of which it attracts and fixes in the soil, the result of the process being the formation of *carbonate of lime* and *sulphate of ammonia.* Both these substances are powerful stimulants, as has been explained above; and it is *they*, and not the sulphate of lime originally applied to the soil, which often produce the decided effects noticed after the application of this substance. Combining as it does, the action of *two* important and powerful agents, one of which is obtained *gratis*, as it were, from the atmosphere, it is used with great advantage on clay or loam soils, not naturally strong, which have been temporarily exhausted by severe cropping; serving very effectually the same purpose as fallowing, besides enriching the soil by the ingredients it supplies. It is known, however, to be ineffectual, and sometimes injurious, on *acid* soils (¶406)—for reasons not perfectly understood. It is a *special* manure for clover, peas and leguminous plants generally.

437. Quicklime and Carbonate of Lime.—I have repeatedly mentioned the mode of action of *lime* (¶368, ff.); I now resume the subject in connection with some general remarks on the use of the calcareous marls of the State. I premise that in this respect, the only difference between the action of burnt and unburt lime (the latter being the carbonate, or combination of the former with carbonic acid), consists in the greater rapidity and energy of action in case of the former as compared with the latter. Hence, a small amount of burnt lime (provided it has not been allowed to become *air-slaked* (¶310), will, when properly diffused through the soil, exercise the same effect as a much larger quantity of unburnt, or air-slaked lime.—The process of *air-slaking* consists in a *resumption* of water and carbonic acid from the air by the lime; and is therefore the reverse of *burning*, in which process the same acid is *expelled.*

438. *Action of Lime.*—I have already sufficiently alluded to the action of lime as a stimulant of the soil, by rendering available to plants ingredients heretofore inaccessible to them. Its office as an indispensable article of food to vegetables has also been mentioned (¶368, ff). There are, however, several other important purposes it may be made to serve, according to the necessities of the soil; the chief among which are the following:

439. *Firstly:* It will correct the *acidity* of soils, which is usually the conse-

quence of the decay of vegetable matter under water, or at least in very wet localities, where moisture remains stagnant and the access of air is limited (¶406). It will be observed that the blackest of soils, when derived from a high, or at least, a dry locality, will not sensibly color water filtered through it; the decayed vegetable matter, or humus, they contain, is evidently not soluble, to any sensible degree, in water. Such is the case, for instance, with prairie soils, and all good bottom soils. On the other hand, the brown tint imparted to stagnant water in which vegetable matter decays, is familiar to every one.

440. The most striking example of this kind on the large scale, occurs in the south-eastern counties of our State, especially those bordering on the Gulf of Mexico. In the level and sandy pine lands of that region, from which the waters drain slowly, percolating through the porous soil filled with the fine, fibrous roots of a flora most peculiar and characteristic, the conditions above referred to are amply fulfilled; hence the waters of the creeks and branches, though so transparent as to cause to the uninitiated, unpleasant mistakes of judgment in regard to depth, and allowing the angler every opportunity of watching the motions of his game, are frequently so deeply tinged with brown, that a cupful of it on the breakfast table might well deceive the eye, though not the taste, as to its precise character. Almost all the grasses growing in that region are of the tribes popularly known as *sour grasses*—not so much so, however, but that cattle will thrive and do finely on the pasturage they afford. I have not learned whether any peculiarity of taste is observable in the milk and butter raised in the region; but the flavor imparted to these products by the pasturage in the sea-coast marshes, will hardly escape the notice of any one. The soil of these marshes, too, is very sour, or *acid*, and their water deeply tinged with soluble vegetable matters.

441. The analyses of the soils of these regions (which will be found under the head of the "Sea-coast Counties") show that in proportion to other ingredients, lime is particularly and unusually deficient in them. There can be no doubt that the soils of the marshes, so far as they can be drained, and are not too sandy or salty, can be effectually reclaimed and made subservient to agricultural purposes, by drainage and the application of lime; and it is highly probable, that the sowing broadcast of a small amount of burnt lime on the Pine Meadow pastures, would make the sour grasses disappear, and give place to others better suited to be the food of cattle generally. Ashes, likewise, produce similar effects and may be used with advantage where they can be cheaply obtained. Lime forms with most of the soluble vegetable acid contained in these brown waters, insoluble compounds, and completely neutralizes its acidity.

442. It effects, moreover, another important change. It is found that soils very rich in humus, while they absorb and retain with avidity most of the nutritive ingredients of plants (¶423), are incapable of retaining to any considerable extent, *Silica*, whenever it is in that soluble condition in which it is available to plants. Hence we find that in many soils very rich in vegetable matter, the cereals, which require a great deal of silica, bring forth weakly stems, incapable of supporting the weight of the ear. This defect is promptly corrected by the application of lime, which at once gives the to soil the power of abstracting from a solution every trace of soluble silica. From a number of instances which have come under my observation, it would appear that the "running to weed" of cotton in thrifty bottom soils, can be corrected to a considerable extent by the same means (¶429).

443. Another important property of lime is to *promote and quicken the decay of vegetable matter*, and by its presence, to insure its conversion into true, healthful humus (¶406, 439). Hence the intensely black color possessed by *true* prairie soils. In fact, an unusually dark tint in any soil, no matter whether sandy or clayey, light or heavy, is a pretty certain indication of the presence of a large amount of lime; and consequently, the planter may take it for granted in such cases, that the further application of pure lime to his soil (but not that

of calcareous marls, containing other useful ingredients) would be quite superfluous and useless. It must be remembered, however, that the reverse is not necessarily true, viz: that the light color of a soil is a sign of the absence of lime; it is so only when at the same time, a copious supply of vegetable matter is present in the soil.

In addition to the qualities just named, it has been observed that calcareous soils are less subject, as a general, thing to injury by excess of wet, or drouth, than land otherwise similarly constituted, but poor in lime. This may be referable, to some extent, to the favorable influence of lime on the production of humus, which, as mentioned before, is a safeguard against both these causes of injury.

There are, however, over and above the points mentioned, a great many special cases in which the application of lime to soils may serve as a correction, or to fit it for special purposes of different kinds. Taking all this into consideration, the importance to an agricultural State, of an abundant supply even of pure lime in an available from, becomes obvious enough.

444. *Difference between Lime and Marls.*—With reference to the large majority of the *marls* of this State, the case assumes yet another aspect, and that of the highest importance. They are not merely mixtures of carbonate of lime with clay (silicate of alumina), but they contain, besides, considerable amounts of *most or all the other ingredients required by plants*, and foremost among these, of *Potash;* also Soda, Magnesia, Phosphoric and Sulphuric Acids. When, therefore, we apply these marls to land, we not only *stimulate* the latter, but we add to its capital stock of fertility; and in a great many cases, we can thus fully replace all the drain of nutritive matter which the increased activity of vegetation may withdraw. We can thus, in fact, *sustain* the fertility of our soil without resorting to any other means than marling, and from time to time, plowing down a green crop. For, knowing the composition of the crop we have raised, and hence being able to calculate precisely how much of the mineral nutriment of vegetables has been withdrawn from our field; knowing also, the composition of the marl we may have at our command: we can return to the soil all it has lost; and if we do so conscientiously, the soil will *improve* in the course of time, instead of deteriorating, as is commonly the case. It is not to be understood, by this, that this replacement will be made perfectly by adding simply the amounts of marl which would be calculated from the analysis made, as corresponding to the loss sustained by the land in cropping; for only a portion of the ingredients obtained in analysis can be considered in an available condition, and we must therefore add a large excess over the calculated amount. Yet we are thus enabled to proportion our dressings, in a great degree, both to the quantity and quality of the ingredients withdrawn on one side, and to be furnished on the other.

445. *Different Condition of Ingredients in Soils and Marls.*—In comparing the analyses of some of the rich soils analyzed with those of the marls. it will be seen that the former contain more *potash*, for instance, than some of the latter, which are nevertheless recommended as fertilizers. The question may then be asked, why, if it be profitable to apply these marls, it would not be equally so to employ those *soils* in a similar manner?

The reason is, that in most soils the greater part of the nutritive ingredients are in a condition in which they are not immediately available to plants, and only become so by the long continued action of the atmosphere, or of stimulants; whereas the marls usually contain their potash, for instance, in the state of greensand grains, which very readily give it up to the roots of plants. Or, in the case of clay marls in which greensand is not demonstrably present, the case is still the same as when we apply a strong dressing of lime to soils rich in potash, etc. We thus render available a considerable amount of nutritive ingredients, in the course of a few years (¶368, ff.), by the powerful action of lime on the undecomposed minerals of the soil. If such is the effect of lime during the brief period in which *we* can observe its action, it is clear that in the case of *marls*, where lime has been in action from times immemorial, the greater part of the nutritive ingredients must be at once in an available condition. And hence it is, that the comparatively small amount of potash and other useful ingredients which, besides the lime, a dressing of marl introduces into our soil, exercises such a powerful effect; for the greater part of them is at once ready to serve as food for the vegetable economy, as in the case of stable manure.

446. *Limited Duration of the Effects of Marling.*—This consideration leads us to understand also, the cause of a phenomenon which has caused many discussions, and fruitless attempts at explanation, so long as marls were considered as owing their efficacy merely to the lime they contain. It was found that the period during which the effects of a dressing of marl continued, was much more limited than the slight waste of lime from the soil would justify; analysis, moreover, proved an abundant supply of lime still to be present in the soil; and nevertheless it appeared to have lost its efficacy.

A higher degree of accuracy in chemical analysis, which we have since attained, has enabled us to detect in marls formerly regarded as purely limy, others of the nutritive elements of plants, the presence of which had before been overlooked. Their quantities, it is true, are sometimes extremely minute; but not more so than are the respective amounts of the ingredients withdrawn from our fields by crops, when divided out over the whole surface and mass of the soil; or those which, when furnished to the soil in the form of stable manure, are well known to be eminently effective, because they are in a soluble condition.

If a dressing of 200 bushels per acre, of marl containing 40 per cent of lime, and ¼ of a per cent of potash, and the same amount of phosphoric acid, ceases to be effective, (and therefore requires to be repeated) in the course of ten years, as might be the case in practice; it is very plain that its want of efficacy cannot be attributed to the slight diminution of the lime introduced, by the small amount which our crops (cotton or corn) have withdrawn. Not so, however, with respect to potash and phosphoric acid; for in case of heavy cropping, the amount of *these* substances contained in the crops would form a large percentage of the whole quantity introduced in the marl, quite sufficient to explain the inefficacy of the latter beyond the period stated.

447. Cases in point have been very commonly observed in the "Northeastern Prairie Region" of our State. Some of the prairie soils in cultivation contain from 5 to 15 per cent. of carbonate of lime; consequently they are not deficient in that substance. Yet it is found, that a dressing of the bald prairie marl, or Rotten Limestone, sensibly increases their productive capacity for several years thereafter—obviously not on account of the increase of the (already very large) supply of lime in the soil. The analysis (¶ 149) teaches us that the Rotten Limestone contains, not only Carbonate of Lime, but also, one quarter of a per cent. (0.248) of Potash, besides other important ingredients; which circumstance explains, very simply, the cause of the phenomenon observed.

448. Classification of Marls.—Geologically, the calcareous marls of Mississippi occupy, in the main, four different positions, viz:

1. *Cretaceous marls*, of the *northeastern portion* of the State, including the greater portion of the counties of Tippah, Tishomingo, Pontotoc, Itawamba, Chickasaw, Monroe, Oektibbeha, Lowndes, Noxubee and Kemper (¶ 140 to 146). There is a great number of varieties of these marls, but they may on the whole be distinguished into three classes, namely:

449. a. *Greensand marls* of the upper cretaceous formation or Ripley Group, (128, ff.), occurring in Tippah, Pontotoc and N. Chickasaw, between the prairies proper and the Post Oak Flatwoods (¶ 143 to 146). They are generally of a sandy character, sometimes largely mixed with scales of mica (popularly termed isinglass), and of a bluish or greenish-gray tint. The earthy and loose varieties, which are easily worked with the spade or mattock, contain from 10 to 20, on an average, 15 per cent. of carbonate of lime, and form one half to one per cent.

of potash, owing to grains of greensand scattered through the mass. Such are the marls at Ruckersville, at Braddock's, at Ripley, and at Col. M. Berry's ; also on Dry Creek, and on the E. fork of the Hatchie, in Tippah ; those cropping out on the banks of King's Creek, Okonatyhatchie, and on the western slope of the Pontotoc Ridge generally, down to its termination in Chickasaw county, between the heads of the Houlka and Chuckatonche (¶144). Near their western limit, skirting the Flatwoods, they are often associated with (usually overlaid by) ledges of sandy limestone, which at times appears compact and solid, and then furnishes good lime for building purposes (¶151) ; at others, being unequally impregnated with lime in its different portions, assumes the character of "bored" or "horsebone" limestone. Like the marls, this limestone is often very rich in greensand grains (¶153). It is a soft variety of this limestone, frequently associated with a heavy, gray, clay marl, which forms the bald hilltops on the Pontotoc Ridge.

450. c. *Clay marls* of the Rotten Limestone character and age, (¶141) ; passing *into* the Rotten Limestone by insensible gradations, and containing from 20 to 85 per cent. of carbonate of lime. Their admixture consists prevalently of *clay*, instead of sand, as in those before described.

On an average they are poorer in potash than the greensand marls, although the Houston marl still contains near $\frac{3}{4}$ of a per cent (¶141) ; while the Okalona Rotten Limestone contains only one quarter of a per cent. (¶149). The marls of Tishomingo and western Itawamba (at Richmond, and on Old Town Creek) ; and that of Chiwapa, Coonewa and Tallabinela Creeks, in eastern Pontotoc, belong to this class.

451. c. *Greenish sands*, very micaceous, of the lower Rotten Limestone (or Tombigbee Sand) age (¶140), occurring in Monroe and Lowndes counties, on the Tombigbee and some of its western tributaries. Thus at Aberdeen (¶113), Barton (¶107), Waverley, Plymouth Bluff, and Columbus (¶114).—Of these materials, only one specimen has as yet been analyzed, viz : that from Waverley Bluff, which gives only between two and three per cent. of carbonate of lime, and a very small amount of potash (¶140) ; so that its use as a manure would hardly pay for the hauling. The material occurring at Plymouth and Barton Bluffs, however, is evidently richer in lime, and may prove valuable.

452. II. *Marine* tertiary marls, occupying a belt extending across the State in a W. N. W. direction, from the Mississippi, at Vicksburg, to the Alabama line ; represented, on the map, by the several shades of blue, and bluish-gray. These marls are scarcely less various in their character than those of the cretaceous formation, to which they bear a great general resemblance. The tertiary greensand marls are on the whole distinguishable at once by the want of mica, from those of a similar general aspect derived from the northeastern or cretaceous marl region ; while the white tertiary marls, corresponding in aspect to the Rotten Limestone, are distinguished by their granular or crystalline texture, and their yellowish (instead of bluish) tint when freshly dug.

They are on an average richer in lime and potash than those of the first class, containing from 50 to 95 per cent. of carbonate of lime, from $\frac{3}{4}$ to $1\frac{3}{4}$ (as far as known) per cent. of potash, from 1 to 3 per cent. of magnesia, and $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of phosphoric acid.

453. *Greensand marls* occur more or less in all of the three stages of the marine Tertiary (see Geological Report, ¶277).

Almost always, however, they are accompanied by the white marls, and cannot therefore be as distinctly circumscribed in their limits as in the case of the cretaceous formation. They are generally rather sandy, as compared with the *white marls ;* some of which, as those of Madison and N. Hinds counties, are very clayey, with but a slight admixture of sand ; in other cases (as near Brandon, ¶285 ; in S. Jasper, and N. Wayne, ¶294), are almost entirely composed of granular carbonate of lime, often passing imperceptibly into hard limestone ; and at other times, as imperceptibly into greensand marls, *e. g.* at

Vicksburg (¶220, 278), Byram Station (¶280), Falling Creek (¶218, 290), and numerous other localities.

454. As in the case of the cretaceous marls, the *green* and *blue* marls of the Tertiary are, as a general thing, richer in potash and poorer in lime, than the *white* marls. The former are therefore to be considered rather more in the light of *true manures*, the latter, rather as *stimulants*. None of them, however, are entirely void of potash; the white marls of Rankin and Hinds counties average from two-tenths to five-tenths of a per cent. while the greensand marls usually range between ¾ and 1¾ per cent. of the same substance.* (For analyses of these marls, see Geological Report, ¶278, 280, 282, 283, 285, 202). As for the yellowish-white or gray clay marls of Madison and N. Hinds, such as are common on the road from Jackson to Canton (¶281), no complete analyses showing their character and quality have as yet been made (for partial analyses see ¶283). There is no doubt, however, that if judiciously selected, they will be of great service on the yellow loam lands of the counties mentioned.

455 III. *Clay Marls* of the upper, *fresh-* (or *brackish-*) *water* Tertiary, or Grand Gulf Group (¶230, ff.) of South Mississippi. They are found interspersed in patches, sometimes of very limited extent, in the beds of gray, green and blue clays which occur, alternating with sandstone ledges, in the whole region S. of that which furnishes the marls described under No. 2; or south of a scolloped line extending from Grand Gulf, *via* Clinton, Brandon and Raleigh to Winchester, in Wayne county, and thence into Alabama (see map, and ¶296 to 302).

The materials of this formation appear to be very generally rich both in Magnesia and Potash (¶231), although the eye cannot detect in them any grains of greensand. The analyses thus far made (¶296, 300, 302) show from one to two per cent. of *Magnesia*, seven-tenths to one-fourth per cent. of *Potash*; and from 1½ to 22 per cent. of *Carbonate of Lime*; not, however, any large amount of Phosphoric and Sulphuric acids. Their most usual character is that of heavy, gray or bluish clays, which, when rich in lime, contain irregular veins, nests or layers of white calcareous concretions, which when wet, are sometimes quite soft and friable; but so far as my observations reach, contain traces only of fossils—no distinct shells, as do the marls of the other formations.

There occur also, in this formation, materials not sufficiently calcareous to claim the name of marls proper, yet still likely to prove useful as fertilizers when conveniently situated. Concerning these, as well as the localities of occurrence of the clay marls mentioned, see Geological Report. ¶295, 203.

456. The deposits of disintegrated shells imbedded in black clay, sometimes found on the streams of the Coast (¶248, 249), have not as yet been saticfactorily examined. Particulars concerning them will be found in the place above referred to, as well as under the head of the Sea-Coast Counties.

457. IV. *Fresh water marls*, of more modern age than the Tertiary.

Among these may be classed the calcareous silt or loam which forms the main body of the hills of the Southern River Counties; and under the latter head will be found an analysis, as well as a full discussion of the merits of this material.

Limited deposits of a character not unlike the above, are sometimes found in the sites of lakes in the Mississippi bottom, as described by Prof. Wailes (First Report, p. 231), under the head of "Lake Marl." Being unacquainted with the mode and extent of occurrence, as well as with the composition of this material, I have nothing to add to what is said in the passage referred to.

458. Marling.—As to the *mode* of applying the marls just described, little need be added to the general rules already given (see also under the head of Agricultural Chemistry, what is said concerning the use of lime, ¶368, ff.)

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*It may be necessary in this connection to call attention to the fact that the analyses of New Jersey greensand, which show it to contain ten per cent. of potash (as is frequently quoted), refer, not to the whole, *average mass of materials* which is used in practice, but to the *picked, pure* grains of *greensand proper* (glauconite).

They ought to be scattered broadcast, as a *general* improvement of the land, not in the drill; and whenever practicable, they ought be to used in conjunction with vegetable matter.

The very precept of broadcast scattering, necessarily involves the condition, that the material should be in a certain state of comminution; not in blocks or lumps, such as it may form immediately after digging from the pit. In most cases, exposure to a few rains with dry spells intervening, will cause the material to crumble sufficiently for all purposes. It is only the white marls of the Tertiary, which sometimes resist this treatment, and require to be pounded—which is rarely, however, an operation of any difficulty. Generally, the marl may be hauled to the field as it comes from the pit; being thrown from the carts in small piles, it will be in a favorable condition to be acted on by the weather, especially in winter; it may then be scattered, and turned under by the first plowing, in spring.

459. With most of the *bluish* marls, this preliminary exposure becomes a matter of great importance, and often of necessity, on account of their frequently containing small amounts of iron pyrites. This mineral, by the action of the atmosphere, is transformed into green vitriol or copperas (¶258), and as such, would, for the time being, prove highly noxious to plants—causing "dead spots" wherever a crystal or lump of the mineral thus decays. In the presence of a plentiful supply of lime (with due access of air), however, the copperas would be rapidly transformed into gypsum or plaster, and inert peroxide of iron; thus adding a useful ingredient to the components of the marl. This renders the previous exposure or weathering of the marls, doubly important.

460[1] As to the *quantity* of marl to be used, so much depends on circumstances, that it is difficult to give any general rules in regard to it. On heavy clay lands, and such as contain a large supply of vegetable matter, "overdressing" will not readily come to pass. Dressings of 300 bushels per acre, of marls containing 40 per cent. of carbonate of lime (and proportionally less of those containing a higher percentage) are quoted by Mr. Ruffin, in his "Essay on Calcareous Manures," as being unobjectionable on soils moderately heavy, while on very heavy land, dressings of 500 to 600 bushels was no overdose. Within these limits, a little more or less, the *duration* of the effect of marling will be approximately proportionate to the quantity employed. That is to say, if the perceptible effect of a dressing of 300 bushels will last fifteen years, that of one hundred will last about five. This, of course, is only very approximately true; in the example just quoted, for instance, the effect of the 100 bushels would not be quite as prominent at any time, as that of the 300, and would, therefore, be likely to last longer *in proportion*.—Every individual must judge for himself, whether it is more profitable for him to apply a heavy dressing at once, or lighter dressings in more rapid succession.

460[2] *Overdressing with Marl*.—On sandy lands, poor in vegetable matter, overdressing happens more easily, and must be guarded against. If at all practicable, the marls ought to be composted, or at least applied conjointly with, vegetable matter of some kind: most conveniently, in many cases, by being turned under with green crops.

The effects on a corn crop, of overdressing with calcareous marls, is described by Mr. Ruffin to consist in the paling, yellowing and final drying up, of the young plant, during the months of May and June; a phenomenon very similar, apparently, to what we see in the "salty spots" of Hinds and Rankin counties.

Stable manure, or decaying vegetable matter, is stated by him to be an effectual remedy; even as, if applied from the outset, it is a certain preventive.*

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*As it would not come within the province of the present Report, to give this subject a discussion as special as might be desirable and proper in the Final Report, I would refer those who intend to practice marling on a large scale, to the work of Mr. Ruffin, above quoted, which contains a vast amount of useful practical rules and information on this subject.

461. *Effects of Marling on Health—Disinfecting Action.*—Over and above the favorable effects of liming or marling on the productiveness of soils, another important result is often experienced in districts where marling has been practiced on the large scale, viz: the improvement of the general health of the region, especially where the soils were acid and ill drained. This effect on the large scale may be understood in some measure, when we recollect the *disinfecting* and *deodorizing* powers possessed by burnt lime—frequently used for that purpose in sewers, cesspools, hospitals, etc. The effect in this respect, of marls, or carbonate of lime, is, of course, less *energetic* than that of burnt lime, but it exists none the less, and the general use of our marls for these purposes, would not be among the least benefits conferred by them on the population.

With these materials at hand, there is little excuse for pestiferous privies, and offensive offal or manure. If the addition of lime or marl cannot in all cases obviate offensive odors, it can at least deprive them of their most noxious components; while in the case of manure piles, the value of the material is greatly enhanced by the addition of calcareous materials (see below).

462. *Gypseous Marls.*—This class of marls, which contains the *sulphate* of lime instead of the carbonate, or sometimes both, is of frequent occurrence in some parts of the southern marl region, and is found, more or less, from the northern line of that region to within a few miles of the sea-coast. Notwithstanding this large range of occurrence, however, the amount of *available* gypseous marls found in the State is much smaller than that of the "calcareous" class. Not only are its deposits more limited, but the beds frequently consist of heavy, gray clays, with only *here and there* a large lump of gypsum; so that it would be equally impracticable to make use of the gypsum *without*, as *with* the accompanying matrix of inert clay. Specialities concerning some of these marls will be found in the places referred to in ¶303[2], as well as in the Special Part, under the head of the "Central Prairie Region."

In general, the same rules which apply to the use of gypsum, as a manure, will hold true in the case of gypseous marls; unless indeed, analysis should show them to contain other ingredients which could essentially modify their action.

463. STABLE MANURE—COMPOSTING.—All the manures heretofore discussed, are more or less *partial* in their action; supplying only one, or a few, of the necessary constituents of a good soil, or stimulating it into a temporary increase of productiveness. The manure of manures, which by itself alone supplies all the ingredients necessary to insure permanent and active fertility, is that derived from the excrements, both solid and fluid, of animals, which, in its usual mixture with straw or other materials which may have been used as litter, is known as *stable, barnyard*, or *farmyard manure;* and the same holds good, in a still higher degree, of *night-soil* and the preparations derived from it, such as *poudrette.*

464. The pre-eminence of stable manure in this respect cannot be surprising, when we consider its origin, in connection with the principles laid down in the preceding pages. The solid excrements carry with them the greater portion of the mineral matters contained in the food of the animal; and such parts of these as have been temporarily retained by the animal system, at last pass off likewise in the urine, in the regular course of the change of substance, which is constantly taking place in the animal economy. All the food consumed by animals, is derived, directly or indirectly, from plants; in the excrements of animals, therefore, we must find the indestructible matter which, having been originally derived from the soil, will renew its fertility when returned to it; particularly when connected, as in this case, with abundance of ammoniacal salts (formed by the decay of animal matter), and vegetable matter which has passed through the body without essential change. The mineral ingredients of stable manure, as a general thing, are in an easily soluble, highly available condition, and all the facilities required for their rapid transfer to the vegetable organism,

are afforded by the ammoniacal salts and the carbonic acid formed in the decay of the animal and vegetable matter which this material contains.

465. *Preservation of Stable Manure.*—In collecting and preserving stable manure, for agricultural purposes, it is of the last importance to keep in mind the circumstances last mentioned. The important mineral ingredients being in a soluble condition, it is obvious that the fluid drainings from the stable may contain the most valuable portion of the manure; and unless proper care be taken to prevent their wasting, the effective value of the manure pile will be greatly lessened. Again, if we allow the decay of the animal and vegetable ("organic") matter to proceed, without taking care to retain the volatile products of this process (among which, carbonate of ammonia is the most prominent), we shall also suffer a serious loss.

There is a number of ways and means by which the loss of these ingredients can be prevented, or at least, greatly reduced. In the stable itself, an abundance of litter, and a solid, compact floor, which will not allow water to percolate; so long at least as the manure is not allowed to accumulate too much, but is regularly removed, from time to time, to the manure pile. If no good absorbent litter can be obtained, the fluid drainings from the stable ought to be so directed as to be received by the manure pile.

466. *Litter* acts not only as a mechanical absorbent, like a sponge, but in its decay it forms *humus*, which, as we have seen, is powerfully retentive both of ammonia and of the nutritive mineral ingredients. Its decay, however, is not usually as rapid as that of the animal matter, which furnishes the greater portion of the ammonia; and hence, unless something more rapidly active is supplied to the manure pile, we run the risk of losing a great portion of the ammonia formed. The retention of these volatile ingredients, as well as of those soluble in water, is one of the chief objects of *composting*. By this process, we at the same time, attempt to increase the supply of nutritive ingredients, and to favor decomposition.

If we recall to mind what has been said above (¶378, 425) concerning the retentive power of humus, and of clays, a number of materials useful for these purposes will at once suggest themselves to the thinking agriculturist; who will have to select among such as may be at his command, those most suitable to the attainment of his object, always keeping in view the employment of such a material as will serve several purposes at one and the same time.

467. Marsh, swamp, or pond muck, and also decayed wood, are materials very commonly accessible in all parts of the State. These supply, not only humus, but also valuable mineral ingredients.

In the regions in which lignite beds prevail (¶252, ff.), materials useful for composting may frequently be found in the dark colored lignitic clays, which crumble and pulverize very readily under the influence of the atmosphere; and also, in the lignites themselves. Besides the organic matter, these clays often contain notable amounts of potash and other useful substances. In the Pine regions of the south, pine-hollow muck, which is even now used as a manure by itself, will be found useful; and in the same regions, the green and blue clays of the upper Tertiary, which are often rich in potash, lime and magnesia (¶455), can frequently be used to advantage. Each one must judge for himself, however, as to which material suits best his particular case. It must be recollected, that the addition of clays, and the like, materially increases the *weight*, and, therefore, the expense of hauling, of stable manure; for which reason the *excessive* admixture of any inert clay, *merely* for the sake of preventing waste from the pile, must be avoided. In this respect, muck is much less objectionable.

468. *Use of Marls in Composting.*—Few substances can be better suited to the purposes of composting, than the calcareous, and no less the *gypseous* marls, before described; and for this purpose, the *clayey* (in contradistinction to the *sandy*) varieties of both ought to be selected by preference.

The mode of action of *gypsum* in fixing the ammonia of the atmosphere, has already been referred to (¶436); and its effects, when used as a composting material, are equally favorable. In many cases where the direct application of gypsum to land is too expensive in proportion to the effects produced, it may be made to pay exceedingly well, when used as a composting material—not only (not in excessive quantity) with stable manure, but also with *cottonseed*, that peculiarly southern fertilizer. It has been observed by agriculturists, that decayed or "rotted" cottonseed is much inferior in value as a manure, to the same material when applied in the fresh state. The odor evolved by cottonseed when decaying, leaves little doubt as to the cause of this deterioration: a great deal of ammonia escapes into the air, leaving behind only the mineral ingredients with some humus. These, in the absence of ammonia, act much more slowly, and do not, therefore, produce so obvious an effect upon one and the same crop, as the fresh seed would have done while decaying in close contact with the living plant. By a proper intermixture of the seed with some plaster, when piled up for preservation as a manure, the ammonia may be retained, and the effective value of the material essentially increased.

469. With respect to the use of lime or its carbonate in composting stable manure, it is true that on chemical grounds its use has been discouraged, on account of its property of so decomposing the salts of ammonia, as to allow the latter substance to escape into the atmosphere. While this is strictly true of an *excess* of lime, which effectually expels all the ammonia not combined with humus, later experiments have shown that a certain *moderate* amount of lime added to stable manure, *favors* the retention of these volatile ingredients, while at the same time it hastens essentially the decomposition of vegetable matter. But in the case of our calcareous marls, the favorable action is exercised not only by the marl on the stable manure, but also *vice versa*, by the decaying manure on the alkaline ingredients of the marl, which are rendered more soluble, and, therefore, more rapidly available to plants, by the combined action of carbonic acid and ammonia. Thus these fertilizers mutually improve each other, and a collateral advantage is gained by the *deodorizing* effects of the calcareous material. The simultaneous addition of vegetable matters already decayed, such as swamp or marsh muck, is particularly advantageous in this case, as it will more effectually prevent the escape of ammonia; even if in some parts of the pile so much lime should have been accidently accumulated as to expel the ammoniacal gas.

470. *Superphospate of Lime*, wherever it can be had cheaply, is a highly valuable addition to the manure pile, being most effectually retentive of ammonia; it may thus be made to subserve another purpose, besides supplying its important nutritive ingredients to the soil (¶433). It ought not, however, to be used conjointly with lime or calcareous marls, which would re-convert it into bone-ash, from which it was originally manufactured. The chief advantage possessed by the superphospate over ground bones, is its greater solubility; which is lost when it is brought in contact with lime, either pure or as carbonate. There is not, however, any objection to using it conjointly with gypsum or plaster, or marls containing the same.

471. *Ashes.*—Among the offal frequently available to American agriculturists, and which may be profitably used as an addition to the manure pile, *ashes* of all kinds, both leached and unleached, occupy a prominent place in point of usefulness. In leached ashes, lime, magnesia and phosphoric acid, together with a small amount of potash and soda still remaining, are the important ingredients; in the unleached material, a large amount of potash, and some soda, with chlorine and sulphuric acid, are superadded to the above. The ashes of different woods are of different value in *this* respect as well as in regard to soap-manufacture. The ash of the Post Oak, for instance, is very poor in potash, while that of the Black Jack Oak is selected for the purpose of soap-making, as is that of the pine burrs. The agricultural value of these ashes is quite as variable.

472. *Fresh and Rotted Manure.*—The question is frequently asked, whether

fresh or rotted manure be the most efficaceous, and whether it be more profitable to allow it to complete its fermentation in the pile, or to transfer it to the soil as rapidly as possible ?

In this general form the question is unanswerable, inasmuch as according to circumstances, either the one or the other alternative may be advisable.

473. If our arrangements are such as not to permit the escape of any useful ingredients from the manure pile ; if we prevent the loss of either fluid drainings or ammoniacal gases, by some of the means just described ; then, as a general thing, it is well to allow the decomposition to advance considerably, since we can control the process better in the manure pile than in the field, where drouth, excessive wet, or exposure on the surface of the ground, may stop the progress of decomposition entirely, thus preventing the ingredients from becoming rapidly available as vegetable nourishmen . The manure pile ought to be kept moist, but not excessively wet; it ought, therefore, if possible, to be sheltered partially at least, from both the sun and the rain ; and similarly, when manure has once been hauled to the field, it ought to be put underground as soon as practicable.

474. In the fermentation of manure, a great deal both of its weight and bulk is lost ; it becomes more concentrated as it were, *i. e.*, its percentage amount of *mineral* ingredients increases. If, therefore, we were to *buy* manure, it would generally be preferable to buy the rotted rather than the fresh. When we make it *ourselves*, the distance to which it must be hauled often requires to be taken into consideration, and we may find it profitable to let decomposition advance further than we should otherwise have chosen to do, in order to diminish its weight and bulk and the consequent expense of hauling. So also, the kind of crop for which it is intended, and the season of the year at which it is to be applied, requires consideration. If intended for crops requiring, or able to bear, the powerful stimulus of fermenting manure (as for instance, corn or pumpkins) the *immediate* effect will not be as great, if we allow the fermentation to be completed ; and the manure should, therefore, be used, if possible, in an early stage of decomposition. Such manure, however, unless used with great care and judgment, will often " burn up" cotton, as does *cottonseed* when applied in large quantities, immediately to the roots of the young plant ; which ought, therefore, to receive by preference, such manure in which the violence of fermentation has subsided.

C. METHOD OF CULTURE.

475. In the preceding pages, the ways and means by which, in particular cases, land may be rendered capable of producing profitable crops, have been discussed, with particular reference to the resources of this State. It remains, before p ssing to the special description, to say a few words in regard to the general plan of culture on which all special operations ought to be based—modified more or less by local circumstances, yet still the same, essentially, all the world over.

476[1]. ROBBING THE SOIL.—Experience has shown, that we cannot, under any circumstances, or under any system of rotation whatsoever, continue to raise useful crops on any land for a length of time, unless we return to it in the shape of manure, a part at least of the ingredients which the crops have abstracted from it. This is a truth so anciently, and apparently so well known, that it would seem superfluous to re-iterate it. Yet in my travels through the State, I have found many, and otherwise very intelligent persons, in whom the extraordinary fertility of their soil had induced the conviction, that *some* soils, at least, were inexhaustible ; and that by diligent search (usually by moving westward) they might find a place on which they and their children might live without ever troubling themselves about manure. I have met many who, when informed of the general object of the Agricultural Survey, expected that such an examination of their soils should reveal to them a talisman, or some mystic formula, by which, *without trouble*, they might regenerate their soil and raise a bale of cotton per acre, as of old. And when they discovered that instead, it would be necessary to haul to their fields and scatter over them, a marl occurring in a bluff outside of their fence, or to apply to them manures thus far carelessly thrown aside: would turn up their noses in contempt of such old-fashioned, commonplace advice, and perhaps remark that whenever their cultivated land gave out there was plenty more to be had; and as for manuring, *it was too troublesome and would never pay.*

476². While I am far from attributing sentiments like these to the majority, or even to any large part of the planters of Mississippi, I have not so rarely met with opinions like the above, but that I might hope to do some good by assuring and if possible, convincing persons holding them, that to entertain the hope of any soil remaining productive forever, or even for any considerable length of time, without manure, is utterly futile; that we cannot anywhere in physical nature produce a useful effect without a corresponding waste of power and material, which must at some time be recruited or replaced, if the effect is to continue; and that, if their land happens to be of such a quality that it can do without manure in *their* lifetime, their children surely will have to resort to that expedient, and will be taxed the more severely by the task of renovating the soil, the more recklessly it has been drafted upon by the parents. And be it remembered, that the burden thus imposed upon posterity (and not a far distant one either) is quite out of proportion with the temporary advantage the present generation may derive from it; that in practicing a system of *robbing the soil*, we wantonly keep them from the enjoyment of what does not afford us any corresponding advantage, and what would have been theirs, had we not shirked the burden, and declined bearing our just share of the sentence imposed upon all mankind—that they shall eat their bread in the sweat of their face.

477. *Imminence of Exhaustion.*—It is not necessary, however, in all, or even in the majority of cases, to take this high moral stand-point, respecting the necessity of economizing the powers of the soil. So far from this, even the present generation is rife with complaints about the exhaustion of soils—in a region which, thirty years ago, had but just received the first scratch of the plow-share! In some parts of the State, the deserted homesteads and fields of Broom-sedge, lone groves of Peach and China trees by the roadside, amid a young growth of forest trees, might well remind the traveler of the descriptions given of the aspect of Europe after the Thirty Years War. And true enough, here, too, there has been melancholy waste of precious resources; the soil has been effectually stripped of all that was readily accessible; its *hidden* treasures, which a little judicious management would readily have coaxed out of it, have been allowed to run to waste. Even now, the rich prairies, the garden-spots of Mississippi, are giving out under the operation of the same pernicious system; lands which, six years ago, could not have been bought at thirty dollars per acre, are now offered at ten. It is a peculiarity of the calcareous prairie soil, that it gives out all at once, with little warning; and whenever it does give out, it is among the most difficult to renovate.

478. I do not mean to say, that the *early* settlers *could* or *should*, under the circumstances which surrounded *them*, have pursued a different course, and commenced, at once, a regular system of agriculture. But for the roving disposition of these hardy pioneers of civilization, who will not stay to take any trouble with a "tired" soil, the "Far West" would still be a wilderness. But what was justifiable in them, is no longer so with their successors. As members of a christian commonwealth, it is their right to use, but not to abuse, the inheritance which is theirs, and to hand it down to their children as a blessing, not as a barren, inert incubus, wherewith to drudge through life, as a penalty for their fathers' wastefulness.

479. *Exhaustive Culture Irrational.*—When we see a capitalist expending every year, not only the interest on his money, but a part of the capital also, we can calculate with certainty how long it will be before that man becomes a beg-

gar; and all unite in blaming him as foolish and improvident. Now, the capital of the agriculturist is the fertility of his soil, of which he ought to use the interest, but without seriously diminishing the principal. The power possessed by the nutritive ingredients of the soil, of assimilating from the atmosphere, under the influence of vegetable life, the constituents which form the main bulk of agricultural products (361), is like the interest-bearing power, so to speak, of invested capital. And the simile holds good even so far that, if we *add* or *return to the soil, yearly, what we have drawn from it in the shape of crops*, the amount of available, interest-bearing capital *increases*.

For what we return in manure, is in an *available condition;* and besides this, the action of the atmosphere continually renders available an additional supply from the undecomposed minerals of the soil. Land thus treated, therefore, continually *improves* by culture, and will always yield full crops.

Obedience to the maxim just quoted is the *conditio sine qua non* of *sustaining* the fertility of a soil in the literal sense, *i. e*, of rendering it *equally* and *evenly* productive for all time to come.

480. *Cultivating too much Land.*—There is another very general rule which applies everywhere, and is sinned against, very generally, throughout the West, viz: that it is more profitable to keep a small tract of land in a high state of cultivation and productiveness, even by the aid of artificial manures, than to raise indifferent crops on a large area; even though the *aggregate* amount of the crops should be the same in both cases.

The truth of this maxim is so easily demonstrated, that the departure from it in practice, which is so very common, can be explained only on the basis of the difficulties which lie in way of the introduction of any change of habit, however salutary.

481. The labor of culture is the same for equal *areas* of land, whether rich or poor; and the cost of production of a bale of cotton on land which produces only *half a bale* per acre, is nearly or quite twice as great as in the case of land which produces a *bale* on the same area; the profits, of course, being proportionally diminished. If therefore, we can *double* the production of "half-bale-land" by the employment of half of the force which was needed to cultivate the unimproved land, in the improvement of the soil (by deep plowing, preparing and hauling manure, etc.); we shall certainly *lose* nothing, even if we abstract from the improvement of the staple, and consequent higher market value of the product, when raised on a more generous soil. In the overwhelming majority of cases, however, it will be found in practice that far less than one half of the force of a plantation, will be sufficient to bring about, and sustain, the improvement in question, in the case assumed above; and the same holds true, more or less, in all analogous cases; the result being that in planting lands in a high state of cultivation, we can produce *more*, and a *better quality* of crops, than we possibly can by the employment of the same force on poor or indifferent soils, no matter how large their area. The inferiority of the *quality* of crops raised on poor lands, is not often taken into consideration, even by those who watch most anxiously the smallest fluctuation in the average prices of cotton; when the same amount of anxiety and attention, if bestowed on the *cultivation* of the staple, might have increased its intrinsic value per pound, not by eighths, but by as many entire cents.

RETORATION OF EXHAUSTED SOILS: AND MAINTENANCE OF FERTILITY.

482. We shall now inquire how far the various methods at present employed of improving land, fulfil the conditions previously referred to.

1. ROTATION OF CROPS.

483. What is the rationale of the efficacy of rotation of crops, has been previously stated (¶393, ff.). One and the same plant repeatedly grown on the

same soil, will so diminish the available quantity some ingredients, that for the same plant there is not, henceforth, an adequate supply of these; while yet there may be enough left of these same ingredients to supply a crop of another plant, which requires them in smaller quantities and different proportions. The same may happen with the second crop; while still, a third one, different in its nature, may succeed well. Finally the atmospheric influences may, during the several years that the soil has been occupied by different crops, have restored productiveness for the *first* crop of the series; which series may thus be repeated many times over.

484[1] But not *ad infinitum.* The time during which any system of rotation can be successful, *by itself alone*, depends altogether upon the native resources of the soil; the *best* will at length become exhausted. The great advantage of a judicious system of rotation, however, consists in this: that while we *do* exhaust the soil, we do so *to the best advantage*, extracting from it all that is really nutritive; whereas, if we exhaust it by continual repetition of *one and the same crop*, the land becomes sterile while still containing a large, perhaps the greatest part of its nutritive ingredients, but in *proportions* unsuitable to any useful crop. Rotation may, therefore, double, triple, quintuple the *duration* of land, as compared with that which *uniform* cropping allows to it. The latter method is really, therefore, a wanton spoiling of the soil, and a sin against our children, if not ourselves.

484[2] There is still another effect exercised by some crops, such as clover for instance, viz: that their deep roots *draw up*, as it were, the nutrive ingredients of the *sub*soil, so that when the clover is afterwards turned under by the plow, a real *addition* is made to the fertility of the *surface* soil. This process, therefore, is somewhat of the same effect as subsoiling, or turning up the subsoil; with this difference, however, that the ingredients yielded to the soil by the clover are in an *available condition*, while the subsoil, when turned up *itself*, requires the action of the atmosphere, or of stimulants, before it will produce.

485. At the North, where *farming* rather than *planting* is the system of agriculture, a great variety of successive crops is open to the farmer, and rotation may be made very perfect. In the South, on the contrary, the one great object is, or has been, to raise the one staple, COTTON. Of late years, the disadvantage of importing all our provisions from other States having become too manifest, corn has been planted more plentifully. Beyond these, field-peas, oats and sweet potatoes, with some wheat, completes the list of crops which it is usual to plant on the large scale in Mississippi. Nor do we often find on the *large scale* any other regular rotation than between corn and cotton; to which wheat and oats are now coming to be more and more frequently added.

486. *Order of Rotation.*—As for the most proper order of succession of these several crops (¶394), the analyses we possess of the two principal ones are still too few and defective to allow of settling the question definitely *a priori.* It is my intention to investigate this point particularly in the course of the Agricultural Survey; not only with reference to the (*now*) principal crops, but also all others which are of any serious importance to Mississippi agriculture, and which have not thus far been satisfactorily investigated.

487. *Rotation in Manured Lands*—It is not, of course, in *unmanured* lands only that rotation is profitable in practice. It helps us, also, to *use up*, as it were, the whole of our manure. It would be a mere matter of accident, if any manure we apply should happen to be *completely* consumed by one crop. The quantity we have applied may not be capable of supplying more than one crop *of one and the same kind* with its proper food; but it may be abundantly able to cause several other *different* kinds of crops to thrive, before it is all consumed.

488. *Rotation not Intrinsically Desirable.*—Important and beneficial as rotation is in practice, it is, nevertheless, an unpleasant necessity in a *planting* commonwealth, whose interest it is to produce year after year *on the same land, the same staple products.* We ought, therefore, to use all the means in our

power to obviate its necessity; and here again we must work by the rule already pointed out: *return to the soil every year, what has been taken from it by the crops.*

489. To ascertain this item *precisely*, we must have analyses as a basis for our calculation. But, meanwhile, a great deal may be done by simply taking care *not to withdraw* from the soil, by cropping, *anything more than what is strictly necessary. Let no part of the crop that is not very profitably convertible into currency, be lost to the land on which it was raised!*

Every plant, generally speaking, is its own best manure; nor will it, when properly applied, serve *as profitably* for any other as for *itself, i. e.*, its own species.

490. Exhaustion Caused by Cotton Cropping.—Cotton as a crop, when nothing but the lint is actually exported, is one of the least exhausting crops known. The amount of mineral ingredients in a four hundred pound bale of cotton, is no more than is contained in seven to eight bushels of corn; less by twenty to twenty-five bushels than it is usual to raise on land which will bring a bale of cotton per acre.

But the matter assumes a different aspect, if we fail to return to the soil the seed and the stalk. In this case, according to the analyses we possess of these parts of the cotton plant, and their proportion by weight to the lint, the amount of mineral ingredients withdrawn from the soil, is fully twice as great as that which is contained in a corresponding crop of corn. Twelve hundred and seventy-five pounds of seed cotton (assumed as yielding a four hundred pound bale of ginned cotton) contain about forty-two pounds of mineral ingredients; of these, four pounds only belong to the lint, and represent, therefore, the *necessary* exhaustion of the soil, while thirty-eight pounds belong to the seed. A crop of thirty-five bushels of corn (shelled) contains only twenty-five pounds of mineral ingredients, so that *in the cottonseed alone, we have mineral ingredients sufficient for one and a half crops of corn.*

491. If, therefore, a soil equally well adapted to corn and cotton, will continue to produce remunerative crops of corn for thirty years without rotation or manure (as many prairie and bottom lands have been known to do), then its productiveness for cotton might reasonably, under the same circumstances, be expected to continue for more than a century; provided always, that the stalk and seed be returned to the soil. If, on the contrary, these are allowed to go to waste, as is very commonly the case at the present time, the duration of the land will be reduced to the same figure, or less, than in the case of corn.

This comparison is not strictly correct, inasmuch as the ingredients withdrawn by corn exist in the latter in different proportions from those we find in cotton lint. If, however, we take into account, severally, the most important ingredients of both, the comparison is thereby only rendered more striking.

492. *Manuring with Cottonseed.*—In view of the facts just quoted, if it be wantonness to exhaust our soil by incessant cotton-cropping, what shall we say of allowing to go to waste, annually, hundreds of thousands of bushels of cottonseed—that part of the cotton crop which contains by far the greater portion of all the mineral ingredients withdrawn from the soil?—It is true that in returning the seed, we do not return what the lint has withdrawn; thus far, therefore, the replacement is imperfect. But we cannot have *lint* without *seed;* if we obtain the seed, the lint is very likely to be there also. Suppose that, in planting corn, we were aiming merely at obtaining the *shucks*, whereas the stalk and ear were returned to the soil; is it not palpable that the loss to the soil would be quite insignificant as compared with that which it sustains from a full crop of ears? And such, precisely, is the case with cotton. Now, considering the small amount of exhaustion which is *necessarily* consequent upon a cotton crop; is it justifiable that lands like those of Madison and Holmes, and the prairies themselves, should already be on the verge of exhaustion? Is not this simple consideration enough to condemn the system of culture which has

brought about these lamentable consequences, and to cause its abandonment?

493. So long as cotton is our staple (and "*Cotton is King*"), we cannot afford to lose a bushel of the seed. Nay more, we cannot properly afford to apply it as a manure, on the large scale, to anything but our cotton crop. If applied to our corn, the interest realized will ultimately fall far short of that which would have been received, had it been applied, in a proper manner, to the cotton-field.

494 *Manner of Applying Cottonseed.*—It is commonly stated, that cottonseed is a better manure for corn than for cotton. It is unlikely in the last degree, that cotton should form an exception to a rule so well established for other crops; but it is not at all unlikely that the present *manner of applying* the cotton, seed manure, may be such as to produce the above result. The young cotton plant is much less hardy than corn, and the contact with its roots of hot, fermenting cottonseed, seems to act similarly to an overdose of stable manure in other cases. On the other hand, it is well known that if the fermentation or decay of cottonseed is allowed to progress very far, or to terminate before the seed is used as a manure, the *energy* of its action is very sensibly lessened.

495. Probably the best means of avoiding both inconveniences, would be to allow the decay of the cottonseed to take place *in* the soil itself, on the spot where it is intended to exercise its action; introducing it some weeks or even months *previous* to the planting of the cotton, so as to allow the violence of the fermentation to subside, while the volatile products of the decomposition (which are to a great extent lost when the seed ferments in the pile), are completely retained by the soil. Let the seed be scattered in a furrow drawn in the middle of the future bed, and then covered over deep enough to prevent its ever coming in immediate contact with the rootstock of the young plant. The tap root and its fibres will then reach and assimilate the nourishment contained in the seed, at the period when the plant is not only able to bear without injury the powerful stimulus, but is most particularly in need of it; while no injury can result to the young seedlings from having "too much of a good thing" thrust upon them, before they are able to bear it. Planters who have made use of the cottonseed in this, or a similar manner, have borne high testimony to its peculiarly favorable effect on its parent stock, especially *when the same policy is regularly continued on the same field.*

496. *How does Cottonseed Act?*—If we examine or sift the soil of a field where cottonseed has been applied as a manure, perhaps 6 or 8 months before, we shall find the majority of the seeds entire, protected by the hull, with a black, shrunk kernel inside, which still retains the greater portion of the nutritive mineral ingredients of the seed. The conclusion is inevitable, that the action of cottonseed on any crop, *during the first year*, is due chiefly to the stimulant action of the carbonic acid and ammonia generated in its fermentation, and not to the direct supply of the requisite mineral ingredients. Now, since the ammonia and carbonic acid evolved from decaying cottonseed do not in any manner differ from the same substances as derived from other sources, there is no reason why in this case, the cottonseed manure should act more favorably on its parent crop, than on any other. Being essentially, during the first year, a mere stimulant, it will of course act most favorably on such crops as are particularly in need of stimulants—of which corn is one, since it will grow on a dunghill, which cotton will not. But in the second, and succeeding years, when the mineral ingredients of the seed have returned to the soil in an available condition, the principle that every plant is its own best manure, will undoubtedly be found justified in all cases.

It has been with respect to the cottonseed manure question, as with all others in practical agriculture; the unsystematic experiments of one, or of a few years, cannot decide them with any degree of certainty. It is to the results of a *settled policy continued for many years*, that we must look for the final settlement of questions like these; and unless, in such experiments, we are guided by the principles of scientific research, and bring to bear on the subject such lights as science may afford: generations upon generations may experiment, as they have done in Europe—under great disadvantages; and with no other result than the final and disastrous failure of every one of the *empirical* systems successively devised, upon insufficient and partial data.

497. *Feeding Cottonseed.*—We cannot afford to feed cottonseed to our cattle, unless we keep them at home and collect the manure, to be scrupulously returned to the soil from which it is originally derived. For, not only does the land lose, with the cottonseed, *twice* the amount of mineral ingredients which a corresponding crop of corn would have withdrawn; but even in stable manure, the differences in the composition of the food from it is derived, are continued, and hence the manure of corn-fed cattle is best for corn; that of those eating cottonseed, for cotton. If we apply them to different purposes, we shall have used them to less advantage to ourselves.

498. *Cottonseed-Oil Manufacture.*—We cannot afford to sell our cottonseed, for a trifle, to the oil-manufacturer, unless we take back at least the *oil-cake*, and if possible the hull also. For in a bale of cotton, even the latter, according to determinations I have lately made, carries with it twice the amount of mineral matter that the lint does; while in the cake we have a highly concentrated cotton-manure, containing $8\frac{1}{2}$ *per cent.* of the mineral ingredients required for the growth of cotton, and also in a more favorable condition for use as a manure, than is the case with the raw cottonseed. When the latter is used, not only does the hull (which is slow of decay) interfere greatly with the action of the more powerful, and more rapidly decaying kernel, but the oil contained in the latter renders its decay sensibly slower than is the case with the oil-cake meal, in which but a small amount remains. Persons who have used the latter, compare its action, so far as its *energy* is concerned, to that of guano; while the effect of the cake-meal is much more lasting, and the latter can be obtained at one-third of the cost of guano—about $20 per ton.

499. *How can the Manufacture of Cottonseed-Oil be afforded?*—Nothing of any consequence is lost to the land in the *oil*, which is not in the *agricultural* sense at least, the "fat of the land," as seems to be supposed by many planters; for it contains only a trifling amount of mineral matter; and a similar amount of sawdust would be of equal or better effect than the oil. It seems on the contrary, that planters could profitably afford to let the oil-manufacturer have their seed gratuitously, on condition that the cake be returned; inasmuch as, in the latter condition, their cottonseed will not only be more valuable as a manure, but also in a more convenient form for feed, if desired as such. The cake may be kept, without deterioration, in a dry place, for a great length of time; and as a feed for milch cows it seems to possess the special advantage of imparting much less of the peculiar flavor to milk and butter, than is the case when raw cottonseed is fed. It would seem as though all these advantages could be realized in a manner profitable to all parties, by the establishment of cottonseed-oil manufactories in all large cotton-growing neighborhoods, or at least in every county; thus avoiding the expenses of long transportation.

500. *Selling Manure.*—European agriculturists consider that any one who even *sells* the manure made on his land, instead of returning it to the soil, is fast ruining his estate.

Even thus, cottonseed is the manure which nature furnishes to the cotton planter, without the necessity of passing it through the system of a troublesome herd of stock, as is the case in Europe. But for the rest, the same principle applies to both, and the cotton planter ought no more to lose, or sell for a trifle, his cottonseed, than the European agriculturist should throw away his stable-manure. Were the cottonseed-oil manufacture (which has been expanding so rapidly of late) to be the means of withdrawing from the cotton-fields their legitimate return of the mineral ingredients of the seed, its introduction might, I think, be justly qualified as an unmitigated calamity to the South, and to every individual planter. For, the income accruing to the country from this manufacture, is grossly disproportionate to the injury, which the withdrawal of the life-essence of cotton-planting would inflict upon the prosperity of the whole.

501. *Cottonseed in the Mississippi Bottom.*—It is a common practice with planters in the Mississippi bottom, with whom cottonseed is a drug, to haul it into the bayous, where a part of it is eaten by their hogs, the rest is carried off to the Father of Waters, and by him to the Ocean, the great ultimate receptacle of the wasted fertility of the continents, which pours into it from millions of sewers in the great cities. All such is lost to mankind, at least until the bottom of the Ocean shall be upheaved and transformed into cultivated fields.—Were the planters who adhere to the above practice, aware how dear their cottonseed-fed pork costs them, or will have cost their children, and how bitterly *posterity* at least will rue the loss of what has been sent to the bottom of the Gulf, they would surely prefer that the wagons which now carry the seed to the bayous, should be garrisoned by a hand or two, to scatter abroad the seed while passing through the field! For though, of all others, the planter of the Mississippi bottom appears to be most firmly convinced of the inexhaustibility of his soil; yet, if the present system be continued, even the present generation will here and there awake to the unpleasant fact, that like all other earthly things, the fertility even of the Mississippi bottom is finite.

It is said that the soils of the Bottom are so thrifty "*anyhow*," that an additional dressing of cottonseed would cause the cotton to run to weed. But while this might be a tenable objection against using it in the drill or furrow, it certainly cannot be held against merely scattering it on the surface of the ground (several months previous to planting, if necessary), in the proportion in which it was taken from it. Yet this would fully insure to the soil the ultimate advantages of a restitution of its nutritive elements.

502. Of late, some of the planters of the Bottom, instead of making the summary disposition of their cottonseed, above alluded to, have preferred selling it to the cottonseed-oil manufactories. While it may be gravely doubted, that the small increase of profits thus accruing to them is in any manner commensurate with the disadvantage of the undiminished drain on their lands, it is at least so far commendable, as it prevents these valuable materials from being lost to mankind, and affords the upland planters a convenient opportunity of transferring to their lands, a part of the surplus fertility of the Mississippi bottom—an exchange of commodities to which they at least ought not to object, and of which they should avail themselves freely.

The cotton stalk and leaf are even now pretty generally returned to the soil, inasmuch as their removal would be more troublesome than the inconvenience they cause in tillage. Be it remembered, that each stalk so retained is the equivalent of another prospective stalk; as each and every seed returned, is representative of another prospective seed; with its necessary appendage, the lint.

What is true of cotton, its seed and stalk, holds good also, of course, with reference to other crops. Of all, whatsoever is not otherwise used, ought to be conscientiously returned to the soil; thus, both the necessity of rotation, and the exhaustion of the soil generally, may be reduced to their minimum.

2. SUBSOILING.

503. This term comprehends two operations essentially different in their nature and effects. In one sense, it means merely the breaking up of the subsoil, without necessarily bringing it to the surface to any great extent; in another, it signifies the turning up, *on the surface*, of the subsoil itself, or mixing it with the surface soil. It is chiefly in the latter sense that I mean to discuss subsoiling here, for in the *former*, it is advisable almost everywhere—objectionable only in a few special cases. For in simply breaking up the harder stratum beneath the soil, we secure some of the advantages of deep plowing, whether the subsoil be poor or rich. *Deep plowing*, like thorough drainage, *tempers the*

injurious effects of extremes both of wet and drouth; facilitates the penetration of the soil by the roots, affording them, at the same time, a wider range wherein to seek their nourishment. In this general point of view, little more need be observed in regard to this operation, than that it should not be practiced, where there is danger of breaking through the retentive strata into loose sands, which would allow manures to sink (¶401).

But whether or not it may be useful in any particular case to *turn up* the subsoil, is dependent entirely upon local circumstances, and cannot be decided without a close examination, and frequently not without analyses of the soil and subsoil.

504. When the soil itself is so deep that the plow cannot conveniently go beyond the soil stratum, then in fact, subsoiling means nothing else than deep plowing; while, whenever it goes beyond, turning up the subsoil, it is subsoiling, properly speaking (¶350,ff.). We must recollect in this case, as in that of manures proper, that when we mix the subsoil with the soil, two different kinds of effects will be produced. In the first place, the subsoil may act as a *mechanical manure*, by improving the physical condition of the soil; by rendering it lighter, if heavy, or heavier, if too light (¶418). The latter case is very common, viz: that a heavy subsoil clay underlies a very light soil, and that the latter is very much improved by intermixture with the former, though it may not be richer in nutritive ingredients.—The former case—a light subsoil underlying a heavy soil—is much less common, and in this State, almost entirely confined to bottom, pond, and some Marsh soils.

505. Secondly, the subsoil may act as a *chemical manure* (¶416), by adding to the stock of nutritive ingredients within reach of the roots of plants, whenever it is richer in these than the surface soil; either naturally, or in consequence of the exhaustion of the latter by cropping.

To determine whether in any particular case, subsoiling may be advisable or not, is oftentimes a question very difficult of decision, unless by actual experiment, or more briefly, by analysis. Yet even the latter is not always a safe guide, unless accompanied by observation on the spot, the of circumstances under which the soil and subsoil occur.

506. *Treatment of Subsoiled Lands.*—It is essential to recollect, that, however nearly analyses may show the two materials to be alike in *ultimate* composition, the subsoil will almost invariably differ from the soil in two respects, viz: 1st. In containing less vegetable matter than the latter. 2d. In containing its nutritive ingredients in a less available condition, on account of being so little accessible to atmospheric action, and also, to that of decaying vegetable matter (¶357, 422).

It is owing to these causes, that during the first season, subsoiling often seems to produce none, or even an unfavorable effect. For so long as the nutritive matter contained is in an inactive condition, it follows that for the time being, it must exercise the same effect as though we had mixed with the surface soil a subsoil of inferior fertility, which would naturally deteriorate it.

The remedy, therefore, is simple enough. After subsoiling, we must try to supply as rapidly as possible the deficiency of vegetable matter, either by plowing in green crops, or by manuring with muck, saw-dust and the like; and we must, if possible, *stimulate* it by the use of lime, plaster of Paris, or ammoniacal manures, as the case may require. Moreover, here, as almost everywhere, stable manure is in its right place. But wherever there is no stringent necessity for occupying the subsoiled land with heavy crops the first year, it is best to allow them a season of rest or fallowing, with light crops, such as wheat or rye; after which, the stimulants will be found less necessary.

507. Whenever no serious change of the *physical condition* (as to lightness or heaviness) is to be anticipated in consequence of the intermixture of soil and subsoil, the question is reduced simply to the inquiry whether or not the subsoil is *equally* fertile, or *more*, or *less* so, than the soil. In this case, analysis will

give a categorical answer. If the subsoil, while similar in its physical condition to the soil, is similar to it in composition also, with only the differences produced by their relative position (¶506): then sub-soiling will, in matter of fact, mean little else than deep plowing. If the subsoil is *poorer* than the surface soil, then it will manifestly be inadvisable to *dilute* the latter, as it were, by the admixture of inert matter without a corresponding addition of nutritive ingredients. If on the other hand, the subsoil is *richer* in the latter than the surface soil, subsoiling is, *as* manifestly, indicated as advantageous.

As instances in which the *physical* condition of soils will be very little changed by subsoiling, I may mention, most of the soils of the main Pontotoc Ridge; the Marshall county Table lands; and the majority of the yellow loam lands of Yallabusha, Holmes and Madison counties; also, to a great extent, the prairies. In these cases, therefore, simple comparative analyses of the soils and subsoils will decide as to the usefulness or injuriousness of *subsoiling*, in the sense of *turning up* the subsoil.

508. When, as in a large number, perhaps the majority of cases, an essential *change* in the physical character of the soil may be produced by subsoiling, the question whether it be profitable or not, becomes a much more difficult one, and cannot be answered in a general manner. For while on the one hand, we may derive from it double advantages, if it should happen both to correct the physical condition of our soil, and to add to its stock of fertility; it may, on the other hand, utterly and irrecoverably ruin our land, if the change produced with respect to lightness or heaviness, should happen to fall in the wrong direction. In this case, even a greater native fertility of the subsoil would be of little use. Whenever a soil possesses the proper physical constitution, however poor naturally, it is *susceptible* of improvement at least, and thus far valuable. But if its physical properties be extremes on either side (whether naturally or in consequence of injudicious subsoiling), the soil will always be an unsafe one, no matter how great its stock of nutritive elements, and whether native or superadded in the shape of manures. [With reference to this subject, see ¶401 to 403].

509. Cases in point are far from uncommon in this State, and that with reference to both extremes of constitution. Among light soils, which would be rendered still lighter, and would, therefore, be injured by subsoiling, I may mention, most of the hommock soils of the Sea coast, a large portion of the ridge soils of Kemper, Lauderdale and Jasper counties, and a large part of bottom soils, *e. g.*, those of upper and middle Pearl River. Of those which, being sufficiently heavy in themselves, would be rendered excessively so by the admixture of their subsoil, the heavy Flatwoods soils, and a large portion of our prairie soils (especially those overlying the Tertiary, in South Mississippi), are examples; also, the bottom soils of the lower Pearl, and lower Pascagoula Rivers.

510. *Light Subsoils.*—In some cases, especially of *sandy* soils, there is, at times, still another objection, of a serious character, to subsoiling. One of the most important advantages of a good subsoil is that it prevents the "sinking" of manure, *i. e.*, of the soluble portion of it, to a depth beyond the reach of the roots of cultivated plants. It does this, not only by virtue of its density, but also, and perhaps chiefly, in consequence of its possessing the strong retentive power (which has been discussed before, ¶378, ff.) both for moisture and for the nutritive ingredients of plants. Hence the great importance which is justly attached to the question, whether or not any tract of land possesses a subsoil of the proper physical constitution. For even if the surface soil should happen to be so light that it would not ordinarily retain a supply of manure more than sufficient for a single crop, still, if the subsoil be capable of retaining it, the land is *susceptible* of permanent improvement; because the nutritive elements thus retained are not allowed to pass beyond the reach of the roots of plants.—Such s the case with a large part of the "Piny Woods" region of South Mississippi.

While naturally poor in the nutritive ingredients of vegetables, these lands often possess an excellent subsoil of yellow loam, which renders them capable of improvement to any extent; nor can there be any doubt that they will be so improved, so soon as that portion of the State shall have been rendered more accessible to the world's commerce.

511. A different state of things, however, obtains in another class of soils, examples of which have already been mentioned as occurring in many of the ridge soils of Kemper, Lauderdale and Jasper, and some of the adjoining counties. These soils, while naturally fertile, are so light and porous, that even without tillage, the roots of plants would find little difficulty in penetrating the subsoil. In examining the latter, we find at a certain depth (from 10 to 15 inches) a kind of crust or indurated portion, the presence of which explains the fact that soils so extremely sandy in themselves, will resist drouth to a considerable extent, and will also retain manure. Below this crust, however, there is nothing but loose and sterile sand. Now it is evident, that if by subsoiling we break through, and destroy, the subsoil "hardpan" in question, we shall destroy also, and irrecoverably, the capacity for improvement of the land so treated.

512. *Heavy Subsoils.*—If extreme lightness and porosity of the subsoil is a serious drawback to any permanent and reliable improvement of the soil, more can hardly be said in favor of subsoils whose character is the extreme opposite, viz: very heavy and clayey. What has been said (¶401 to 403) in regard to *soils* of this character, applies in a similar manner to *subsoils* of that class. The great density of the mass refuses to allow of the percolation of the rain water, which is, therefore, obliged to take its course along the surface, denuding the latter of whatever soil there may be of a lighter character. Hence the barrenness of the surface in the undulating portions of the Flatwoods Region, in which the heavy clay soils prevail. The soil, as analysis shows, is not too *poor* to bear grass, and with some admixture of vegetable matter it might do well. But no sooner has a thin layer of such material accumulated, than a heavy rain carries it off into the gullies, leaving the hills bare. Where the heavy Flatwoods soil occupies level tracts, each heavy rain floods the country, and the subsidence of the sheet of water spread on the surface is so slow, that crops are frequently drowned out, or perish for want of tillage.—Such are the disadvantages of a subsoil of this kind in wet seasons; in times of drouth, they are scarcely better in their action.

513. It is true that heavy clays are very retentive of water, and we shall rarely find one of these heavy under-clays dried out even during the dryest season; but unfortunately, they retain their moisture with such pertinacity, that they will not share it with the surface soil, as good subsoils will do. And as their great density forbids that the roots of plants should penetrate them, their moisture thus remains perfectly useless within them. The evil is still aggravated by the circumstance, that they oblige the roots of plants to remain nearer to the surface than would be the case in a generous soil, thus leaving them much more exposed to the injurious influence of atmospheric changes.

We thus perceive that an improper physical condition of the subsoil may be quite as injurious to crops as though the soil itself was in fault. And since it is extremely difficult, and often impossible, to remedy the defects of the *subsoil*, while the *soil* may almost always be improved, the importance attached to having "a good foundation" underlying the latter, is fully justified. The faults of a heavy subsoil may be remedied to a great extent, by thorough drainage, as has been explained above (410); but those of light and unretentive ones are often very difficult to deal with.

514. As for the ultimate and permanent advantages to be derived from subsoiling, it will readily be perceived, that *at best* they are the same as those attained by deep plowing in a fertile soil.

When after exhausting the surface soil, we throw up a subsoil of equal or superior fertility, we shall thus have, in matter of fact, a fresh soil. We can readily exhaust this soil in its turn, by the same mode of culture; and then, if our subsoiling has reached as deep as agricultural implements can conveniently go on the large scale, we shall have no further remedy but a regular system of manuring. Subsoiling, therefore, in connection with fallowing, may serve to correct the physical condition of our soil, and to increase the *duration* of natural fertility; but it is not by any means a *permanent* safeguard against exhaustion, which will inevitably arrive sooner or later, unless we restore to the soil, from an independent source, the ingredients which we have withdrawn.

515. *Tullian, or Lois Weedon System.*—It is true that a regular system of subsoiling and fallowing combined, will in many cases sustain the productiveness of soils without sensible diminution, for a considerable length of time—sufficient to convince of its unceasing efficacy, those who imagine that the experience of a few years, or even of a decennium or two, can decide *positively* as to the merits of a system of Agriculture. We can readily prove a *negative* in a short time; if a thirty years culture without rotation or manure renders our land incapable of producing cotton, the proof that our system is wrong is plain enough. But if some of our land remains productive beyond that period, it certainly does not prove that the system is correct, and that under it our land will last forever. Yet such, precisely, is the logic of some modern agricultural writers, on the subject just in hand. The system of deep and thorough tillage and fallowing, which, a century and a half ago, was devised by Tull, and during a considerable period, sustained its reputation as a panacea against the exhaustion of soils, until *time* proved its insufficiency, has lately been brought back to us in a new guise, and upon the (as is contended) *irrefragible* proof afforded by a success of *twelve years* (*!*), is proclaimed to us as a full and sufficient remedy for the growing and threatening evil. We are told that we must retrace our steps, and unlearn what the bitter experience of centuries has taught us—all for the twelve years experiment at Lois Weedon! It is nothing to the enthusiastic, but short-sighted proselytes of this system, that its temporary results are foreseen and well understood in the science of agriculture; it is nothing to them, that the system supposed to be infallible for *centuries*—that of cattle-raising for the sake of manure—has at last been found wanting, and has buried in its ruins more than one agricultural commonwealth in the old world. And not a small amount of so-called, half-understood "*science*" is brought to bear on the subject; notwithstanding that, in the same breath, science is denounced as untrustworthy, and its results, the sum of all experience, declared to be obsolete.

516. Subsoiling and fallow combined, as in the "Lois Weedon System," will help us to *eke out* a certain percentage of deficiency in the replacement, by manure, of the ingredients withdrawn: and it is not unlikely, that with crops as slightly exhaustive as cotton, when the seed and stalk are retured (¶490, ff.), several generations might not feel the want of manure, in soils of good native fertility. But if we regard it otherwise than as a safety-valve or regulator, by which we may render insensible the accidental variations in the regular compensation, and to which we may resort in a "rainy day"; if we violently appropriate to ourselves in a short time, all that portion of the fertility of the soil which the fallow could develop with useful rapidity: then we shall arrive precisely at the point to which the excessive use of lime or guano brings us, which "enriches the father, but impoverishes the son."

517. Drainage has already been mentioned as being somewhat analogous in its action to subsoiling (¶409), though it carries with it numerous other advantages. But however valuable as an improvement, and especially as protecting the crops against the vicissitudes and accidents of the seasons, it cannot, any more than rotation, subsoiling or fallowing, prevent the exhaustion of the soil. It is true that, if we look only to the direct experience on lands artificially thorough-drained (which has not been very lengthy), numerous instances might be quoted in which the good effects at first experienced, still

remain the same after a series of years. But in this as in many other cases, a few well established negatives as to its power of preventing exhaustion, will disarm any number of positives which have not stood the test of time. And there are plenty of soils *naturally* thorough-drained, whose utter exhaustion plainly proves the fact, that for the latter, drainage also is only a palliative, not a remedy.

3. MANURING.

518. It remains to say a few words in reference to the general policy to be pursued in the utilization of the powers of the soil, and their sustentation or restoration by means of manures.

The Dung-producing System of Culture.—It has been already stated, that stable manure and night-soil may be considered as *universal manures*, containing all the ingredients required by plants, both directly and indirectly. Experience had proved this to be the case, long before the causes upon which this universality depends, had been recognized; and hence very naturally it was thought that the unfailing plan of culture consisted in producing on the farm an amount of stable manure sufficient to allow of dressing with it the land cultivated, whenever it should give out; or else, to sustain evenly its fertility, by dressings repeated at regular intervals.

519. Such, in fact, is the method which, for a considerable period, has been dominant on the continent of Europe, and was regarded as perfectly rational, long after the gradual failure of crops of every kind had, in thousands of individual cases, practically demonstrated the fallaciousness of the system. Such instances were ingeniously explained away on special grounds; and even at the present time, when the progress of Agricultural Chemistry has established beyond all cavil the true causes of the failure alluded to, the great bulk of the agricultural population of Europe still fondly clings to the fallacy which has been handed down to them by their fathers. They raise stock for the sake of manure, wherewith to fertilize their grain-fields; a portion of their land being always set apart for the sole purpose of raising the necessary feed.

520. *Fallacy of the Dung-producing System.*—It is obvious that in this procedure, all that is gained is to concentrate on the *grain-field* a part of the nutritive ingredients which have been withdrawn from the *clover-field* and the *meadow;* these, having been converted into manure in passing through the animal system, are thus transferred from one field to the other in a highly available condition, accompanied, also, by abundance of ammonia and vegetable matter. Ultimately, they are converted into marketable grain. Another portion of the ingredients abstracted from the feed-fields, remains with the stock, in the shape of flesh and bones, and is in part sold as such, partly as milk and cheese.

Now, whether the produce of the feed-fields be sold in its first form, as hay or turnips, or whether it be previously converted into grain and meat: it is plain that the mineral ingredients contained in these products, are *finally* withdrawn, and entirely lost to the soil, while nothing is given in return. Thus the capital stock of fertility is continually drafted upon, and will, of course, come to an end at last; as experience has shown. And but for the importation of manures from foreign countries, it is difficult to say what would be the present condition of a large portion of Central Europe.

521. In *this* country, wherever the necessity of manure has come to be felt, the first movement has been towards the establishment of a similar system. "We must raise more cattle in order to get a supply of manure!" has been the cry, which is now heard even in this State.

The change which it is thus proposed to effect in our agricultural habits, is a very serious one. The propriety of so far increasing our stock, as to supply our own demand for meats, has been much discussed of late, and will hardly be questioned. But when it comes to encumbering ourselves with millions of living dung-manufactories, the question assumes a very different aspect. To raise the feed and to attend the cattle, will occupy nearly, or quite, one-half of the laboring force of the country; which will, therefore, likewise be occupied in manufacturing dung, in order that the other half may be enabled to raise cotton—provided, such a thing could be done profitably under such circumstances.—Nor could the *meat* thus raised avail us anything; it would be a drug, for which we could find no market that would pay us back the cost of raising. And over and above all these inconveniences, we should only arrive at last at the same point which we might have reached by a much less circuitous route (*e. g.*, by subsoiling and fallowing alone, according to the Tullian, or Lois Weedon system); to-wit: utter exhaustion of our soil.

522. While it is a matter of the last importance that we should avail ourselves to the fullest extent, of such stable manure as a sound policy will enable us to obtain as a *collateral* product: the doctrine of cattle-raising *for the sake* of manure is based upon a fallacy; and a consistent adherence to it will slowly, but inevitably lead to bankruptcy of any agricultural commonwealth. It is true that under this system, when combined with deep tillage and a suitable method of rotation, land will endure longer than under any *other* which does not replace the nutritive ingredients annually abstracted from the soil It is admirably contrived to make the most of the finite stock of fertility which the land may possess. But in this case, as in many others, the longer we allow ourselves to be deceived, the more difficult will it be to repair the damage done. When at last our children or grand-children arrive at the "end of the string"; when our lands, incapable of further producing even feed for our cattle, shall doggedly refuse to furnish us the every-day necessaries of life, unless in exchange for a corresponding quantity of manure; we shall find ourselves obliged either to import the latter, or else, the necessaries of life themselves. Our native stock of fertility being exhausted, we shall be entirely dependent upon this supply from without, every irregularity or failure of which will be felt as a national calamity.

Thus, if at the present time, the supply of guano* to Europe were to fail for a single season, the consequences would be most disastrous to whole countries, which are unable to make their lands produce save by the action of that powerful agent. In such a case, the deficiency in South American guano would probably have to be supplied in the shape of corn and wheat, from the United States. It is not necessary to be an expert in National Economy to perceive how ruinous must be the consequences of such a state of things.

523. THE LOST FERTILITY.—It may be asked what has become of the indestructible matter which formed the original stock of fertility, now lost by mismanagement? The answer will readily suggest itself to every thinking man, when he considers what is the ultimate destination of agricultural products, viz: to serve as food and raiment to man. Whatsoever we feed to our stock, is partly consumed by man as meat, milk, cheese, eggs, etc., partly returns to the fields through the manure pile—diminished by the amount contained in our food, each time it thus circulates. For, unfortunately, night-soil, the most efficacious of manures, is thus far mostly regarded as a nuisance, to get rid of which is a problem which has occupied much ingenuity and talent. Our privies, and the sewers of our cities, are undeniably the channels through which the fertility of our lands is either drained into the ocean, or else accumulated in receptacles which, by common consent, are held as being among

*Guano, on the continent of Europe, is generally combined, or used at the same time with, other manures, which it renders more effectual, without producing the exhaustive effects which are known to follow its exclusive use, in this country.

the most unpleasant necessities of our fallen state; yet they are, in reality, so many Guano-islands, whose benefits we can realize with only a nominal cost of transportation.

524. In the conscientious utilization in agriculture, of human excrements, both fluid and solid, together with bones, dung and all other offal, now partly used for these purposes, we have beyond a doubt, the only *universal* preventive of the exhaustion of cultivated lands. For it is they into which almost all the products of our fields are *ultimately* transformed, and in them we shall, therefore, expect to find all that has been withdrawn from the former. And if instead of eatables, we raise cotton, we shall have to import a corresponding quantity of provisions; these, when transformed into night-soil, would more than replace all the drain on our lands caused by the cotton crops, if properly distributed.

It may be objected, that if we were to husband the material in question, as the Chinese have successfully done for ages, we should have to change our habits, and blunt some of our senses, and delicacy, to an alarming extent.—Fortunately, the science which has annihilated space and compelled lightening to be the messenger of thoughts, does not abandon us in this problem, momentously simple as it is. The use of disinfecting agents (many of which themselves enhance the value of the material for agricultural purposes), in connection with the proper mechanical contrivances, would enable us even at the present moment to preserve these valuable fertilizers, without any serious offence to our delicacy, if we would but introduce, in this respect, a regular, uniform system; and if we are to judge by analogy, we can scarcely doubt that more perfect contrivances for the purpose would be forthcoming, so soon as the demand for them should become general and urgent. On the continent of Europe, the agitation of this subject has already been attended with the most beneficial results.

525. It would be extravagant to expect, that such a system should be universally established in this country, until the necessity shall have been more keenly felt. But we have this great advantage, that in our agricultural population there is less settled prejudice and routine to be overcome, than in Europe. They are eager and willing to accept the teachings of true science, and we may hope with some confidence, that by a timely application of these to practice, the ills which now weigh down a large part of the agricultural population of Europe, may be avoided.

526. But while, in a new country like ours, it may not be practicable to establish *at once* a system of agriculture *perfectly* rational, we may try to approach such a system, as nearly as we may under the circumstances. Let us husband the powers of our soils by a proper system of rotation, taking care at the same time, not to withdraw from our fields more than is necessarily contained in the marketable portion of our crop. Let us apply to our fields all the manure we can conveniently obtain, without waiting for the soil to become "tired." If we have once thus far exhausted them, we shall be obliged to expend *at once*, in its *restoration* to fertility, a much greater amount of money or labor, than that which its *sustentation* would have cost us, and which, being expended at convenient times, when there was little else to do, would scarcely have been felt.

Wherever marls containing the elements of fertility are convenient, let them be applied at once, regularly and systematically; marling every year a certain portion, at least, of our lands, so that the whole shall have received a dressing in the course of from four to ten years, after the lapse of which we shall begin again at the point from which we set out. Let us recollect that while in the use of stimulants (lime, gypsum, etc), in connection with subsoiling and fallowing, we have the means of relieving our *immediate* necessities, we cannot rely on them for the *future*, and that each application of the former shortens the *duration* of fertility, in precisely the proportion in which it increases our crops. A regular and constant succession of good average crops, which enrich slowly but surely, is certainly preferable to a brief period of brilliant crops, followed by exhaustion of the soil.

And while, in this respect, each one must be left to judge, and act according to, the stringency of his own particular case; yet let him recollect that the time will surely come, when he will have to yield obedience to the inexorable law, that *no land can be permanently fertile, unless we restore to it, regularly, the mineral ingredients which our crops have withdrawn.*

2. *SPECIAL PART; AGRICULTURAL FEATURES OF THE STATE OF MISSISSIPPI.*

THE NORTH-EASTERN PRAIRIE REGION.

Comprising the Counties, and parts of Counties, East of the Flatwoods Region, viz: Tishomingo, East Tippah, Itawamba, East Pontotoc, Monroe, East Chickasaw, Lowndes, East Ocktibbeha, East Noxubee, and Northeast Kemper.

527[1]. The name given above for this group of counties, must not be understood as implying that the whole, or even the greater part of the area included therein, is of a prairie character; but only as including all that part of North Mississippi in which prairies do occur, more or less. It might perhaps have been more properly, though less intelligibly to agriculturists, designated as the Cretaceous, or North-eastern Lime Region, inasmuch as its prominent agricultural as well as geological features, are dependent upon the several calcareous strata of the Cretaceous formation (¶99, ff.); with the exception of a few townships in E. Tishomingo county, where the limestone and sandstone strata of the Lower Carboniferous formation (¶80, ff.) prevail.

For a full understanding of the agricultural conditions of this region, it will be well for the reader to refer to what has been said with reference to the cretaceous formation, in the Geological Report, pages 60 to 106. For convenience, however, I shall here briefly recapitulate the general features.

527[2]. The cretaceous formation of Mississippi consists essentially of four different stages or beds, which have a W. or S. W. dip of about 25 feet per mile, and possess the following general characters. The uppermost of these divisions (Ripley Group, ¶128), which of course appears to the westward of the others, consists of hard, sandy limestones, with strata of blue shell marl between, and generally, one of heavy gray calcareous clay on top: these strata, overlaid by a yellow or orange-colored loam, form the Pontotoc Ridge. The middle stratum consists of white clay marls or soft limestones—"Rotten Limestone" (¶116, ff.), and forms a level or gently undulating surface, mostly with heavy, calcareous soils, partly prairie, partly oak uplands, poor in springs and with limy well waters—the Prairie Region proper. The other two (EUTAW, and TOMBIGBEE SAND GROUP, ¶101 to 115) consist of sands, more or less clayey and in part (on the territory colored dark green on the map—Tombigbee Sand Group) limy; the region occupied by them is hilly and sandy, and the soil generally inferior; springs are abundant and their water mostly freestone. The lands on the territory of the Carboniferous formation (which consists of hard limestones and sandstones) do not differ essentially, or at least *characteristically*, from those of the last mentioned groups, save perhaps in that pebbles are very abundant on the surface; as are also fine, cold, freestone springs.

I must observe that unfortunately, at the time of my visit to the counties of Tishomingo, Itawamba, Tippah, as well as the greater portion of Pontotoc and Monroe, (1856), the special examination of the soils was not considered, as it is at present, the paramount object of the Survey, and hence, my observations there on this point are greatly wanting in completeness, and but few specimens of soils from that region are in my possession. The gap will, of course, be filled up hereafter, as soon as possible.

528. TISHOMINGO AND ITAWAMBA.—There is so great a general resemblance in the geological and agricultural features of these two counties, that they may as well be considered jointly. In the western portion of both, we find gently undulating oak uplands, interspersed with spots and patches of *black* and of *bald* prairie, with wide, fertile bottoms; this region is indicated on the map by a yellowish-green tint. Passing eastward from it, we enter a more hilly region, with a poor sandy soil, whose prevalent timber is Short-leaf Pine, Black Jack and Post Oak, together with Chestnut; the bottoms being narrow, but fertile. This is the character of the "Pine Hills" of N. E. Mississippi; whose supply of water is generally dependent on, and bears the characteristics of, the Orange Sand formation (¶75 to 77.)

Beyond these we find in Tishomingo, on the waters of Big Bear, and Mackay's Creek in part, a more gently undulating region with a more fertile soil, whose timber is a rare mixture of trees otherwise not often found together on the same soil.

529. SANDY UPLANDS OF EAST TISHOMINGO AND EAST ITAWAMBA.—The Tennessee River has little or no bottom on the Mississippi side, the Pine Hills (on which the slaty hydraulic limestone crops out—¶92. ff.), coming up pretty close to the bank, which is timbered with Walnut and Sycamore—trees not common in the interior in this region. Yellow Creek, which at its heads is remarkable for the width of its bottom, possesses but a very narrow one in the lower portion of its course. The hills immediately bordering on the bottom, which have gentle slopes, are quite fertile; but as we recede from the creek, Pine Hills set in.

The heads of Yellow Creek generally possess wide and fertile bottoms, timbered with a fine growth of White, Water, Willow and Chestnut White Oak, "Poplar," Sweet Gum, Hornbeam, and Birch. Large Cypress is found in the lower portion of the course. The ridges intervening between the several forks of Yellow Creek, however, are poor Pine Hills, cultivated chiefly in the minor bottoms and hollows.—The same is true in reference to the lands on Indian Creek. In the region around, and S. and S. W. of Eastport, to the M. & C. R. R., the surface of the country is very pebbly, and the hillsides come down quite abruptly into the valleys. There are occasionally tracts of good loam uplands in this hilly region, but they are generally small, and cultivation is mainly confined to the bottoms and their slopes—Pine, Post Oak and Black Jack forming the prevalent timber, with which, where the land is of better quality, the Spanish ("*Red*") and (*true*) Red Oak mingle. The slaty hydraulic limestone of this region (¶92) might, when burnt, be profitably used as a fertilizer on the loam soils. A great deal of good pine timber still exists in this region ; and plenty of fuel, for the manufacture of hydraulic cement, could be obtained.

530. The lands of the immediate Bear Creek valley are very fine, and produce abundant crops of corn and cotton. The Pine Hills themselves, as we approach Bear Creek, become less broken and more fertile ; generally (especially in S. W. Tishomingo) we find on the W. side of the creek a level or gently undulating tract, or terrace, elevated 30 or 40 feet above the water, which often comes up to the very banks of the stream ; where there is a steep descent.

The timber, as before stated, is singularly various ; chiefly Oaks—Spanish ("*Red*"), Water, Red, Black, Post, Black Jack and Chestnut White Oak, Sweet Gum, "Poplar," Dogwood, Pine, and occasionally some Red Cedar—all grow together harmoniously, the soil being quite fertile. The same feature extends, more or less, to its tributaries also. On the pebbly ridges, however, Pine, Post Oak and Black Jack alone prevail.

On Cedar Creek (Ala.), and on the waters of Mackay's Creek, where the hard siliceous sandstone of the Carboniferous (¶88, ff. ; 96) prevails, the timber is remarkably sparse and generally small ; and the rocky Pine Hills are very poor.

On the main Mackay's Creek, as well as on the heads of Little Brown's Creek, we have some gently undulating tracts of loam lands, where the absence or scarcity of Pine, and the good size of the Oaks, testifies to the improvement of the soil, which nevertheless, on the higher dividing ridges, is of the Pine Hill aspect.

531. For the rest, almost all the territory covered by the deep green tint in Tishomingo, embracing the heads of Yellow Creek, the E. heads of the Tuscumbia River, and those of Big Brown's Creek down to the line between townships 5 and 6, is of the Pine Hill character, as above described—with narrow, though fertile bottoms, and sandy ridge soils which not unfrequently, however, possess a good loam subsoil, and are susceptible of good improvement. Southward of the line mentioned, the higher points of the ridges only are of the Pine Hill character, while the slopes (on *lower* Big Brown's, Twenty Mile, Mackay's Creek, etc), which are but gently undulating, bear a fine growth prevalently of Spanish Oak and Hickory, with which the other upland Oaks mingle more or less. Though not first class lands, these soils, which are generally light, are quite productive and well adapted to every improvement (¶111 ; 140).

532. East Itawamba, beyond the wide and fertile bottom of the Tombigbee (unfortunately subject to annual overflows), is very much broken and possesses a sandy, inferior soil, of the Pine Hill character, which is often remarkable for its deep orange-red tint. Occasionally there are tracts possessing a surface covering of good loam soil; and the bottom, though narrow, as well as the slopes towards them, have soils of good quality, which are not as sandy as might be expected, in consequence of the streams cutting their channels, not unfrequently, into the clays ("soapstones") of the Eutaw Group (¶101).

The bottoms of Bull Mountain, Hurricane Creek, etc., are wide, heavily timbered and very fertile; their bottom soils contain a great deal of bog ore or "black gravel" (¶387, ff.). On the dividing ridge, in the fork of the Tombigbee and Bull Mountain, we find quite a fertile red loam, timbered with large Post, Spanish ("*Red*"), Scarlet ("*Spanish*"), Red, and sometimes Black and White Oak, with Hickory and usually some sturdy Short-leaf Pine. South of the Bull Mountain, as we approach Smithville, the country becomes level and there begins the extensive flat or second bottom, which skirts the Tombigbee on the east, with a width of from two to six miles, down to the Alabama line; while in North-east Monroe, we observe the character of the hilly country adjoining this flat on the east, to be the same as in East Itawamba.

533. East Monroe, and Valley of the Tombigbee.—The portion of Monroe county lying between the flat or hommock of the Tombigbee, and Sipsie and Buttahatchie Creeks, is generally hilly and broken (as indicated on the profile, Fig. 2, Pl. I.), and its northern portion, as has been stated, differs little from the Pine Hills region of East Itawamba; the creek bottoms, though fertile are narrow, and it is but occasionally that in the uplands, small tracts of good loam soil are found.

The land gradually improves, however, as we advance southward, Pine becomes less frequent, and the ridges broader. Eastward of Athens, the main dividing ridge between the waters of the Tombigbee and Buttahatchie, is a kind of plateau or table land, possessing a fine mellow soil resembling in aspect the yellow loam land of the Pontotoc Ridge (see below, ¶562), and forming some considerable bodies of good farming land, which is already well settled. The loam stratum is not very thick, however, and being underlaid by loose sands, it "caves" and washes away badly on the hillsides (on which extensive gullies are often formed), though otherwise possessing, to a considerable extent, the advantage of being underdrained by the pervious sands. On the slopes or rather, the spurs of the main ridge, however, the Pine Hill character is prevalent, and rocky knolls not unfrequently appear perched on the ridges (¶11, 12).

534. With the extreme south-east portion of Monroe, and north-east Lowndes, I am thus far unacquainted. The bottoms of the Sipsie and Buttahatchie are wide, heavily timbered, and possess a rather light, fertile soil, bearing chiefly Beech, "Poplar," Sweet Gum, Black Gum, Shell-bark and other Hickories. The slopes towards these bottoms are mostly gravelly (¶18), and springs with freestone water are generally abundant.

535. The hommock which, south of the Itawamba line, skirts the Tombigbee on the east (while on the west side it is usually bordered by high hills or bluffs), generally possesses a rather light soil, underlaid by a pale yellow loam subsoil, which is somewhat heavier, but commonly at the depth of a few feet, is underlaid

by yellow sand or gravel; the latter being always reached at a depth of fifteen to twenty feet, at which a good supply of freestone water (generally brought up by sweeps), is obtained The surface of this hommock, which slopes off gradually into the bottom proper, is almost perfectly level to the eye; here and there, however, limited ridges composed of gravel, pebbles, or "Orange Sand," stand out in the plain like islands—prominent instances of which may be observed on the road from Aberdeen to Columbus on the east side of the river; while small patches of the same kind are found more or less all over the region (542).

The soil is generally fertile, and well suited to both cotton and corn; in some points where (as near Columbus) it is very sandy and gravelly, it will at least bring fine sweet potatoes. It may, as a general thing, be considered as being naturally underdrained; though in some localities the loam stratum is too thick to allow the water to subside readily into the underlying sand and gravel. The timber is various; throughout, the Bottom Pine (*P. taeda*) and Dogwood are very prominent; near Smithville, these are accompanied by Black Jack, Post, Spanish (" *Red*") and Scarlet (" *Spanish*") Oak; lower down, as between Athens and Aberdeen, the Chesnut White Oak, Sweet Gum, Black Gum, and (upland) Hickories prevail largely. As we approach the river, the timber gradually assumes somewhat more of the bottom character, and Cypress, Tupelo, Hackberry, Shell-bark Hickory, Ash, etc., appear.—The region is, thus far, not nearly as much settled as its fertility and easy cultivation would seem to warrant, in consequence, it is said, of the prevalence of fevers—which will, no doubt, disappear in due course of time, as has been the case elsewhere.

536. In Lowndes county, where the wide bottoms of the Buttahatchie and Looxapalila join the Tombigbee flat, it occupies a very large area on the east side of the river. On the west (or right) side of the river, however, this soil occurs but sparingly—only where large and sudden bends occur. As a general thing, the Tombigbee is skirted on the west side, either *on*, or at no great distance from, the bank, by high, sandy hills, whose lower portion consists of the greenish micaceous sand of the Tombigbee Sand Group (¶108), while the upper consists of Orange Sand or, in a few instances, of the Rotten Limestone of the prairies (¶106). Usually there intervenes between the latter and the river, a tract of high and hilly sandy land, some miles in width, which in some regions (Aberdeen) possesses a fertile loam soil, in others (between Aberdeen and Columbus) consists of Black Jack and Post Oak ridges, from which there is a gradual transition, through yellow loam uplands, to the prairies proper.

537. The west side of the Tombigbee in South Itawamba is generally occupied by Pine Hills or Post Oak ridges, for several miles from the river; beyond, the country gradually assumes the character of the lands on lower Big Brown's Creek (see above, ¶531) and then passes into the "White Lime Country." The same transition occurs in north-east Itawamba—the agricultural features being, as will be perceived, pretty correctly indicated by the lines of the geological formations. As regards the occurrence and use of natural fertilizers in the regions just described, the reader is referred to the Geological Report (¶140, ff.) and General Part of the Agricultural Report (¶450).

538. "White Lime Country" of Tishomingo and Itawamba. This region, indicated on the map (like the Prairie region proper) by a yellowish-green tint, and underlaid by the Rotten Limestone or its equivalents (¶116, ff.), comprises the best lands of both counties, and is characterised by a gently undulating surface, and soils prevalently heavy (and to a great extent calcareous), from which the Pine is absent (except sometimes near its borders, on higher

sandy ridges), while Oaks, and prominently among these the Post, Red ("*Black*") and Black Spanish ("*Red*") and Black Jack Oak, form the timbers of the yellow loam uplands, mixed, most usually, with some Hickory, wherever the limy strata are not very near to the surface. Where these are so near as to influence the soil directly, we have either black (or sometimes "bald"-) prairie soils; or their intermixture with the loam soil—"Mahogany soils"—or, at times, a very stiff, pale greenish-yellow clay soil, constituting the "Beeswax Hommocks," which are timbered exclusively with middle sized Black Jack—representing, apparently, the "Hog-wallow" soils of the Central Prairie Region (¶746).

539. As for the black prairie soil, it rarely occurs in tracts of any great extent within the two counties before us, north of Old Town Creek; except in some bottoms, where the Rotten Limestone is only a few feet underground. Otherwise, it usually appears in patches of a few acres on the hillsides (as also does the "Bald-prairie soil"), the tops or plateaux being occupied by yellow loam, and the soils of the minor valleys and hollows formed by a mixture of the two.

Hence, wherever the surface is somewhat undulating, a very great variety of soils is often produced within very narrow limits. The Honey Locust, Wild Plum and Crab Apple, generally mark the spots where, in the uplands, the soil is either of the black or bald-prairie character; while in the bottoms, in addition to these, the Sycamore, Mulberry, Black Walnut, Ash and "Poplar," and here and there a Cottonwood, are seen; the Chesnut White, or Basket Oak, is also common. The great abundance of Red Bud and Pawpaw in the bottoms, and the beautiful, tall green columns formed by the American Ivy,* not only on living trees, but no less on the blackened stumps in the fields, which elsewhere mar the landscape, also strike the traveler when approaching this region from the Pine Hills of the Hatchie or Tuscumbia. Next to this, he will become acquainted with the fact that springs are almost entirely wanting in this region, and that therefore the creeks are without flowing water during the greater portion of the year (unless heading beyond, in the Pine Hills); and that commonly, either cisterns, or deep bored wells with limy water, supply the place of the natural sources (125, 157).

540. At Farmington, and north and north-west of the same, we have an almost level tract of very fertile lands, whose soil is of the yellow loam character, easily tilled, and timbered chiefly with large, stout Post Oaks, whose trunks, as on the prairies, almost invariably curve to one side; with it occur similarly stout and well-conditioned Black and Spanish ("*Red*") Oaks. The soil is deep, and would no doubt be greatly benefitted by the clay marls (¶140; 141) which in this region, are generally twenty to twenty-five feet underground in the uplands, but may probably be had access to

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*It is a great pity that this beautiful creeper (*Ampelopsis hederacea*), from a very superficial resemblance to the Poison Ivy (*Rhus toxicodendron*), should be so little appreciated (not to say shunned) as an ornamental vine in its native land. In Europe it is highly esteemed, and almost throughout Germany the railroad depots have been beautified by arbors and trellises covered with this plant. It can never be mistaken for the Poison Oak or Ivy, when it is simply recollected that the latter always has only THREE leaves or leaflets on each leaf-stalk, while the Virginia Creeper, which is perfectly innocuous, has FIVE of these.

more easily in the bottoms, in which the soil sometimes assumes a prairie character. Black and bald prairie are said to set in shortly after crossing the Tennessee line, north of this region. At Corinth the heavy clay marls, as may be observed in the Railroad cuts, are much nearer the surface, and the soil is correspondingly heavier. The country between Corinth and Chawalla is more undu ating than the lands near Farmington, and although productive, its soil is not equal, on the whole, to that of the latter, its growth of timber being also inferior, and on the ridges, disposed to be scrubby. The Tuscumbia bottom is wide and fertile, but overflows.

541. South of the Tuscumbia, in the fertile regions about Kossuth and Danville, we have frequent alternations of the yellow loam soil on the uplands, with spots of prairie on the hillsides and in the bottoms.

Here, as elsewhere, the washings from the loam and sand hills often greatly improve the heavy prairie soil, rendering it safer, and forming the thrifty "mahogany" soils. Where the loam stratum is sufficiently thick, so as to allow of this washing without penetrating the loam into the Orange Sand, advantage may be taken of this circumstance, since the loam appears to be equally rich in its whole mass, and a new soil is readily formed on the washed surfaces; but the washes must not be allowed to penetrate into the reddish hard-pan underlying the loam, which cannot serve as a soil. In general, wherever an intermixture of the two soils can be conveniently effected, it ought to be done. The marls of the region (such as that on the Parmeechee (¶118), and at other points on the creeks) will undoubtedly be of great service on the yellow loam uplands, in which deep tillage is found to be highly effectual.

542. In TT. 1 and 2, R. 6 E., pine ridges divide the waters of the Hatchie and Tuscumbia, the line given on the map running very nearly on their eastern slope, *e. g*, near Bone Yard. In the S. W. part of T. 3, and W. half of T. 4, however, gently undulating oak uplands form a dividing pla'eau, whose timber—Post, Black Jack and Spanish ("*Red*") Oaks, with Hickory—seems to indicate a fair soil, although thus far it is but thinly settled—perhaps on account of the scarcity of water, which can, however, be remedied by bored wells.

Further east, near, and south of Rienzi, the country is essentially the same as near Danville, and as described in the general remarks on the region (¶538)—the black prairie soil, as well as the bald prairies, being on the whole more frequent near the eastern than the western border of the belt; and the same features continue, with little variation, to Old Town Creek, in Pontotoc and Itawamba, so that to describe every portion of this tract would involve continual repetition. The conntry around Richmond and Ellistown is a copy of that near Rienzi, only that in general, as we advance southward, the prairie soil appears more frequently, and in larger patches, until, after crossing Old Town Creek in Pontotoc, we find in the "Chickasaw Old Fields" (¶121) the beginning of the prairies proper, which set in inforce on the Chiwapa, Tallabinela and Luckatubby, in the south-east corner of Pontotoc county.

543. On the eastern border of the prairie or "White Lime Country" belt (as near Carrollville, Richmond, etc.), we generally notice rather a gradual transition of the gently undulating, yellow loam uplands, into the sandy soils or Pine Hills before described; and while in North-east Tippah we meet pretty suddenly the

Hatchie Hills, in South-east Tippah, and Pontotoc, we mostly find the fertile hilly lands and highly colored soils of the Pontotoc Ridge, distinctly marking the western outline of the "prairie country." In South-west Itawamba, east of Old Town Creek, the creek bottoms are remarkably wide, not of a prairie character, but timbered largely with Willow and Water Oak, and possessing a fertile, easily tilled soil. We here find also at the western border of the sandy region (*e. g.*, near Borland, P. O.), a belt of "beeswax hommocks" (closely resembling those of the eastern portion of the Pontotoc Ridge opposite) whose soil is formed from a very clayey variety of the Rotten Limestone, which often crops out on the hillsides. Southward of this point, however, the "beeswax hommock" soil is not often seen, and the soils of the prairie region usually become lighter, as we approach the eastern border.

544. THE PRAIRIE REGION PROPER.—The surface configuration and general features of this territory have of necessity been discussed, to a great extent, in the Geological Report, under the head of the Rotten Limestone Group (¶116, ff.), to which place I refer the reader for the chief points, while giving more specially, in this place, such observations as the limited examination which its soils have thus far received, has enabled me to make.

The prairies proper—level, or very gently undulating tracts, possessing a deep black, heavy soil, on which timber is very much scattered or altogether wanting—form, as has been stated, belts, or series of disconnected patches, having on the whole, a north and south course; and are interspersed with tracts of a more rolling surface, mostly with a shallow, pale, light soil, timbered with the common upland Oaks—Spanish ("*Red*"), Post, Black Jack, and sometimes Red and Black ("*Black*") and Scarlet ("*Spanish*") Oak—which, though usually perhaps of average fertility, is sometimes absolutely poor, as may be gathered from the scrubby, stunted growth it then bears; the productiveness varying, it appears, very nearly in proportion to the approach of the Rotten Limestone to the surface. Here, we find not unfrequently, where these uplands slope off toward the creek bottoms, "hommock" lands, increasing in fertility as we descend, and in the bottoms themselves (where the white rock is only a few feet underground), passing into black prairie soil, differing little from that on the ridges; though, perhaps, in general it is somewhat lighter, and richer in vegetable matter.

545. The character of the soil of the cretaceous prairies has been repeatedly referred to (116; 336, ff.; Gen. Agr. Rept.). It is a very heavy clay soil, of a dark tint, and possessing a pale, dirty greenish-yellow subsoil, of equal or greater heaviness, underlaid, at a depth of three to ten feet (on the prairies of Monroe and Chickasaw) by the Rotten Limestone. The soil is sometimes without timber of any kind, but usually bears clumps at least, of Crab Apple, Wild Plum, Honey Locust, and Persimmon. These mostly occur even on the "bald prairies," where the rock is so close to the surface that its admixture to the soil is evident to the eye; while whenever the soil and subsoil are of greater thickness, isolated Black Jacks and Post Oaks, of a stout growth and peculiar form (the Black Jacks with a round, close top; the Post Oaks with a stout, rapidly tapering trunk and very dense, rounded top), also occur. On the regular "black prairie," the color of the soil exhibits little change for twelve to eighteen inches; and sometimes an admixture of vegetable matter is perceptible

even to the depth of three feet—which in the *bottom* prairie soils, is quite usual. Lower down we find the stratum of a uniform tint (see above), down to the surface of the Rotten Limestone.

546. Towards the edges of the black prairie, the black soil becomes shallower, the pale, greenish subsoil approaches the surface, and finally reaching it, forms the "Black Jack prairie," which generally skirts the prairie proper, and possesses a soil resembling that of the "beeswax hommocks" further north. By degrees this soil passes over into the lighter soils of the oak uplands.

I have not yet analyzed the soil of the Black Jack prairie; it is evidently, however, of the same origin as the prairie soil and subsoil proper, and probably differs from the latter essentially in the smaller proportions of the Rotten Limestone which it contains—the rock being too far underground to have contributed essentially towards its formation. It is therefore, highly probable, that if this defect were remedied by marling it with the rock, or the lime made therefrom, and a proper amount of vegetable matter introduced, the yellow clay soil of the Black Jack prairie could be made to resemble very closely, in its properties, the true black prairie soil.

547. As regards the composition of the latter, I have to regret having been unable to complete the analysis, already begun, of a specimen from the prairie belt of Monroe county. I shall give, however, such determinations as have been made, together with the complete analysis of its *under*-subsoil.

No. 172. Monroe Prairie Soil.—From the prairie on the Pikeville and Aberdeen road, S. 20, T. 14, R. 6 E.

Depth: Eight inches.

Vegetation: Large, sturdy Post Oak and Black Jack, scattered.

Color, dark gray when dry, black when wet. The soil, in washing with warm water, yielded 2.1 per cent. of smooth, round concretions of Iron Ore, from the size of buckshot down to that of a Poppy-seed (¶336), together with a little sharp, white sand.

Saturated with moisture at 67.1 deg. Fahr., it lost 10.535 per cent. of water at 400 deg. Fahr.

The soil thus dried lost, by ignition, Organic Matter and Water 6.031 per cent.

548. The immediate *subsoil* at this point, though also sampled, has not as yet received any examination, the object of the following analysis being to ascertain the agricultural value of the average mass of the whole stratum.

No. 173. Monroe Prairie Under-Subsoil.—*Locality:* Same as the preceding.

Depth at which taken: Three feet. Color, a dirty greenish-yellow. Forms an exceedingly tough paste when wet, but like the surface soil, crumbles in drying.

The same kind and quantity of iron ore concretions as in the preceding, were washed out of this subsoil. Saturated with moisture at 67.1 deg Fahr., it lost 12.821 per cent. of water at 400 deg. Fahr., dried at which temperature it consisted of:

Insoluble Matter	71.539
Potash	0.542
Soda	0.230
Lime	1.075
Magnesia	0.771
Brown Oxide of Manganese	0.046
Peroxide of Iron	5.419
Alumina	13.153
Phosphoric Acid	0.051
Sulphuric Acid	0.036
Organic Matter and Water	6.992
	99.945

This underclay is undoubtedly poorer in the nutritive ingredients of plants, than the higher portions of the stratum, in which they have accumulated from the vegetation of many years, being, at the same time, tenaciously retained by the heavy surface soil. The latter probably approaches nearer, in composition, to the soil of the tertiary prairie (¶744). The composition of the above subsoil is still, however, that of a good average soil, and suggests at once the importance of affording the roots of plants as much opportunity as possible to penetrate *deeply* into the soil; the more so as the large amount of alumina which in this instance passed into solution (compare in this respect the analysis of the equally clayey Heavy Flatwoods Soil, ¶571) seems to indicate that the ingredients contained are, through the action of the lime in the mass (¶437, 445), to a great extent in an available condition.

549. While it would be premature to attempt to discuss more specially the relations of the soil and subsoil of the prairies, until further analyses shall have been made, the data already obtained are sufficient to give some important hints concerning the cultivation of the prairie soils of the region before us. They are almost throughout very heavy soils, and what has been said in general regarding these (402[1], ff.), applies pre-eminently to the prairies of N. E. Mississippi. Unlike the heavy Flatwoods soil, however, the prairie soil and subsoil, when they dry after a thorough wetting, crumble into small fragments, so that, on a sunny day, one unacquainted with the nature of the soil might suppose that the crumbly or powdery soil before him was of quite a light character. The cause of this property seems, to some extent, to lie in the *lime* contained in the soil, for it is observed to exist in most of the calcareous clays of the State (¶203; 281), and causes the formation, by the roadsides in the prairies, of deep washes, which otherwise one is accustomed to see only in sandy soils.

550. Like most heavy soils in their natural condition, those of the prairies are now considered *unsafe*; *i. e.*, crops suffer very severely by every extreme of wet or dry, and it is difficult to obtain a "stand", if the season is at all extreme. The peculiarity above mentioned, *viz:* that of crumbling readily whenever a change from wet to dry occurs, is pre-eminently favorable to the correction of the prairie soils in this respect; for it is evident that proper *drainage* is all that is required to render the soil safe against the ordinary vicissitudes of the seasons. The advantages derived from the underdrainage of clay soils (¶409, 410) will be comparatively of easy attainment in the prairies. So soon as, by this improvement, we enable the roots of our crops to penetrate to where the prairie crawfish keeps up an unfailing supply of water during the dryest seasons, we shall not

have much reason to fear the latter; while it will enable us to *plow at the proper time*, without fear of working the soil into brick-bats. For there are few soils more severely injured by wet plowing, and also, be it remembered, *by the trampling of cattle*, than are those of the prairies. As regards the latter, there are few cases probably in which the feed obtained and the dung dropped by the cattle, can compensate for the injury done to the soil by turning in stock, especially during a wet spell.

551. *Drainage*, therefore, will undoubtedly serve to correct essentially the physical properties of the prairie soil, while at the same time, it will afford the crop an opportunity of seeking its nourishment within a wider range, in the fertile subsoil; thus restoring to fertility, for the time being, those soils which, after a series of years' severe cropping, have now given out. *Deep plowing* will, of course, itself be a considerable step towards the attainment of the same benefits, and is to be greatly recommended throughout the prairies. The use of the Rotten Limestone as a marl (¶142), especially in connection with green crops, will also benefit essentially the *exhausted* soils. Yet it must be recollected, that all these means combined are no talisman against ultimate exhaustion, if the fundamental maxim of the maintenance of fertility (488, ff.) be violated; and that the prairies as well as the Mississippi Bottom will give out, if their soil is continually drafted upon without return.

552. *Bald Prairies.*—A large supply of vegetable matter seems to have proved the best remedy against the diseases which crops grown on this soil are subject to; they may be considered, in fact, as soils having received an overdressing of marl (¶460). Wherever practicable, the intermixture of the bald-prairie soil with those of the yellow loam character, ought to be favored.

553. *Prairie Uplands of Kemper and Noxubee.*—In N. E. Kemper and the adjoining portions of Noxubee, there is within the prairie region a great variety of soils. The prairie soil proper occurs only in patches, on hillsides or in depressions, where the limestone approaches the surface, and not unfrequently forms small bald prairies also—very similarly as in Tishomingo (¶438). The black prairie soil here, however, contains a good deal of coarse sand, and differs from most of those further N., in that it frequently rusts cotton very badly, while producing splendid crops of corn and wheat. In point of vegetation, these prairie patches resemble the "Chickasaw Old Fields" of Pontotoc (¶121); the limestone, however, is not generally so near to the surface.

On the higher ridges there often prevails a very heavy, dark orange colored soil, preserving very nearly the same appearance for 2 to 6 feet, where it is underlaid by the Rotten Limestone. Its natural timber is short, sturdy Post Oak and Black Jack. Gov. J. J. Pettus, on whose plantation, among others, this soil occurs, states that it produces fine wheat and also good cotton, which does not grow high but bolls very well; and that, moreover, when it is mingled with the black or bald prairie soils, it prevents their rusting cotton. Since this soil occupies the ridges and is, therefore, easily transported to the prairie beneath it, this observation may in many cases be turned to practical advantage. Its chief defect appears to be the lack of vegetable matter, which can, of course, be supplied to it by means of green crops.

554. The soil of the level or greatly undulating uplands of the region, is formed by a rather light and sandy, yellow loam, timbered with a good growth of Post, Spanish ("*Red*") and Red ("*Black*") Oak, and Hickory. It is a fair soil for corn, wheat and oats, and will generally for some years produce good cotton also; it is in general, however, considered inferior to the soils previously mentioned. It does not appear to redeem the promise held out by its timber, owing perhaps to shallow tillage. Its vegetation would seem to indicate that it would be benefitted by the use of the Rotten Limestone as a marl. In one instance where this was attempted (by J. M. Jones, Esq., S E. of Wahalak), no notable effect seemed to result therefrom; a single experiment, however, cannot decide the question, and it would be well worth while to repeat it at other points.—Intermixtures of the three primary varieties of soils just mentioned, are, of course, abundant, and produce excellent soils of intermediate character; in some points, soils closely resembling the "Marshall county Table Lands" (¶616) appear.

555. Between Wahalak Creek and the Flatwoods, *e. g.*, near the plantation of W. W. Beck, Esq., we find a level country interspersed with prairie spots, and timbered essentially like the upland soil last referred to, with the addition of Short-leaf Pine, and, in the branch bottoms, the common White Oak. It is somewhat heavier than that of the uplands E. of Wahalak Creek, and produces cotton well; it is obviously very deficient in *vegetable matter*. Mr. Beck has experienced fine effects from the use on it of the Rotten Limestone marl; and the fact that cotton grows luxuriantly wherever the prairie soil mixes with that of these uplands, seems to point to the propriety of using in their improvement, the material from which the former derives most of its active ingredients. Where the marl requires to be hauled to a considerable distance, it may in many cases be found advantageous to diminish the cost of transportation as well as the quantity required for a dressing, by previous burning (¶147 to 149).

As to the means of preventing the rusting of cotton in the prairie soils of this region, it is to be hoped that they will be developed by analysis.

556. EAST TIPPAH.—The general character of the Pontotoc Ridge (embracing the greater portion of the territory of the Ripley Group, see map) has been described in the Geological Report (¶128 to 130, 137). It is, however, only the southern and western portion of that territory as laid down on the map, which is thus characterized; the greater part of the country watered by the Hatchie being of a very different aspect, and consisting chiefly of broken "Pine Hills" (¶427²). In N. Tippah, therefore, the lands bearing, more or less distinctly, the character of the Pontotoc Ridge, are confined to a narrow band, only a few miles in width, between the pine lands of the Flatwoods Region (¶591) on Muddy Creek on one side, and those of the Hatchie on the other.

The road from Ripley to Pocahontas runs almost in the middle of the fertile belt, for the greater part of the distance to the State line (¶134); yet even on this route we occasionally meet a pine ridge, and Pines are in sight, from time to time, on either side. E. of the Hatchie, in TT. 1 and 2, RR. 5 and 6 E., the character of the Pine Hills is rather exceptional, the Post Oak and Black Jack, elsewhere commonly occurring, being, to a great extent, replaced by White Oak. This, as well as the frequent appearance of Hickory on the hills, would seem to indicate a better soil than usually accompanies the other oaks; yet the region is very thinly settled, and cultivated only in the narrow bottoms. Further S., the Pine Hills resume their usual growth of Short-leaf Pine, Black Jack and Post Oak, with scattered Chestnuts; the ground being occupied by the "Devils Shoe-string" (*Tephrosia Virginica*), Grasses (*Andropogon*) and Fern (*Pteris aquilina*), and at the proper season, rendered quite showy by various flowers of the Sunflower tribe (*Rudbeckia hirta, Coreopsis lanceolata, Silphium,* etc.).

557. Between the two forks of the Hatchie, in TT. 3, 4 and N. W. ¼ T. 5, R. 5 E., the country is mostly of the same character—very hilly and broken, soil very sandy and thin, and timbered as above, with the addition of the Rock Chestnut Oak (*Quercus prinos monticola*), which is of rare occurrence elsewhere; some of the highest elevations in the State, probably, occur here (¶3) on the high Orange Sand ridges, which are frequently capped with ledges of ferruginous sandstone (¶11 ff.; 57). Towards the W. fork, however, the land gradually improves, and after crossing it, the country assumes, within 5 miles E. of Ripley, the character of the region S. of the latter place.—It is noticeable that in TT. 4 and 5 especially, the "Poplar" and other lime-loving trees frequently appear in the ravines and on the hillsides, as well as in the bottom of the Hatchie itself (which is very fertile, but subject to overflow). It is quite likely, therefore, that at many points, the marls, of the Ripley Group (¶143) are near to the surface; and such as that occurring on the bluff of a creek near Kellum's mill, on Hatchie (¶134), would prove highly beneficial to the poor soils of the region. The black clays of the lower Hatchie, however, are useless for that purpose (¶134).

558. Further S., between the heads of the Hatchie and Tallahatchie, the extreme Pine Hill character is gradually lost, the country becomes less broken, the soil less sandy, and the other upland Oaks gradually mingle with the Black Jack and Post Oak, while the Pine becomes less frequent.

Such is the character of the country near Molino, where some of the uplands produce 500 to 700, others 900 to 1000 lbs. of seed-cotton per acre. But as we advance southward, after crossing Wilhite's Creek, we enter fully upon the fertile lands of the Pontotoc Ridge (the "Buncombes"), which here adjoin, on the W., level or gently undulating uplands timbered chiefly with sturdy Post Oak and Hickory, and here styled "Flatwoods"—which are underlaid by the Rotten Limestone (S E. ¼, T. 6, R. 6 E.), and form the transition from the lands of the Ridge proper, to those of the "White Lime Country" (538). Similar, fertile lands skirt the latter on the W., in T. 5, near Dry Run P. O., or Jumpertown, where excellent marls seem to occur (¶135); which thus far, however, in that immediate neighborhood, have only been found in wells. The high ridges W. of Blackland (¶120) are covered chiefly with a rich Oak growth, mixed with "Poplar" and Locust; bluish marl of fine quality is found in the gullies (*e. g.*, at the "Big Hill", S. 18, T. 5, R. 6 E). Only the highest ridges sometimes bear a few Pines, on knolls covered with brown sandstone.

559. South Tippah and the Pontotoc Ridge.—The narrow belt of fertile land underlaid by marl beds, which extends northward from Ripley (556), bears essentially the same character as S. Tippah, E. of the Flatwoods and W. of the Hatchie Hills. A more or less undulating, sometimes hilly surface, with a deep mellow loam soil bearing a rich Oak growth, interspersed more or less with Hickory, and frequently also bearing the "Poplar" and Walnut, characterize the first class lands of the region, whose permanent fertility is insured by the abundant beds of marl (¶143, ff.), and glauconitic limestones (¶153), so easily accessible. Where the Oak growth becomes lank and thin, and a great deal of Scarlet ("*Spanish*") Oak mixes with it, the soil is often inferior on the surface, but everywhere possesses a fine subsoil. Long spurs of pine

ridges sometimes extend into this region, forming large scollops, and sometimes almost cutting off from the main body minor tracts of fertile soil.

560. "*The Buncombes*".—Near the southern border of the county, in T. 6, RR. 3 and 4 E., we find, included mainly between Wilhite's and King's Creek, the singular soil of the "Buncombes"—a red sandy loam deeply tinged with iron, and filled with smooth, shining, brown pebbles, of a rounded shape (¶336), to such an extent that, to the uninitiated, the soil in many points looks unpromising in the highest degree, and almost too stony for tillage. Yet these uplands bear a vigorous growth of Oaks, Hickory, "Poplar", Black Walnut, Umbrella-Tree (*Magnolia auriculata*), Locust (*Robinia*), etc., and will yield, with little trouble, 60 to 80 bushels of corn, and more than a bale of cotton per acre; added to all of which, it "wears well", and will be easily resuscitated by means of the greensand marls which abound in the region (¶135, 136; 144), conjointly with the use of the subsoil plow.

561. "*Red Lands*".—These ferruginous, concretionary pebbles characterize, more or less, all the first class uplands, and more especially the "Red Lands" of the Pontotoc Ridge, although they are not often found of so large a size as in the "Buncombes," but vary from that of a poppy-seed to that of a buckshot, as in the prairies (336; 517). They are frequently not observable in the surface soil, but may very generally be noticed in the subsoil. The loam stratum which forms the latter is often of considerable thickness—from 6 to 10 feet on the ridges, and of a deep orange, or "red" tint.

From its mellowness, it is disposed to wash badly unless protected; but the great fertility even of the lowest portions of the subsoil may be readily judged of by the luxuriant growth of weeds which covers the sides of these "red washes", so soon as by exposure to the atmosphere for some time (fallowing—¶357) they have been sufficiently stimulated. The same effect, of course, would follow the use of the calcareous marls so commonly accessible on the Ridge, or of the lime burnt from the "bored limestone", which, as has been stated (¶153), is far superior to the purest lime, for agricultural purposes. Deep culture, therefore, both for the purpose of bringing up the fertile subsoil, and for the prevention of washing; and the use of the calcareous manures of the region (if possible conjointly with vegetable matter, in which most of the soils of the Ridge are deficient), will long be sufficient to maintain the productiveness of these soils; among whose advantages is, also, a great capacity for resisting extremes of wet and drouth, which would be increased by the further addition of lime (443).

562. "*Mulatto Soils.*"—Of course there is, within the class of soils thus generally characterized, a considerable number of varieties which, for the reasons given (¶527[2]), have not as yet received special consideration. Besides the extreme "red lands" character, in which the deep-tinted surface soil often contains but a trace of vegetable matter (¶424), one of the most frequent, and most esteemed kinds of land is the "mulatto soil" of the western portion of the Ridge.

The surface soil of this character, from 8 to 12 inches in depth, is generally of a light chocolate tint, its subsoil pale orange-yellow above, but becoming deeper tinted, and more like the "red lands" subsoil, as we go deeper. A specimen of this kind of soil is the only one of the soils of the Pontotoc Ridge of which I have as yet been able to make a (partial) analysis.

No. 226. "MULATTO SOIL" from Stephen Dagett's land, S. 33, T. 10, R. 3 E., Pontotoc county.

Depth: Ten inches.

Vegetation: Spanish ("*Red*"), Black and Post Oak, Hickory—all large and stout trees; some Black Gum, Sweet Gum, and Black Walnut.

Color when moist, a light chocolate tint.

Mellow, easily tilled.

The airdried soil lost 3.663 per cent. of moisture at 400 deg. Fahr., dried at which temperature it consisted of:

Insoluble Matter	90.572
Potash	1.096
Soda	0.423
Lime	0.178
Peroxide of Iron	2.060
Alumina	3.555
Magnesia, Brown Oxide of Manganese Sulphuric and Phosphoric Acids, Water and Organic Matter (determination not completed)	2.116
	100.000

The amounts of Potash and Soda shown by this analysis are unusually high in a soil containing so much insoluble matter. The amount of Lime is not proportionately high, and hence great benefit will no doubt be derived from the use of calcareous manures on this soil—which has already been experienced in the neighborhood of Pontotoc (¶153), where the same soil, or nearly so, prevails. The ingredients not determined must be present in a fair proportion to the rest, for the land *averages* 1,000 lbs. of seed-cotton, and will produce as high as forty and more, bushels of corn.

563. There are among the soils of the Pontotoc Ridge, two other chief varieties, which have been mentioned before (¶127), viz: a heavy, yellow or greenish-yellow clay soil, timbered almost exclusively with Black Jack, forming "beeswax hommocks" similar to those described in Itawamba (¶533); and "bald prairie hilltops," formed either by the "bored limestone" or its representative, the white calcareous sand (¶135); soils of this character, and those resulting from their intermixture with the more prevalent loam soils of the Ridge, generally bear a growth of stout, sturdy Post Oak, with trunks curving to one side (¶540), interspersed with Crab Apple, Honey Locust, etc.

The soils of the latter kind are generally very productive, especially for corn—they will sometimes rust cotton, but this can probably be obviated by giving them a supply of vegetable matter.

As for the "beeswax hommock" or Black Jack soil, though probably possessing a good supply of the elements of fertility, it is so stiff and intractable, as to render its cultivation somewhat precarious, since it is severely injured both by wet and drouth It is almost destitute of vegetable matter, and the addition of this and of sandy marls, would probably be the first step towards its reclamation; it has not yet, however, received sufficient attention.—There are, of course, a great variety of intermixtures of these various soils, especially on the hillsides, where it is often difficult to obtain a definite idea of the prevalent character.

564[1]. The agricultural features of the Ridge in Chickasaw do not differ essentially from those in Pontotoc. Even the "Buncombe" land is represented (for instance, with a great abundance of ferruginous pebbles of various sizes, in the southern portion of T. 12, R. 3 E., near Houlka P. O.); but, as we approach Houston, the "mulatto soil" becomes heavier and less deeply tinged with iron, forming a transition into the oak uplands of the prairie region.

564[2]. But for the brokenness of the surface, which in many points renders inconvenient the culture of large tracts, few upland regions in Mississippi could boast of equal agricultural advantages with the Pontotoc Ridge generally. Nor are the comforts of life often marred (as is the case in the prairies) by the lack or scarcity of good water; springs being quite abundant and wells, in most cases, easily obtained, either in the Orange Sand overlying the marl and limestone, or else by shallow bores (seldom much exceeding 150 feet) within the strata of the Cretaceous—in which case the water, it is true, is limy, but not nearly as much, commonly, as in the Rotten Limestone region. Not unfrequently the waters thus obtained, which rise to within 40 to 70 feet of the surface, are more or less sulphureous and chalybeate, the same being the case sometimes with the natural springs; they do not often, however, contain any notable quantity of magnesian salts. Artesian bores have not, so far as I know, as yet been attempted, although it seems quite likely that they might succeed, especially in the W. part of the Ridge, where the land is not very high.

565. WATERS OF THE NORTH-EASTERN PRAIRIE REGION.—Those of the Pontotoc Ridge lands have just been referred to. In those portions of this region which have been above described as being, more or less, of the Pine Hill character (the territory of the Eutaw and Tombigbee Sand Groups, and also that of the Carboniferous formation—see map), there is generally little difficulty in obtaining a good supply of water. The Orange Sand, which forms the surface, is underlaid by the impervious strata of the other formations, giving rise to numerous springs; wells obtain water at moderate depths, either *above* the older formations, when it is of the free-stone character—or else *within* the latter, when it is often limy and sometimes slightly sulphureous, but not often so far impregnated with mineral ingredients as to interfere with its daily use for drinking purposes.

Fetid and undrinkable water has been obtained, on the territory of the Eutaw Group, between Weaver's Creek and the Little Sipsie (¶105); cisterns require to be used in that region.

There are, however, some strong mineral springs within the State, E. of the Rotten Limestone region, some of which deserve, and have attracted, considerable attention.

566. At Iuka, on the M. & C. R. R., there are several mineral springs (¶98), of two of which I have analyzed specimens furnished me by Geo. W. Stamps, Esq., of the Iuka Female Institute.

"No. 2. GUM SPRING."

Sulphuretted Hydrogen, largely,
Bicarbonate of Iron, largely,
Free Carbonic Acid (sufficient to cause it to sparkle), with small amounts of
Bicarbonate of Lime,
" " Magnesia,
" " Potash and Soda,
Chloride of Sodium.

In 10.000 parts this water contains 1.10 of solid ingredients, chiefly oxide of Iron. It is a strong "Red Sulphur" water.

"No. 3. BOX SPRING."

Bicarbonate of Iron, largely,
Free Carbonic Acid,
Very small amounts of the Bicarbonates, Chlorides and Sulphates of Lime, Magnesia, Potash and Soda.—Is almost a pure chalybeate, tonic in its action.

There is still another water, but the bottle containing it was broken in the transmission. The accessibility and healthful as well as pleasant location of these springs, no less than the quality of their water, seem destined to render them a favorite place of resort.—The strong, copious chalybeate spring at Mr. Aleck Peden's place has been mentioned (¶62).—A mile S. of Corinth, there is a copious chalybeate spring containing the proto-sulphate of Iron, some lime and common salt.

567. The mineral springs flowing from the bluff of the Tombigbee near Fulton, Itawamba county, are generally magnesian chalybeates, sometimes slightly impregnated with sulphuretted hydrogen.

The analysis of one of these, situated about a mile below Judge Bullard's place, on the Tombigbee, gave the following result:

Bicarbonate of Iron, largely,
" " Magnesia,
Free Carbonic Acid,
Chloride of Magnesium,
Minute amounts of the Chlorides, and a trace of the Sulphates, of Potash and Soda.

This water is said to be precisely the same in quality as that at "White's Springs," 4½ miles S of Fulton, which have acquired some reputation—there seems to be more free Carbonic Acid in their water. Similar waters are found both in springs and wells, on the Bull Mountain; *e. g.* in a bored well on S. 13, T. 10, R. 9 E. In the latter, however, a part of the iron is contained as proto-sulphate.

Not far from this point, a mineral well was obtained by Mr. W. Medley; out of it there was dug a gray clay possessing an astringent taste, which was found to be quite effectual as an external application to old sores, etc. An analysis of a specimen of this earth, furnished me by G. W. Stovall, Esq., of Richmond, gave the following result:

Insoluble Matter (Sandy Clay)	86.879
Lime	0.732
Magnesia	0.237
Peroxide of Iron, and Alumina	4.548
Sulphuric Acid	1.385
Water	6.083
	99.864

The styptic and astringent properties observed in this clay were therefore owing, no doubt, to a certain amount of the Sulphates of Alumina ("Alum") and of Lime (Gypsum).

The character of the wells in the Tombigbee Hommock has been referred to (¶535). Deep bored, and artesian wells would no doubt succeed in its northern portion as well, as further S. between Aberdeen and Columbus.

568. *Waters of the Rotten Limestone Region.*—Generalities concerning these have been given in the Geological Report (¶122, 123, 125). Sipe-wells are so rarely practicable, that we may generally consider the alternative as lying between cisterns and deep bored wells, in some of which the water rises above the surface, in others only within available distance. In the latter case, either a pump, or more commonly, a long narrow bucket, of the diameter of the bore, having at the bottom a valve opening upwards, is employed in bringing the water to the surface.

In consequence of the dip of the Rotten Limestone stratum, these wells are, of course, deepest at the western border of its region of occurrence, and quite shallow on the eastern side; while wells situated at no great distance northward or, in the southern portion, north-westward of one another, are generally of similar depth. In the southern portion, depths increase pretty regularly between 25 and 30 feet per mile, westward or south-westward; but in Tishomingo, there is less regularity, and shallow sipe-wells are not uncommon. At Farmington, there are sipe-wells 20 to 25 feet deep, with freestone water, and others 40 to 50 feet, with limy water, possessing but little rise.—At Corinth, bored wells 70 feet deep, in which the water rises to within 12 to 15 feet of the surface. A deeper bore would doubtless bring it out above the surface, so soon as another vein of water should be struck.—A few miles E. and N. E. of Bone Yard, wells 250 to 270 feet in depth have been bored. At Bone Yard, as might be foreseen, no water was struck in a bore of 200 feet (it could not be expected at less than 325 to 350).—At Kossuth, some sipe wells 18 to 20 feet deep, and a bored well (Mr. Wright's) of 270 feet.

At Rienzi, wells 60 to 75 feet; water rises only 15 to 20 feet. There is a very good chance here of a much higher rise within the next 2 to 300 feet.—Due W. of Rienzi, near Mr. Bynum's, S. 7, T. 4, R. 6 E., sipe-wells 20 to 25 feet; a little further N. E., the same, or bored wells 200 to 260 feet.

At Blackland, wells are comparatively shallow—120 to 140 feet; the water rises only 15 to 20 feet, and the vein is probably a different one from that supplying the wells heretofore enumerated.

At Mr. J. W. Yates', S. 11, T. 6, R. 6 E., bored well 35 feet; little rise.—At Carollville, about the same. On S. 36, T. 6, R. 5 E, at Mr. Humphrey's, 200 feet.—At Mr. McManus', S. 35, 210 feet; Dr. Agnew's, S. 27, 271 feet; half a mile E. of Dr. A's, 210 feet. The depth increases westward and northward from Dr. Agnew's—there being wells 300 and 330 feet deep. In all of these, the water rises to within 40 to 70 feet of the surface, according to elevation; that of the five last named wells is pretty limy, that of McManus' excessively and unhealthily so; most of them (*e. g.* Dr. Agnew's) are slightly sulphureous and chalybeate.

The examples may suffice to show the condition of things in Tishomingo. Very nearly the same exists at corresponding points of the Rotten Limestone belt in Pontotoc and Itawamba counties, the deepest bores rarely exceeding 300 feet, water rising within 40 to 60 feet of the surface. Here also, deeper bores might bring artesian water, derived from the high Pine lands further E. (¶532); thus far, cisterns are extensively used.

569. *Bored and Artesian Wells of Monroe and Lowndes.*—Between Camargo and Richmond, wells vary from 80 to 120 feet; the water rises only 15 to 20 feet. The most northerly *artesian* well of which I have any knowledge, is 3 miles N. of Camargo; depth 200 feet, water rises 2 feet above the surface. At Camargo, in a well 280 feet deep, water rises to within 60 feet of the surface. Between Camargo and Aberdeen, on the W. side of the Tombigbee, the depths vary between 2 to 500 feet (the public well at Aberdeen being 512 feet deep); the water rises to within 60 feet and less, and flows out at Aberdeen, and thence to Columbus; there being numerous artesian wells in the Tombigbee hommock (¶535), in which, from the low level at which they are situated, the depths are sometimes much less, and the pressures greater, than in those on the high lands of the W. side--the depth being sometimes within 200, and rarely exceeding 300 feet; and the pressure being mostly sufficient to form handsome fountains. It is evident, however, from the variability of depths in localities similarly situated, that several water-bearing strata contribute towards supplying these wells, with streams of different strength and composition; which cannot be surprising, in view of the great irregularity in the stratification of the Eutaw Group, from which these waters are derived (¶102, 106, 155). The public well at Columbus (371 feet deep), and others situated on the ridge, are obviously derived from the same stratum as those in the hommock, inasmuch as, a short time since, when a nine inch bore (intended to supply a tanyard) in the lower part of the town, gave vent to a large volume of water, all the wells on the ridge ceased to flow, but were restored when the large vent was partially closed. Most of the artesian waters at Columbus and Aberdeen are somewhat chalybeate, and often sulphureous also (¶156).

570. I regret that want of space precludes me from entering more fully upon the details of this important subject, which will be given in a subsequent Report. As we recede westwardly from the Tombigbee, the depths of wells rapidly increase; the prairies being an elevated plateau (¶122, ff.), and the wells rarely sunk to the strata which supply the Aberdeen and Columbus wells, their water does not often flow out, but only comes to within available distance of the surface. A remarkable local exception occurs in the case of Dr. Ellis' artesian well, on the Chuckatonche, S. 12, T. 17, R. 5 E., which yields a strong stream at 246 feet, and is the only one of the kind, so far as I know, on this meridian. At Palo Alto, a bore of 500 feet passed through the Rotten Limestone into sand, bringing the water within 70 feet of the surface.

At Pikeville, a bore of 614 feet brought the water to within 23 feet of the surface; whether a deeper bore has since brought the water to the surface, I have not learned. At Buena Vista, a similar rise was obtained at a corresponding depth, allowing for the westward dip.

Mr. Dexter's well, on Kilgore's Ridge, has been mentioned above (¶123). At the E. foot of the ridge, there are several wells yielding a copious supply of fine water—thus Wm. G. Carradine's, S. 24, T. 15, R. 5 E. (¶537 feet deep, water within 41 feet of the surface), which in summer, alone supplies several plantations, even with stock water.

Near the W. edge of the prairie region (in S. Chickasaw, Ocktibbeha, Noxubee and Kemper), as has been mentioned (¶122), wells require to be sunk to great depths—800 to 1,000 feet, and more; and then, the first stream struck does not generally rise more than within available distance of the surface; though if the bore were continued to greater depths, a flow might be expected. At Macon, at a depth of 760 feet, I believe, artesian water has been obtained.

Data regarding the wells at Houston and Sparta have been given above (¶122, 157); at these places, the chances of artesian water would probably lie between 1200 and 1500 feet. The shallow well at Okalona has been mentioned; there can be little doubt that a bore between 300 and 600 feet would bring a copious supply, perhaps of artesian water.

THE FLATWOODS REGION.

COMPRISING PARTS OF THE COUNTIES OF TIPPAH, PONTOTOC, LAFAYETTE, CHICKASAW, CALHOUN, CHOCTAW, OCKTIBBEHA, WINSTON, NOXUBEE AND KEMPER.

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561. *Geographical Position and Surface Conformation.*—The level lands, timbered chiefly with Post Oak, often accompanied by Black Jack and Short-leaf Pine, popularly styled the Flatwoods (¶164, ff.), form a narrow belt, which borders on the west, the cretaceous, or North-Eastern Prairie Region. The usual width of the Flatwoods *proper*, is from three to six miles; in some regions the bordering hills encroach upon them so as to greatly reduce their width; in others, the hills recede so far as to enclose between them a level tract of ten or twelve miles. Their outline is, therefore, much scolloped, and difficult to define with accuracy. Commencing at the north, on the southern bank of Tippah Creek in T. 4, R. 2 E., Tippah county (¶169), they occupy the greater part of R. 2 E. of the Chickasaw Survey. From the south-west corner of Chickasaw county, they bear S. S. E., in the direction of DeKalb, in Kemper county, where the Succarnoche river may be considered their southern limit; for beyond, they gradually lose their character and pass into the common yellow loam uplands of that portion of Alabama.

562. In their upper portion, down to Houlka creek, their *eastern* limit is pretty sharply defined by the abrupt hills and deep ravines of the Pontotoc Ridge, whose "Red Lands," with their growth of "Poplar", Walnut, Hickory, Black, White and (*true*) Red Oaks, contrast strongly with the white soil of the Flatwoods, and their uniform growth of lank Post Oak and Short-leaf Pine; their general outline on this side being pretty correctly represented by the Range line between RR. 2 and 3. Westward of the town of Pontotoc, however, they approach within one mile of that place; the Houlka, also, carries them across the Range line for a short distance. Then again, we meet them three-fourths of a mile west of the town of Houston; and for a few miles below, the yellow loam hills are found skirting them, in a due south course. There, however, the ridge turns south-eastward, in the direction of Sparta (¶122), and the Flatwoods follow it very nearly up to the latter place, forming a large scollop to the eastward of the main body.

With the Flatwoods of Octibbeha county, I am not personally acquainted; but from what I can learn, they are there bordered on the east, not by hills, but mostly by level upland prairie. Such, also, is the case in S. Noxubee, and in Kemper, where I have personally observed them. In passing from Gholson towards Wahalak P. O., it is difficult to say where Flatwoods cease and the prairie begins; in the eastern portion of the Flatwoods, though the *kind* of timber is still the same, its growth is sturdier, and the land, whose soil is not so excessively heavy, yields fine cotton crops. The railroad is here very nearly on the dividing line between the two kinds of land (¶555).

563. In this southern portion of the Flatwoods Region, its *western* outline is as sharply defined, as the opposite is, further north. From the Noxubee Hills (¶645), about four miles east of Webster, and from the Gholson or Summerville Ridge, about the same distance east of Gholson, we descend very suddenly (at the latter place about one hundred feet) from the very sandy ridge (¶647), into the level Post Oak Flatwoods, whose soil would often times seem to be of more immediate interest to the potter, than to the agriculturist.

564. It seems that in N. E. Winston and S. W. Octibbeha counties, the Flatwoods are crossed in all directions by the drainage of the country, viz: the Noxubee River and its tributaries;* a natural consequence of their situation at the foot of ridges considerably elevated above them. But further north, and up to the neighborhood of the town of Pontotoc, they assume the character of a dividing plateau between the waters of the Mississippi and Tombigbee; their general surface being but little below the level of the hilltops of the adjoining country. In Tippah and N. Pontotoc counties, they give rise to numerous tributaries of the Tallahatchie; further south, the main prongs of the Yokeney-Patafa, the Loosha-Scoona, and Yallabusha take their rise in them on one side, on the other, the headwaters of Chiwappa, Chukatonche, Houlka and Tibby. Some of the waters of the two first named streams, (viz: the Chiwappa and Chuckatonche), *cross* the Pontotoc Ridge, therefore, after taking their rise in the Flatwoods, at a lower level; hence the deep ravines which they form in this first part of their course.

565. In this northern portion of the Flatwoods tract, its *western* limit is generally ill defined and somewhat arbitrary. In passing westward from the level portion of the Flatwoods immediately adjoining the Pontotoc Ridge, the country gradually becomes more undulating, and frequently passes quite insensibly into a hilly, pine country, similar in its general aspect to the Pine Hills, further inland, save in that its soil is prevalently very heavy, and its vegetation more similar to that of the Flatwoods proper. I shall therefore include the description of these lands, which occupy the greater portion of R. 1 E., and large parts of R. 1 W., under the general head of the Flatwoods Region (¶587, ff.) In South-west Chickasaw and adjoining parts of Calhoun and Choctaw, the western portion of the Flatwoods (as well as the adjoining hilly country) is characterized by the superaddition of the White Oak to the ordinary growth of the Flatwoods, indicating a corresponding improvement of the soil. This region I shall designate as the *White Oak Flatwoods* (584, ff.).

THE SOILS OF THE FLATWOODS REGION.

566. It has been mentioned in the Geological Report (¶ 164, ff.), that the Flatwoods, as well as the hilly country adjoining them to the westward, are generally underlaid by the stiff gray clays of the lowest, lignite stage of the eocene Tertiary. Outcrops of these

*For information concerning this portion of the Flatwoods Region (which I have not personally visited) as well as for other favors, I am indebted to G. C. Snedecor, Esq., of Louisville, Winston county.

clays are very common on bluffs and hillsides throughout the region. While wet, they appear dark gray or almost black, but when dry they are usually of a light gray, and sometimes almost white. When in their natural place, or recently thrown out, they usually possess either a slaty structure, or else, and most frequently, a tendency to split into rounded, nodular forms, familiar to every one who has traversed the Flatwoods.

This "Flatwoods clay" (¶165) does not readily "dissolve" or form a plastic paste with water; but whenever by dint of repeated kneading (such as the wheels of vehicles will perform) it has been made to form a paste, its tenacity is such as to be scarcely exceeded by the most approved "prairie mud." Nor can the black prairies of Pontotoc and Monroe, during the wet season, present more formidable obstacles to the wagoner, than do the bottoms and hillsides of the Flatwoods region. Hence the great frequency among its streams, of such names as Mud Creek, and others still more eloquently expressive of the awe in which they are held by those who are habitually obliged to traverse the Flatwoods.

567. There are two chief varieties of soil usually found in the Flatwoods proper; and these two are at opposite extremes of the scale of lightness. One of these is little else than the Flatwoods clay above described, disintegrated and formed into a stratum possessing a massy* cleavage, of a gray tint, with red or yellow spots, and changing but little from the surface down to where the clay still retains its orginal structure. The other variety is in the main, a very fine, almost pulverulent, sand or silt, of a gray tint, and with ferruginous dots; which lower down, sometimes pass into bog ore or "black gravel" (¶387). This soil, also, shows but little change from the surface downwards, save that in many places, it has for its subsoil the heavy gray clay soil above mentioned; in others, wells twenty feet deep have shown it to be the same at the bottom as on the surface.

568. Both soils are timbered nearly alike, with Post Oak of a lank, gawky growth, with long, thin branches, commencing low down on the trunk; the main branches often covered with leaves close to the bark.

Such is invariably, and more characteristically, the case on the *light* soil, which in low places, not unfrequently bears a small growth of Willow Oak, accompanied very generally by small Huckleberry bushes. On the *heavy* soil, the Post Oak often assumes a sturdier growth, and is at times entirely replaced by the Black Jack, which on this soil, very generally mingles with the Post Oak; as also does the Short leaf Pine and Spanish ("*Red*") Oak, which rarely appear on the light soil; and when they do, are usually an indication of the heavy clay subsoil not being far underground.

569. The *heavy* soil is, on the whole, by far the most prevalent of the two. So far as I know, it is only in N. Pontotoc and N. Chickasaw counties that the light soil occupies tracts of any considerable extent. Thus, it constitutes extensive tracts between the waters of the Tallahatchie Mud Creek and Lubatubby, and on the extreme headwaters of Yallabusha and Houlka, in N. W. Chickasaw.

*By "massy" cleavage is meant that the material when cracked or broken, shows no tendency to cleave in any particular direction by preference. The word implies, therefore, very nearly what is popularly expressed in "joint clay".

Smaller tracts of a similar character, however, occur more or less, over the whole Flatwoods belt.

570. It is singular that, while these two extreme soils are so often found contiguous to, and overlying each other, *intermixtures*, which might form soils of commendable *physical* properties at least, are but rarely met with. Thus, in passing from Cherry Hill to Houston, we find the light soil prevailing almost altogether, up to about three miles W. N. W. of Houston, where we find, on S. 34, T. 13, R. 2 E, and thence onward for some distance, a low ridge or tract of land, timbered almost exclusively with scrubby Black Jack, the soil of which, destitute of every blade of grass or other undergrowth, appears to be immediately suited to the potter's lathe. Strips or "ridges" of this kind are not unfrequently met with in the Flatwoods both of Chickasaw and Pontotoc counties. It is only in the bottom soils of the Flatwoods tract that we find the two soils commingled in such proportions as to form a soil of excellent quality, both physical and chemical.

571. Composition of the Flatwoods Soils.—Two specimens of soil from the Flatwoods region, representing the two extremes above described, have thus far been analyzed.

No. 230. Heavy Flatwoods Soil from S. 4, T. 10, R. 2 E., Pontotoc county:

Depth: No perceptible difference between soil and subsoil; specimen taken down to twelve inches.

Vegetation: Post Oak, Short-leaf Pine; some little Spanish ("*Red*") Oak, and occasionally a little Hickory.

The soil saturated with moisture at 72.5 deg. Fahr., lost 9.333 per cent. of water at 400 deg. Fahr. Dried at this temperature, it consisted of:

Insoluble Matter	77.854
Potash	0.753
Soda	0.106
Lime	0.178
Magnesia	0.831
Brown Oxide of Manganese	0.167
Peroxide of Iron	5.899
Alumina	10.302
Phosphoric Acid	0.052
Sulphuric Acid	0.032
Organic Matter and Water	3.689
	99.841

572. No. 165. Light Flatwoods Soil, from S. 36, T. 13, R. 2 E., Chickasaw county:

Depth: No perceptible difference between soil and subsoil. Specimen taken to the depth of twelve inches.

Vegetation: Almost exclusively Post Oak; very little Spanish ("*Red*") Oak; Huckleberry bushes in the depressions.

A pale gray, powdery soil, mostly fine siliceous matter, with little clay. Its mass is full of ferruginous dots, which increase downwards.

The air-dried soil lost 2.050 per cent. of water at 400 deg.; at which temperature it consisted of:

Insoluble Matter	93.575
Potash	0.254
Soda	0.066
Lime	0.082
Magnesia	0.175
Brown Oxide of Manganese	0.111
Peroxide of Iron	1.445
Alumina	2.605
Phosphoric Acid	0.008
Sulphuric Acid	trace
Organic Matter and Water	1.333
	99.653

573. In comparing the analyses of these two soils, it will be perceived that the difference between them in a chemical point of view, is no less striking than that which exists in their physical properties. The *light* soil (No. 165) is a poor one in *all* respects—deficient in all the nutritive elements of plants as well as in vegetable matter; for the loss of weight of 1.333 per cent. which the soil experiences by ignition, is due almost entirely to the expulsion of water.

In this last named particular, the *heavy* soil (No. 230) resembles the other, being likewise almost entirely destitute of vegetable matter; the loss it experiences by ignition, is mainly owing to the expulsion of water (viz: the water of hydration of the oxide of iron and clay). But in all other respects, it differs very essentially from the *light* soil. It contains an amount of potash equal to that of the best uplands, and even some of the prairie soils. Its supply of Soda is rather small, but perhaps adequate. In Lime it is *deficient*, as compared with other soils containing a similar amount of potash; a circumstance directly contradictory of the prevailing popular impression on the subject, it being frequently said that the failure of crops on this soil is owing to an excess of lime (¶370, ff.). Of Magnesia, there is an abundant supply; so also of Manganese, and of Iron. Of Phosphoric and Sulphuric Acids, the supply is rather small, yet not so much so as to render the soil unproductive, provided they be in an available condition. [Compare, in this respect, the analysis of the soil of the Marshall County Tablelands (¶96, ff.), and others.]

The most important chemical defects of this soil, therefore, consist in its deficiency in Lime and Vegetable Matter, and to some extent, in Soda and Phosphoric Acid.

574. Cultivation of the Flatwoods Soils.—It would be premature to assert, that the analyses of the two soils just quoted, represent correctly the respective average composition of these varieties of Flatwoods soils. The tract on which they occur is so extensive, that perfect uniformity in the composition of its soils, is not to be expected. It is highly probable, that neither are all the light soils as poor, nor all the heavy soils as rich in potash, as the specimens analyzed; and analyses of the specimens collected in other portions of the region, may yield results somewhat different. Yet, from the great uniformity of character over the whole region of the formation from which these soils are derived, it is probable that their general characteristics are pretty correctly represented by the above analyses.

575. A. *The Light Flatwoods Soil.*—As for the *light* soil, I am not aware of its being in cultivation to any extent, save in N. W. Pontotoc, in the region between Tallahatchie Mud Creek and Lubatubby. It has there been found, that soil which at the time of the first settlement of the country would scarcely

produce anything, will now bring average crops. The change, has been attributed, and perhaps correctly, to the circumstance of the trampling of cattle having rendered it somewhat more solid, and therefore less drouthy, and capable, to some extent, of retaing manure.

It is this last named particular especially, in regard to which this soil is most faulty; for being so poor both in clay and vegetable matter, it cannot retain near the surface, within the reach of plants, any notable quantity of the nutritive ingredients in a soluble condition (¶378; 401). Hence the most valuable part of stable manure, for instance, would, on this soil, be rapidly carried down beyond the reach of the roots of plants.

576. Where these lands adjoin the ridge, and sometimes for some distance in the interior, we find, not unfrequently, small ridges or islands, as it were, of the red ridge soil (mingled more or less with the Flatwoods soil), which generally form slight elevations above the general surface of the Flatwoods (¶337). Generally we also find, for some distance around these patches, the red ridge soil forming the subsoil. Such spots are readily recognized by the growth of Hickory and Spanish ("*Red*") Oak, which there mingles with, and sometimes predominates over the Post Oak growth.

Whenever this is the case, it is advisable to bring the subsoil to the surface and to mingle it with the white soil as much as possible. The washings from the red loam hills ought to be so regulated, as to distribute them over the surface of the Flatwoods soil; and as a general thing, ought to be mingled with it wherever practicable without too much exposure.

577. It is sometimes the case, that outcrops of the white Flatwoods clay (see above, ¶566), are to be found on elevations, or in the bluffs of branches in districts where this light soil prevails. It is probable that this clay (which is not properly a marl, as has been thought) would greatly improve the soil in question, both by rendering it heavier and more retentive of manure and moisture, and by adding something to its stock of fertility. For, although this clay has not thus far been analyzed, the fact that the heavy soil which has been formed out of it is rich in potash, indicates that the original material is similarly constituted; and it is probable that if it were applied in connection with some burnt lime [which throughout the Flatwoods can be cheaply obtained from the bordering hills (¶129; 151, ff.),] the artificial marl thus formed would so far correct the soil as to render it capable of profitable culture, and suceptible of permanent improvement, by manure.—Little good, however, can be expected to accrue to this soil, from the application of lime alone.

578. In regard to supplying the want of vegetable matter (which would not, however, be so seriously felt after supplying the clayey part—¶425), it must be remembered that it ought to be applied either in the shape of green crops plowed under during the wet season, or else, in a well decayed condition. The soil is of itself so "open," that the introduction of undecayed straw or leaves would be likely to injure it by rendering it still more so; and the decay of *dry* vegetable materials would be exceedingly slow under such circumstances [See, in reference to this, what is said regarding the sea-coast sand-hommocks (¶860, ff.) and concerning the use of pine straw, in the present Report, ¶793, ff.]. The vegetable matter, whatsoever it may be, would be advantageously composted with lime and the Flatwoods clay, above referred to, and with stable manure, if obtainable. In low spots, especially where the Huckleberry grows, this soil would undoubtedly be much benefitted by underdraining. As a general thing, however, it is abundantly drained, and sometimes too much so, by its own porosity.

Peruvian Guano, "Ammoniated Guano," and the like, would probably be of little avail on this soil, in proportion to their cost. But "Columbian Guano," ground bones, superphosphate of lime; plaster composted with vegetable matter or with stable manure; and the *clay* marls of the adjoining marl regions, would be well adapted to its improvement.

579. *The Heavy Flatwoods Soil.*—The first necessity, in taking this soil into cultivation, is the provision for its proper drainage.—It might seem that but little could, in this case, be effected by underdrains, since the soil is so dense; it is most likely, however, that (as in most heavy soils), underdraining would soon cause the soil to become sufficiently porous (¶408; 410), and would thus greatly improve it with respect to "safeness" and facility of tillage. Meanwhile, surface ditches, properly disposed, so as to carry off more rapidly the stagnant surface water, would alone be of great benefit; and the nature of the subsoil is such, that little fear need be entertained of the washing of the soil, especially as there is hardly any difference between it and the subsoil. Even in hillside ditches it is carried away with difficulty, and as a general thing the fall of the Flatwoods streams, and that of the country itself, is so slight as to cause difficulty rather in consequence of the *slow* subsidence of the waters, even when all concentrated into one channel. During the rainy seasons, the Flatwoods may sometimes be covered for miles with a thin sheet of sluggishly flowing water; and it is oftentimes only by the increased velocity of the current that the traveller is made aware of his approach to the channel of a creek, and to a ford which, perfectly solid and safe a few days ago, will now bog his horse up to the belly, in mud of the most tenacious kind.

580. The heavy Flatwoods soil is not in itself very thrifty, even where it is of considerable fertility; the crop requires time for its development; and if put into the ground late in the season, in consequence of a late and wet spring, it is liable to be overtaken by the summer drouth before it is able to resist it. This is one of the most frequent causes of the utter failure of the cotton and corn crop in the Flatwoods; for usually, when they do fail, they fail completely. On the other hand, in favorable seasons, very good average crops, both of corn and cotton, are made on this soil. It will be observed that in this respect, the heavy Flatwoods soil resembles the black prairie soil of N. E. Mississippi (¶549, ff.; 402[1]). There also, crops fail in extreme seasons; and if they do not fail as frequently as is the case in the Flatwoods, it is due mainly to the great thriftiness of the calcareous prairie soil, which causes a rapid development of the young plant, and enables it to outlast a drouth which would put an end to all crops in the Flatwoods (¶402[1]).

If we examine the chemical difference between the prairie soil and the Flatwoods soil in question, we find it to consist mainly in the lack of Vegetable Matter, of Lime, and to some extent, of Phosphoric Acid, in the latter; also, perhaps, of Soda. These, therefore, require to be added to it. Potash, Magnesia, Manganese and Iron, are present in quantities very nearly the same as in the prairie soil.

581. The proper mode of improving this soil is, therefore, very plainly indicated. The vegetation it bears at the present time, seems to prove that but little of the large amount of potash which it contains, is present in an available condition (¶357). This can be remedied by the application of lime or calcareous marl (or perhaps, plaster or gypsum, where it can be obtained cheaply (¶368, ff; 436; 462). While the land is thus stimulated, an important ingredient, in which it is deficient will be supplied to it.

Lime *alone* would, no doubt, effect a great improvement in this soil; and fortunately, it is within easy reach in the whole Flatwoods region.

582. But the application of *vegetable matter* would be a great additional improvement in more than one respect; for while it would supply the humus which is so favorable to all vegetation (¶420, ff.), it would also render the soil lighter—easier tilled, more accessible to the atmosphere, and less liable to suffer either by drouth or excessive wet weather. It would undoubtedly prove beneficial to this soil even in a raw condition; sawdust, leaves, pine and other straw may, therefore, be freely used. The best mode, however, of applying both materials simultaneously, would be to compost the vegetable matter—leaves, straw, pond-muck—with lime or calcareous marl, and allow it to decompose

to some extent before applying it to the soil. Plowing under green crops, together with a dressing of lime or marl spread broadcast, will also be an effectual mode of improvement. Bonedust, Superphosphate of Lime, Columbian and Peruvian Guano, and all ammoniacal manures, will be in their place here.

583. Wherever the Flatwoods soil is so situated, that sand, or any light soil, can be conveniently mixed with it—as for instance where it adjoins the ridge, or an *island* of red, sandy soil, or even the *light* Flatwoods soil itself—this intermixture ought to be favored in every practicable manner. In this respect alone, a great deal may undoubtedly be done towards remedying what is now the cardinal objection to the heavy Flatwoods soil, to-wit: that it is unsafe; sometimes yielding good crops, and at others, entirely disappointing the expectations of the planter.

In Kemper and S. Noxubee counties, where (as before observed) the eastern portion of the Flatwoods passes very gradually into prairie and yellow loam uplands (¶553), large and productive plantations are situated on this transition territory; whose soil, as well as its vegetation, is intermediate between, and a mixture of, the heavy Flatwoods soil with the yellow upland loam, and produces fine crops of cotton.

584. THE WHITE OAK FLATWOODS.—As has been stated above, the tract which I thus designate intervenes in S. Chickasaw county, between the Post Oak Flatwoods and the hills. In passing S. W. from Houston, on the Bellefontaine road, we enter the common Post Oak Flatwoods about ¾ of a mile from the town, and they continue unchanged for about 4½ miles, the soil being exceedingly heavy, the growth Post Oak with some Black Jack and Pine; the Huckleberry also is very abundant. Thereafter there is a gradual change; the soil becomes lighter, and assumes a yellowish tint instead of the dead gray; at the same time, the Spanish ("*Red*") Oak gradually takes the place of the Black Jack, the Pine becomes less frequent, and the whole growth sturdier. As we advance, the Hickory and White Oak gradually mingle with the oaks before mentioned and finally, near the foot of the hills, become quite prevalent. The surface of the ground, also, instead of being almost bare, as in the Post Oak Flatwoods, is covered with a fine growth of grass.

585. The soil of this region differs essentially from either of the two before described. On the land of Mr. —— Brooks, S. 33, T. 14, R. 1 E., where I took a specimen of soil and subsoil, the former is rather a *sandy* loam, of a yellowish tint; therefore, by no means a heavy soil, although it gradually becomes heavier as we recede from the hills towards the Flatwoods. Yet it is complained of as being very sobby, and liable to injury by wet; and in wet springs, it remains incapable of tillage until late in the season. It will sometimes appear quite dry and workable on the surface, while at the depth of 12 to 18 inches, the yellow, sandy subsoil is drenched with water. The cause of this state of things becomes apparent when we penetrate to the depth of 4 to 6 feet; it may also be observed in the bluffs of the branches of the region. At the depth mentioned, solid, impermeable gray clays underlie the sandy stratum, and as the tract is perfectly level, the drainage must be exceedingly slow; hence the soil will remain steeped in water for a great length of time, after every rain.

586. This soil has not thus far been analyzed, nor have I as yet ascertained the extent of the tract in which it prevails. According to the best information I could obtain, however, it stretches along the W. edge of the Flatwoods, through S. W. Chickasaw into Ocktibbeha county, for 20 to 30 miles at least; its width varying from ¼ to 1 mile, east and west. It is considered a pretty good soil

as the timber indicates, especially where the White Oaks are short and sturdy. Its chief fault at the present time—"sobbiness"—can undoubtedly be remedied without difficulty by either underdraining or surface draining—the former being probably the better method. It seems to be peculiarly adapted to Sweet Potatoes, and will also make fine Corn in favorable seasons. The region is thus far but thinly settled, and until the soil is drained, it can hardly be considered as having been fairly tested.

587. The Hills of the Flatwoods Region.—The hills which skirt the Flatwoods proper on the west, have so much in common with these in their general character, that I have thought it best to speak of them in connection with the Flatwoods. Since, however, their soils have not as yet been analyzed, I shall confine myself to such generalities as at the present time, may suggest anything of practical importance.

It would be difficult to circumscribe in any definite manner, the district occupied by these hills, the character of whose soil is dependent upon the underlying strata of the Lignite formation. These (as has been mentioned in the Geological Report—¶166, ff.; 168 to 176) are exceedingly variable from place to place; sometimes consisting of gray or yellow sands, of gray sandy clays; finally, in the Flatwoods Region proper, of the gray or whitish "Flatwoods clay," which when disintegrated, gives rise to the heavy soils of which I have spoken above (¶566, ff.; 579, ff.;). The same clay forms the base, and sometimes the whole, of most of the hills in R. 1 E., of the Chickasaw Survey, south of the Tallahatchie River. Thence, numerous strips and scollops of the same kind of land extend westward into R. 1 W., in Lafayette and Calhoun counties.

588. On the Oxford and Tocapola road, the heavy clay soil gradually sets in as we approach McLaurin's Creek; and even on Pumpkin Creek we find hillsides of a similar character; their soil differing decidedly from the yellow loam lands of Middle and W. Lafayette, (which it resembles in color—¶630, ff.;), in that it cracks open in dry seasons, and does not wash away. The Post Oaks also, which on the Oxford ridge are of a sturdy growth, here assume the Flatwoods character (¶568)—tall, slender trunks, with branches beginning low down, forming an open crown somewhat of the shape of a long pecan nut. The Spanish ("*Red*") Oaks are lank and thin, their bark whitish, their crowns tattered and irregular, with long, straight, whitish branches. These characters become more strongly pronounced as we approach the Flatwoods; and a great deal of Scarlet ("*Spanish*") Oak mingles with the other two. At first (as we advance eastward) the hills are capped with strata of the Orange Sand formation, and these, as they are washed down over the heavy hillside soil, mitigate its stiffness to some extent. But as the sand strata on the hills thin out and finally disappear, the hills become less abrupt, the surface soil is of a gray tint, and scarcely less heavy than that of the Flatwoods themselves.—Not unfrequently, ridges of the character just described, alternate with others which are capped with Orange Sand strata; and while it is not difficult to distinguish the one from the other in the field, it would be almost impossible to map them out.—Where the overlying mass of sand is somewhat considerable, springs may be observed to flow out at its base, some distance up the hillside, where a terrace is usually formed by the impermeable clay strata which shed the water. These terraces have been found very convenient for the ridge-roads, as they do not wash away; but on the other hand, formidable mudholes are often found on them even in the dry season; they are fed by the springs just referred to.

589. Very nearly the same state of things obtains in E. Calhoun, and the adjoining hilly portion of Chickasaw, as well as in the N. E. corner of Choctaw county. Further than this my investigations in that region have not extended. It must be observed, however, that where the White Oak Flatwoods intervene between the hills and the Flatwoods proper, the White Oak is also more or less prevalent in these hills, and the soil is on the whole superior to that above described, in E. Lafayette.

590. In Winston county, we find the "Noxubee Hills" bordering the Flatwoods on the west. Their clay soil, of a deep orange tint, which bears the White, Black, and Post Oak, with sturdy Hickory, and some Short-leaf Pine; with "Poplar" on the hillsides and in the hollows, more nearly resembles that of the "Pine Hills" of N. Holmes and Attala counties, and will be described in connection with these (¶637; 644).

This soil occurs as far S. as Winstonville; further S., as has been mentioned (¶563), the hills bordering the Flatwoods are sandy like those of the Gholson ridges. In E. Kemper county, however, where the Flatwoods "run out"—on the Bodka, and headwaters of Succarnoche River—we once more find hills of the Flatwoods character, similar to those of Lafayette (¶588).

Leaving out of consideration, for the present, the red soil of the Noxubee Hills, which seems to be of a peculiar character, it seems highly probable, both from the evident origin of the soils of the hills in question, and from the growth they bear, that they are similar in composition to those of the Flatwoods, and will require a similar treatment to render them productive. Drainage having in this case been, to some extent, provided for by nature, the super-addition of Lime and of Vegetable Matter would here, also, be the remedy indicated; so likewise is the intermixture with sand or sandy soils, which can very frequently be effected with facility, by directing properly the hillside drainage, wherever sand exists on the hilltops.

Unfortunately, Lime is not as easily accessible to the inhabitants of these hills, as it is to those of the level Flatwoods; the application of Vegetable Matter will therefore be more generally resorted to, to remedy the defects of the soil—if, as is probable, they are the same as those of the heavy soil of the Flatwoods proper.

591. North of the Tallahatchie River, in Tippah and Marshall counties, the hills bordering the Flatwoods (which here gradually lose their peculiarities) are of a different character from those described above. As a general thing, the Orange Sand, with its accompanying yellow loams, is much more prevalently the surface formation; the Lignitic formation itself [as may be seen on the bluffs of Ocklimita Creek near Hickory Flat, (¶159)] is generally composed rather of sandy materials, and does not change essentially, the character of the soil. In N. Tippah, it is only near the headwaters of Muddy Creek, that Flatwoods soils prevail on the hills to any extent; though it is rather in isolated patches, than in large bodies.

592. Bottom Soils of the Flatwoods Region.—Of these, no specimen has as yet been analyzed; but the fine growth of timber

which they generally bear, is proof sufficient of their fertility. As may be supposed, they are usually somewhat heavy; hence the Chestnut White Oak is one of the prevalent trees, from Tippah Creek to the Succarnoche. Large Black and Sweet Gums, Shell-bark Hickory, and Willow Oak, are rarely wanting; the Ash, Elm, and "Poplar", also occur with frequency.

It would be to little purpose, were I to go into any special descriptions of localities, so long as no analyses have been made. As a general rule, the Flatwoods bottoms are wide, and habitually overflowed during wet seasons; which added to their heavy soil, indicates leveling and drainage as their first necessity. Of the bottom soils of some of the Flatwoods streams, such as the Loosha Scoona, I have been unable thus far to form any definite idea, never having seen them save in a mushy condition. On the extreme headwaters of the Yallabusha, where the light Flatwoods soil (¶572, ff.), prevails in the upland, the bottom soils also are quite light and easily tilled. Whenever the Flatwoods bottoms have been taken into cultivation, they seem to yield very fine crops; but the inhabitants complain of their unhealthiness, which is assigned as the cause of their not having been more frequently settled. A great improvement in this respect might no doubt be effected by proper drainage of the extensive low swampy portions, in which the water remains stagnant during a large part of the summer, causing offensive effluvia very perceptible to the passer-by; and also in some measure, no doubt, by marling (¶461).

593. In the hilly portion of the Flatwoods Region, where the Bottom soils are generally less heavy, they are often remarkable for fertility, as evinced by the dense and vigorous growth of timber they bear, no less than by the results of cultivation.

The timber is sometimes a serious drawback to their being taken into cultivation, on account of the great labor of clearing; such is the case, for instance, on the Potlockney, a southern tributary of the Yockeney Patafa, in S. E. Lafayette. The soil varies considerably, some streams bringing in sandy deposits, others clay; the latter portions may be recognized by the prevalence of the Chestnut White Oak, the latter by that of the Beech (forming "Beech Ridges"). Besides these, we find the Sweet Gum, both Shell-bark Hickories, White Oak, Black Gum, "Poplar", Ash, Maple, Hornbeam, Red-Bud, Holly, Cucumber tree (*Magnolia auriculata*) and even the bottom varieties of the Spanish ("*Red*") and Scarlet ("*Spanish*") Oak.—Precisely the same timber, and a very similar soil, occur on the Ocklimita, near Hickory Flat, Tippah county; and nearly the same may be said of the Tapashau (¶611), in S. E. Calhoun. The White Oak, especially, is always abundantly present in these bottoms of the hilly Flatwoods Region.

594. Springs and Wells of the Flatwoods Region.—A. *The Flatwoods Proper.*—It is obvious that in a region of the geological constitution and surface conformation of the Flatwoods proper, springs cannot exist; for the rain water cannot percolate the soil to any extent, and all is at once shed from the surface into the water-courses. The latter themselves, while flooded during the wet season, go dry as soon as the slowly subsiding surface waters have found time to drain off; and they remain so during the whole of the dry season, save, when at times, heavy showers fill their channels for a short period. Where the *light* soil prevails, wells can sometimes be obtained at the depth of 15 to 20 feet. In this case, either the gray Flatwoods clays (¶165, ff.), or else the marly or rocky strata of the cretaceous formation (¶116 to 139), form

the bottom of the well. In the former case, the water is sometimes pretty good, though generally inclining to be magnesian. When, however, the cretaceous marls have been reached, the water is usually very limy.

595. Where the heavy Flatwoods soil (¶566, ff.), prevails, it is but rarely the case that water-bearing strata can be found at any moderate depth, and before reaching the marl strata.

The latter, as stated in the Geological Report, underlie the whole of the Flatwoods Region, dipping W. or S. W. from its eastern limit, at the rate of 25 to 30 feet per mile. In the region to the N. of Houston, their upper strata, as may be seen at numerous outcrops on the Pontotoc Ridge, consist of alternating ledges of rock and soft materials very variable in their character and thickness; sometimes clayey marls, sometimes almost pure sand (¶128, ff.). On the whole, water-bearing strata are very common in this uppermost portion of the cretaceous formation; and hence it is, that in the whole of this upper Flatwoods region water is almost certain to be struck in bored wells, so soon as the calcareous strata are reached. Of course the water thus obtained is usually very limy; if not so originally, it is certain to become so by standing in the bore, in contact with the marl strata. Frequently too, it is sulphureous and chalybeate; mineral waters of valuable properties have been repeatedly obtained, and are in successful use in some neighborhoods; although thus far, none of them have become more generally known. The chemical nature of these waters, as might be expected is on the whole the same as that of the natural springs yielding mineral water, which are so common in some parts of the Pontotoc Ridge.

596. The depth of these bored wells increases pretty regularly in some regions, as we advance westwards from the Pontotoc Ridge; and may often be approximately ascertained by the rule above given, allowing 50 to 60 feet for the depth of a well at the *eastern* edge of the Flatwoods. Since, as above observed, the material of the limy strata is very variable, so that water is not always obtained in the same stratum at different places; since, moreover, the level of the surface varies to some extent, and cannot be accurately compared except by actual leveling; these calculations cannot of course, be anything more than an approximation, say within 20 to 25 feet of the distance at which water is actually obtained. Even thus, however, they are useful guides in practice. Boring in these regions is generally easy, and no tubing is in most cases required, the firm clays of the Flatwoods and the marls of the cretaceous being but little liable to "cave". The ledges of rock which are struck, are usually of inconsiderable thickness, averaging from 1 to 4 feet; the thickest ledge of *hard* rock I know of (which requires to be pecked), in N. W. Chickasaw and adjoining part of Pontotoc, being about 8 feet. Locally (¶152, ff.), limestone strata of a more considerable thickness appear; but I have not heard of their being struck in bored wells.

597. It is but during the last two years, that boring of wells has become more common in the Flatwoods; and when these borings shall have furnished a greater number of data, we shall be able to foretell with greater accuracy the necessary depth in other districts. The deepest wells to the westward in the Flatwoods region of which I have any knowledge, are the following:

S. 21, T. 5, R. 2 E., and neighborhood, Tippah county. Bored wells 300 feet deep. Water rises to within 60 to 80 feet of the surface.

Mr. Waltup's, S. 4, T. 11, R. 1 E., western edge of Flatwoods, slightly undulating. Well 448 feet deep; water rises to within 75 feet of the surface. The calcareous strata were first observed at 300 feet.

Mr. Cannon's, S. 9, T. 13, R. 1 E., Calhoun county. Some distance in the hills, W. from the edge of the Flatwoods. Well 404 feet deep; water rises to within 80 feet of surface. Calcareous strata first observed at 375 feet.

Water is sometimes obtained before reaching any of the principal limestone ledges; at others, and especially near the eastern edge of the Flatwoods, no water is struck before passing through some of these. Such is the case on the heads of Tallahatchie Mud Creek, where a number of bored wells exist, some of which I shall mention:

Silas H. Wood's, S. 5, T. 10, R. 2 W. Marl was struck at a moderate depth, but no hard or water-bearing stratum down to 204 feet; below this came alternating ledges, 6 to 18 inches in thickness, of limestone and sandy material, for 56 feet; then two ledges of (calcareous) sandstone, with yellow sand beneath, which yielded water, rising to within 60 feet of surface. Whole depth about 270 feet.

N. of Mr. Wood's, along the W. side of Mud Creek, bored wells average from 240 to 270 feet, with about the same rise of water.

At Mr. Laban Grisholm's, S. 26, T. 9, R. 1 E., limestone was struck at 300 feet; the ledges were several feet in thickness. Whole depth 410 feet; water within 70 feet of surface.

There appears to be, on the whole, more regularity in the uniformity of depth of wells situated N. and S. of each other, than in the increase of depth westward; in which direction, the material of the cretaceous strata seems to be very variable.

598. The above facts and generalities, it will be recollected, refer to the Flatwoods region to the N. and N. W. of Houston. At Houston, and in its neighborhood, water is obtained at depths between 120 to 160 feet, rising to within 40 to 50 feet of the surface; it is probable therefore, that in the Flatwoods W. and S. W. of Houston, water could be reached at corresponding depths, allowing 25 to 30 feet for every mile in a S. W. direction.

I am not aware of the existence of any bored wells in this portion of the Flatwoods. In S. W. Chickasaw, on the waters of Tibby, bored wells reach to great depths—1,000 feet and more, as mentioned under the head of the Northeastern Prairie Regions (¶570); it is probable therefore, that corresponding depths would be required in the Flatwoods of Ocktibbeha; and judging by the depths of wells in Noxubee county, the same would be the case in the Flatwoods of Winston, Noxubee and Kemper. In this southern region, the upper part of the cretaceous formation which contains so many alternating strata of hard and soft materials, does not exist, but has given way to the stage of the Rotten Limestone, whose strata continue without essential changes for 800 to 1,000 feet. Whenever, therefore, in this western edge of the lime region, this rock is reached without obtaining water, there is no further chance for it within the depth just mentioned.

599. On account of this difficulty, cisterns have come into general use in the section of country referred to. As in the prairie region itself, they are usually hewn into the Rotten Limestone itself, which in the level Flatwoods of Noxubee, is reached at depths from 20 to 40 feet. Down to this depth, therefore, a narrow shaft only, like that of common wells, is sunk; while a cavity of the shape of a jug is hewn into the Rotten Limestone, whenever it is reached. The water of these subterranean cisterns is much cooler than that of the cisterns in the Prairie Region, whose arch touches the surface; and whenever it has been used for some time, it nearly loses its limyness, and could not ordinarily be distinguished from freestone well water.

In a few cases, where a sandy soil prevails on the surface, shallow wells have been obtained before reaching the limstone. These, however, usually give out during the dry season.

600. *Wells and Springs in the Hills of the Flatwoods Region.*—As might be supposed, springs are not plentiful in a region whose soil, as well as the main mass of the hills, consists of impervious

clays. It is chiefly in those portions of it, in which the upper part of the hills is formed by sand strata (of the Orange Sand age) that we may expect to find them. Ridges of this character, as has been mentioned (¶ 588), are not uncommonly interspersed with those which consist entirely of Flatwoods clay; and hence it is that the hilly region referred to is not quite as poorly watered as might be supposed. It is true, however, that on account of the limited *extent* of the sand deposits from which they flow, these springs are more liable to give out during the dry season, than is the case further westward, in the regular Orange Sand Pine Hills (¶ 630).

So long as these springs are *shed* by the impervious clay strata, their water is generally freestone, and without any offensive taste. Not so, however, in the *wells* which, in districts where sand forms any considerable part of the hills, may be obtained at moderate depths. In these cases, water is usually struck immediately *above* the clay strata in question (known as "black dirt" throughout the region of their occurrence) and basins for the accumulation of the water are dug *in* them. Thus it has time to extract all the soluble matter, that may be within reach, and among these, salts of magnesia, lime and soda as well as bituminous substances which impart to it a disagreeable taste, and sometimes even a sensible color. Not unfrequently, also, the water becomes impregnated with sulphur (sulphuretted hydrogen); and thus a great variety of mineral waters results, which numerous persons are disposed to consider so much the more "healthy", the more obnoxious their taste and smell happen to be.

601. It cannot be too strongly urged upon the inhabitants of these regions [as well as those of a more southerly portion of the State where a similar condition of things exists, (¶756)] that the *habitual* use of mineral water proper, of *any* kind, is no more rational than would be the habitual use of any other medicine, with persons in a normal state of health. It is often said, that mineral waters are "nature's own remedy"; which may be true enough, provided there is something *to be remedied*. The Epsom Salt, Glaubers Salt, Gypsum, etc., contained in these waters, are no less purgative, debilitating and therefore injurious to persons in good health, than the same articles are when derived from the druggist's vials.

There can be no doubt, that in miasmatic districts, where injurious influences are continually at work, these may be counteracted, to some extent, by the habitual use of preventives; and the *weak* chalybeates which are so numerous all over the State, have in many instances proved a decided benefit to the health of the population using them, as a preventive of fever and ague. But while this may be true to some extent of pure chalybeates, and while, moreover, it is universally acknowledged that water *entirely* free from mineral ingredients is far from being the most healthy; yet there can be no doubt that the *habitual* use of *magnesian* waters is highly injurious to most constitutions, undermining them slowly but surely; especially so in climates prone to the occurrence of the fever and ague. It is very frequently the case, that families moving to residences where such mineral waters occur find their health decidedly benefitted by their use, during the first year. Hence the conclusion is drawn that their mineral spring or well is "mighty healthy water", and its use is continued. The second year, cheeks begin to pale and an occasional chill occurs, which in its turn is treated with increased potations of the "healthy water". After the lapse of the third, and sometimes the fourth year, "tallow face" and "ague cake" prevail all around: and the place is perhaps sold at a sacrifice, under the firm conviction that the country is so unhealthy, that even the "healthiest water" will not protect its inhabitants. The water is not blamed, because the experience of the first year has "proved" it to be beneficial to health.

602. Now, there is nothing surprising in the circumstance, that vigorous plethoric constitutions should be benefitted, for the time being, by a water having slightly laxative properties. So they might be by using small doses of Epsom Salt. But it does not follow that, because the disease, or tendency to disease, has been removed by a medicine, that medicine ought to be continued *habitually*. The return of the original indisposition might thus be prevented; but a new one would be sure to arise in its stead.

Mineral waters of any considerable strength are medicines just as properly, as any prepared in the druggists labaratory; and their indiscriminate use will ultimately produce no better results, than could be expected to follow a systematic consumption of the contents of a drugstore.

603. While this is true of *magnesian* waters, the same cannot be maintained with reference to those impregnated (as the waters of our bored wells generally are) with carbonate of *lime*. Experience has conclusively proven, that persons habituated to the use of waters containing a moderate amount of carbonate of lime, do not *necessarily* sustain any injury therefrom; although their tendency to certain classes of diseases, not so prevalent in adjoining freestone regions, may be increased.

It is quite probable, that a certain small amount of lime, such as spring waters usually contain, is quite beneficial, as furnishing an important ingredient to the animal economy. While, therefore, *excessive* limyness of water in daily use, may prove injurious, and has been known to do so in numerous cases, the amount of lime *usually* contained in the bored wells of the prairie region and the Flatwoods, cannot be considered as *necessarily* unhealthy; though to be sure, they may be to some constitutions, and to those not accustomed to their use.

604. It must be recollected, that the water of wells bored in the western portion of the Flatwoods, and in the hilly region adjoining, may *become* magnesian in consequence of its passage through, or long standing in, the black clays of the Lignitic (Flatwoods) formation, which there overlies the limestone strata. If the taste, or effects on health, should induce any suspicion of this being the case, the following simple test may be applied: boil the water in a *perfectly clean* kettle, for at least an hour; after cooling, pour it out into a clear and clean tumbler, cover it over, and leave it to settle until it becomes perfectly clear and free from floating particles. This may sometimes require a whole day; when it is clear, dip out half a teaspoonful with a clean silver spoon, and let the water so taken evaporate in the spoon, in a place free from dust. It may be set on the stove, but ought not to be made to boil violently. If afterwards any considerable amount of salt (in the shape of a white dust) is found in the spoon, the water ought to be submitted to a chemist.* If, on the other hand, only a slight general tarnish remains in the spoon, it will usually be safe to use the water.

605[1] What has been said above concerning the mineral or magnesian *wells* of the Hilly Flatwoods region, holds good also, of course, in regard to the natural mineral springs, which are not uncommon in the same region, and become very abundant in W. Calhoun, and some parts of Choctaw and Winston counties. There, strata of sand, and black sandy clay, which frequently replace the heavy Flatwoods clays, or alternate with them, give rise to numerous springs, which are mostly more or less mineral. Their most usual character is that of *magnesian chalybeates*, often with *sulphuretted hydrogen*. For some further particulars regarding these waters, see "Waters of the Yellow Loam Region (¶669, ff.).

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*Any specimen of water sent to the State Geologist at Oxford, free of freight or other charges will be examined, and the result communicated to the owner, free of charge.

605² It is not unfrequently the case, that by judiciously selecting the site for a well on those ridges whose upper portion consists of sand, water may be obtained without touching the "black dirt." This can very commonly be done in the heads of hollows, at, or little above the point where the three slopes meet. At all events, however, it is advisable to use cisterns rather than the natural water of the Hilly Flatwoods Region, whenever it possesses any considerable taste of mineral matters.

THE YELLOW LOAM REGION.

COMPRISING NORTH-WEST TIPPAH, MARSHALL, THE GREATER PART OF DESOTO, EAST PANOLA, LAFAYETTE, WEST CALHOUN, YALLABUSHA, PART OF EAST TALLAHATCHIE, EAST CARROLL, CHOCTAW, EAST HOLMES, NORTH-EAST YAZOO, NORTH MADISON, ATTALA, LEAKE, WINSTON, NESHOBA, PART OF KEMPER, LAUDERDALE, NEWTON, (GREATER PART) AND NORTH-EAST CORNER OF SCOTT.

606. I embrace under this head, for the present, all that portion of the State lying between the Mississippi Bottom on the West, the Flatwoods Region on the East, and N. of the territory of the marine calcareous Tertiary (¶192 to 229—see map); which embraces the counties above named.

Of course the soils on this large territory are very numerous and variable, and there is in most cases no sharp line of demarkation from the adjoining districts. Until, however, a greater number of soils from the several portions of this territory shall have been analyzed, it will serve no practical purpose to subdivide it into minor groups.

The general characteristics of its soils may be thus defined: that those of the better class of uplands are formed by a yellow or brownish-yellow loam (¶332 ff.), varying greatly in thickness, from a few inches to as much as 20 feet, but averaging about 3 feet, which forms generally a light soil, and is underlaid by either loose sand, or red hardpan of the Orange Sand formation (¶6 to 77); while on the poorer uplands, the loam is very thin or entirely absent, and some of the materials of the Orange Sand, or their intermixture with the yellow loam, form a sandy soil which, though at times quite productive at first, wears out very rapidly.

607¹. The former soils are timbered, essentially, with Spanish ("*Red*"), Red ("*Black*") and large, sturdy Post Oak, and Hickory, to which, especially in cases both of unusual heaviness, and lightness, the Black Jack Oak is very generally added. In the rich hill soils, and very commonly on the slopes, and near the bottoms, the *true* Black Oak, or Quercitron Oak, is also common.

607.² The Scarlet ("*Spanish*") Oak is found among these commonly occurring trees, everywhere more or less; its prevalence, however, is considered an unfavorable symptom as regards the fertility of the soil—it belongs more particularly to the poorer class of the "Yellow Loam Soils," merging towards the "Pine Hill" and "Black Jack Ridge" soils of North Mississippi, which are characterized in general as above stated, by their sandiness, and as concerns their growth, by Post Oak, Black Jack and Short-leaf Pine, among which the Spanish ("*Red*") and Scarlet ("*Spanish*") Oak appear scatteringly, and of lank or scrubby growth; while Hickory is absent or present only in small trees, and Black and Red ("Black") Oak are wanting. Moreover, the Chestnut tree, though not abundant in individuals, is a very constant inhabitant of the poorer class of ridge soils of N. Mississippi.

608. We find of course, all degrees of transition from one extreme of the soils above mentioned to the other, and it would be futile as well as useless to attempt to define and distinguish them strictly. For these transitions are essentially incident to the manner in which these soils were formed, since, when the loam was carried over, and deposited on the Orange Sand strata, its lower portions would unavoidably become mixed, to some extent, with the loosened materials of the latter. We find, therefore, in examining a profile where (as in road washes) the loam and Orange Sand are exposed together, that near the line of junction, for a foot or eighteen inches, we have a very sandy loam or clayey sand, corresponding exactly to the Pine and Black Jack ridge soils, while higher up, there is less sand, and when thicker than two feet, the loam appears nearly of uniform character thence upwards.

While, therefore, it is convenient to keep in mind these two, as the principal types of soil, for convenience of comparison and description, it will, in many cases, be entirely optional with the observer, to which of the two classes his particular soil shall be counted as belonging.

609. It is very essential, however, in judging of the position of any of these soils in the scale of comparison, to take into account not only the kind (species) of the trees, but also their mode of growth. The Black Jack and Post Oak, especially, as species, belong to the poorest as well as the richest upland soils, both of this region, and of Mississippi generally; and the Spanish ("*Red*") Oak, while its range as to quality of soil is generally less than that of the other two, would cause even a greater number of mistakes, if relied on as a species to indicate any particular quality of soil; not only on account of its wide distribution, but, also, because of the greater difficulty of distinguishing from one another the different forms it assumes on the several kinds of soil.

610. A good sized Post Oak of sturdy, thick-set growth, with stout, crooked branches, which decrease rapidly in thickness, and with a dense well shaped top, will never be found on a poor or easily exhausted soil. But let it be small and scrubby, with numerous small branches, and a long tattered top; or its trunks tall, thin and tapering, with long, rod-shaped branches, themselves often covered with stout foliage; and an open, irregular, or tattered top, or much elongated (in the shape of a long Pecan nut): and little is to be expected of the natural resources of the soil.

611. With the Black Jack Oak, the characteristics are somewhat different. The short and knotty Black Jack, whose trunks will sometimes scarcely yield a straight piece long enough for a fence-post, and generally places the purchaser of cord-wood under a great disadvantage; which possesses short and very crooked branches, and a tattered, open top, is the characteristic tree of the poor sandy Black Jack ridges; and when very small besides, it denotes the very poorest soil. Dense rounded tops, with rather low, but straight trunks, belong to the heavy prairie soils of the cretaceous formation (Monroe, Chickasaw), and on the other hand, to the fertile, but extremely sandy ridge soils of S. Noxubee, Kemper, Lauderdale and Jasper, while on the fertile yellow loam soils of North Marshall, Holmes, Madison, etc., the Black Jack forms large, well shaped, spreading trees, sometimes fifty feet and more in length, with trunks comparatively straight—or at least, not whimsically knotty like those of the Pine Hills;

but generally leaning over to one side with a regular curve, and without straggling branches on the trunk below the top.

There are probably few trees, which, like the Black Jack, can flourish on such extreme opposites of soil (¶347²); and it would be highly interesting to ascertain, by comparative analyses, what is the peculiarity of the soil by which the tree is guided in its selection.

612. As for the Spanish ("*Red*") Oak, it does not frequent soils of any extreme character, either physical (as to lightness or heaviness) or chemical.

Soils where this tree *prevails*, are generally easily tilled, yet not liable to suffer from drouth. But as to their quality, a great deal depends upon the size and form of the tree. If it be rather stout; if the main branches grow out at a large angle (more or less square) so as to form a rounded top, closed on all sides the soil is sure to be a strong one. But if the trunk is lank, slender, and of a whitish hue; forking into straight slender branches tending upwards, somewhat in the shape of a broom, and presenting a tattered top which is open below: little can be expected of the soil.

613. Very nearly the same applies to the *true* Red, and Black Oak proper, which are not distinguished in Mississippi, but are both usually comprehended under the title of Black Oak. The White Oak proper, when of a sturdy growth, with a rounded top, belongs to the best of "hommock" soils; but it is not a safe mark to judge by, when it is a lank and tall growth, with a very long top.

614. I have thus briefly characterised these, the principal forest trees of the Yellow Loam Region, for convenient reference in the special description of its agricultural features. It is necessary, of course, to exercise judgment in the application of the rules given above, which are the result of personal study, as well as, in a great measure, the expression of experience afloat among the people, which, when reduced to a system (as no doubt can be done by careful investigation) will be of the last importance in the selections of lands, and might render analysis almost unnecessary (¶372).

615. It is not only the *mode of growth*, but also, and very essentially, the *size* of the trees which requires to be taken into consideration, in order to come to a correct conclusion concerning the fertility and peculiarity of the soil. It is with these several types of one and the same kind of tree, as it is with many separate species—as for instance, with the Pines. By common consent, we generally consider the presence of Pine among the Oak growth, as a sign of a soil inferior to that which bears the Oak alone; and yet, there is no surer sign of a good soil in many of the bottoms of S. Mississippi, than the presence of huge Pines even among the Sweet Gum, Poplar, Mulberry, and bottom Oaks.

Nor is it to be expected, that in any region all the trees of one species should exhibit the same type of growth. The soil of the hillsides will differ somewhat from that of the hilltops; and moreover, where the growth is crowded, the peculiarities of form may be lost or ill defined. It is the type of *well developed* trees which must be noticed, rather than of the majority of a crowded growth.

616. TABLE LANDS OF N. MARSHALL AND N. W. TIPPAH.—The lands known as the Marshall Table-lands are among the most fertile uplands of the State, and are found to be particularly suited to the culture of cotton. I have not as yet made a detailed examination of this region, and can only give generalities concerning it.—The face of the country (on lower Wolf River and the northern heads of Cold Water) is gently undulating, generally so as to be in little danger of having the soil washed away, provided the process of

"circling" be moderately well executed. The soil is formed of a brown loam, which overlies the Orange Sand strata—the loam is generally from six to eight feet in thickness, but sometimes more. The material is, on the whole, rather heavier than that of the yellow loam lands of S. Marshall and Lafayette, and also of darker color —greatly resembling, in these respects, the brown loam of the Southern River Counties (¶687)—to which, also, it approaches closely in composition.—The timber consists essentially of Oaks and Hickory; the Post is perhaps the most prevalent tree, which is accompanied on the more clayey belts, by the Black Jack, on the lighter soils, more prevalently by the Spanish ("*Red*"), the *true* Red, and Black Oak. The sturdy and vigorous growth of the Post Oak, and the corresponding characteristic forms of the other trees, denoting a soil of great fertility, are very strikingly developed here.

617. The soil proper, as at present existing, is not generally rich in vegetable matter, and often differs but little in aspect from the subsoil found at two to three feet; but we commonly find to the depth of ten to twelve inches from the surface, a soil which differs from the lower layers in being more mellow in cultivation, and having a shade of chocolate or "mulatto" color added to the reddish brown of the subsoil. The following analyses of soil and subsoil of this region, refer to specimens furnished by Judge A. M. Clayton, from his plantation near Lamar, and were considered by him fair specimens of the soil of the slopes of the dividing ridge between the waters of Cold Water and Wolf Rivers.

618. No. 216. Soil of Marshall County Table-lands; from Judge A. M. Clayton's plantation S. 30, T. 2, R. 1 W., near Lamar, Marshall county. From a level tract below the summit ridge:

Depth: Ten inches.

Vegetation: Hickory, Black Jack and Post Oak, mingled with some Sweet Gum and an occasional Spanish Oak.

A mellow soil, of a "mulatto" tint. Saturated with moisture at 62.4 deg. Fahr., it lost 6.842 per cent water at 400 deg.; dried at which temperature it consisted of:

Insoluble Matter	83.347
Potash	0.549
Soda	0.082
Lime	0.245
Magnesia	0.479
Brown Oxide of Manganese	0.760
Peroxide of Iron	4.798
Alumina	6.282
Phosphoric Acid	0.068
Sulphuric Acid	0.062
Water and Organic Matter	4.195
	100.033

619. No. 235. Subsoil of Marshall County Table-lands; from Judge A. M. Clayton's plantation, S. 30, T. 2, R. 1 W., near Lamar, Marshall county:

Depth: Ten to twenty inches.

Vegetation: Same as the preceding.

A pretty solid, yellowish-brown loam. Saturated with moisture at 62.4 deg. Fahr., it lost 7.423 per cent. of water at 400 deg. Fahr.; dried at which temperature, it consisted of:

Insoluble Matter (as above)	83.993
Potash	0.700
Soda	0.049
Lime	0.139
Magnesia	0.579
Brown Oxide of Manganese	0.332
Peroxide of Iron	3.862
Alumina	7.279
Phosphoric Acid	0.236
Sulphuric Acid	0.054
Organic Matter and Water	2.716
	100.399

620. The analyses show the important fact, that the subsoil of the Marshall table-lands is, generally speaking, richer in the most important nutritive ingredients of the plants (Potash and Phosphoric Acid, also Magnesia), than the surface soil, and that those which are deficient in the subsoil as compared with the surface soil (Soda, Lime, and Sulphuric Acid) are those most readily supplied by artificial means. The determination of the absorbing power for moisture shows, moreover, that no important change will be effected in this respect, by bringing the subsoil to the surface—which, by exposure and tillage, soon becomes equally mellow with the present surface soil. Deep plowing and subsoiling, in the sense of turning up the subsoil (¶503, ff.), is therefore clearly indicated as the means of bringing into action, the great native fertility of this soil; in addition to which, the use of *lime*, both as a stimulant and nutritive ingredient, is to be primarily recommended. In view of the deficiency of Soda, in both the surface soil and subsoil, an addition of common salt to any manure used, would be found useful; and plaster (gypsum) would greatly benefit the soil, not only as a stimulant, of which the subsoil stands in need, but also as supplying two important ingredients in which, otherwise, the soil is somewhat deficient.

621. It is important to observe that, as a convenient source of lime, the marl (¶118, ff; 141), and limestone (¶91, ff.), region of Tishomingo is very accessible by Railroad to this section of the country.

The nearest marl deposit on the railroad, with which I am acquainted, occurs near Chawalla Station on the M. & C. R. R. It is probable, however, that deposits of blue marls and glauconitic limestones, occur near at hand, on Muddy Creek, and Hatchie, in Tennessee. The marl at Chawalla (¶141), is of the Rotten Limestone character, yellowish and clayey; a specimen yielded on analysis, twenty-one per cent. of carbonate of lime; but it is likely that marls richer in lime than the one analyzed, and which would pay better for transportation, may be found between Chawalla and Farmington. If the impure greensandy limestone of the Ripley Group (¶150, ff.), should appear anywhere on Hatchie or Muddy Creek, near the railroad, it might pay well to burn it into lime for agricultural purposes.

Further east, near the Mississippi line, and in particular where the railroad crosses Bear Creek, the gray limestone of the Carboniferous formation is found (¶82); which if burnt, on account of its greater purity, might pay better for transportation, notwithstanding the greater distance from the point where it is to be employed.

622. The Table-land soils of North-West Tippah, such as they are found north of Salem, do not differ much, apparently, from those of Marshall; in their growth, the Spanish ("*Red*"), *true* Red, and Black Oak are rather more prevalent, alongside of the Post Oak, than is the case on the soils analyzed, where the Black Jack is very abundant; the color of the loam, also, inclines less towards

brown than is the case further west, and the face of the country gradually becomes more hilly as, after crossing Wolf River, near Spring Hill we advance eastward.

In Marshall county the material underlying the surface loam is generally a reddish hardpan (of the Orange Sand formation), which sometimes is impervious enough even to give rise to springs, or at least, to retain the water in pools in the beds of the streams, after they have ceased to flow—as, unfortunately, they very generally do during a large portion of the summer, in the "table-land" region. As, however, we approach the dividing plateau between the waters of Wolf River and Hatchie, in T. 1, R. 2 and 3 E., and the northern portion of T. 2 of the same range, we find the strata underlying the loam to consist of loose, white or yellowish sand, in consequence of which, the soil washes very badly, though according to the inhabitants, it is "good enough as long as it will stay"; while still further east, on the waters of Muddy Creek, as well as southward, the surface becomes more hilly and sandy and the soil inferior.—The streams of this plateau land flow only a short time even after the heaviest rains, their water being rapidly absorbed by the soil; though even here, a stray layer of clay traversing the sand, will occasionally give rise to a spring. Wells require to be sunk to considerable and inconvenient depths, in order to obtain a steady supply of water during the summer; and stock water requires to be kept in artificial ponds. The peculiar shallow, rounded form of the hollows in this region, immediately recalls the same feature as occurring in the Pine Hills of South Mississippi under similar circumstances (¶77).

623. It is greatly to be regretted, that circling was not practiced at an earlier date in this region; for large tracts, originally covered (though not to a great depth) with an excellent soil, have already been irrecoverably lost to cultivation by washing. When the surface loam has been penetrated, the latter process goes on with fearful rapidity, and requires the most energetic measures to check it. Not only is the soil, and all that could possibly serve as a foundation for a soil, carried away from the hills, but the materials thus removed cover over the fertile branch bottoms, in company with a flood of sand, which renders them useless for all time to come.

The difficulty just mentioned, though rarely met with to the extent to which it is experienced here, is of very frequent occurrence in this State, in consequence of the great prevalence of loose sandy materials as the substratum of the loams forming the soil and subsoil, and may as well find some discussion in this place; since it is especially in the "Yellow Loam Region" that the inroads of the hillside washes are acquiring, more and more, an alarming importance, not only to the cultivators of the soil, but also to many villages and county seats, which seem to have been located very generally, by preference, upon sand ridges, and not a few of which are in danger of going, in the most literal sense, "*down hill*".

624. "Circling" or "horizontalizing" the hill sides, in cultivation, is certainly the first necessity in the present condition of things, and will do a good deal towards preventing the commencement of this evil. This is now becoming so universally known and acknowledged that no one who neglects this necessary measure of self-defence, can claim to be considered as obeying the dictates of ordinary prudence and common sense.

Sufficient attention is not as yet paid, in general, to the careful and accurate adjustment of the level, on which the success of the whole absolutely depends, and without which, the very measure intended to remedy the evil, is most calculated to bring it about.

625. No one can trust his eye alone to recognize the true level with even moderate accuracy; and the common water level, at least, ought to be considered

as indipensable an instrument on every upland plantation, as the steelyards which serve to weigh the crop. It should be found, ready made, in every country store and tinshop—it need not cost more than half a dollar, glass tubes and all. But the planter may in case of need make one himself at any time, from a piece of cane, or the tube of an elder, fitted at each end with a small medicine bottle, such as may be obtained at any drugstore—the bottom being cracked off and the bottle connected, neck downwards, with the horizontal tube, by means of a smaller tube (of cane or elder) which can readily be made to fit both the neck of the bottle and a hole bored into the side of the main piece; the tubes ought to be as wide as possible, but the glass tubes or bottles should not exceed, for *convenient* use, half an inch in width; and the horizontal tube ought not to be shorter than twelve inches—two feet is the desirable length. The facility of sighting over the top of the water in both ends, is much increased to an inexperienced eye, by coloring it in some way—with logwood, indigo, Pokeberry, Blood-root or the like. And it must be recollected, that the points sighted —which should not be at excessive distances, especially when the instrument is short—are on a level, not with the *foot* of the stick on which the instrument is supported, but with the *surface of the water*, or the eye of the observer while sighting; and that, therefore, the height of the latter above ground must be measured downwards from the point sighted on a pole at the other end, in order to obtain the point on the ground corresponding to the foot of the instrument. Moreover, if the surface is at all irregular, a single level taken at the middle of the slope is not enough to insure the plow-hands keeping "on a line" with it at any distance; but several of these level lines ought to be seen and marked off, once for all, if possible.

626. Hillside "horizontalizing", however, is not of itself an effectual remedy, unless accompanied by *deep plowing*, not only in making the furrows between the rows, but in the entire process of tillage.

Unless this is done, so as to render the soil capable of absorbing rapidly a large amount of water, the latter is sure (unless indeed the soil be extremely porous of itself) to accumulate on the surface in the furrows, in heavy rains, to such an extent as to break through at some weak point, from which, thereafter, the washes will extend *so much the more rapidly*, as the process of horizontalizing *itself* has made the collection of the water in channels easier. And the same double inconvenience, precisely, always results from imperfect leveling of the furrows, as any one who will observe the point can convince himself.

Deep plowing, therefore, while advisable almost everywhere as a matter of general policy, is doubly useful in lands subject to washing. And when, in addition, analysis has demonstrated (as in the case of the "Table-lands") that the richest portion of the soil still lies untouched beneath the present range of the plowshare, inducements enough, it would seem, are offered to planters for the final abandonment of the profitless, and in the case of hilly lands, positively suicidal system of shallow tillage, now so generally prevalent.

627. When washing away can be prevented in lands circumstanced as is a large portion of the yellow lands of the State (viz: underlaid, at the depth of a few feet, by pervious sands of considerable thickness, the very causes which at present prove so fatal in many cases, will be turned to positive advantage. For no artificial arrangement, however, complete and expensive, could bring about as perfect a condition of thorough drainage, as naturally exists in these soils.

When, however, the thickness of the retentive loam muck exceeds about 4 feet; or when the underlying sand, instead of being loose and easily penetrated by water, is more or less indurate and cemented into "hardpan", then thorough drainage by artificial means may become, if not absolutely necessary, at least very expedient and useful (¶407, ff.; 413[1]).

628. It is higly important to the agriculturist, especially when the subsoil or loam stratum proper is shallow, to prevent the washes from penetrating the loam into the underlying sand or hardpan.

Should the sand be loose, the moment the water reaches it, an undermining process will begin, which will cause the land to waste with greatly increased rapidity. Should it, on the contrary, be an impervious hardpan, as is very frequently the case, the increased mass and velocity of the water will rapidly widen its channel, casting away the sides of the gully. In any case, when the sandy strata are once reached, the space thus laid bare is absolutely lost to cultivation, unless artifically covered with fresh soil; for the sands of the sea-beach are not more arid and hopelessly sterile, than are those of the Orange Sand formation. So long, therefore, as the washes remain within the loam stratum, the soil can be recovered for purposes of cultivation, not only in the region of the Marshall and Tippah "Tablelands," but very generally where the, remarkably uniform, yellow loam stratum prevails. Old fields cut up with washes need not, therefore, be considered as irreclaimable, unless this loam has been absolutely carried away, exposing the sterile sand—which, in general, it is not difficult to distinguish from the subsoil loam, since the former very rarely possesses tints similar to those of the latter. In N. Mississippi especially, the dull yellowish-brown tints of the loam generally contrast pretty strongly with the reddish-brown or orange hues of the sand.

The loam exposed by these washes, so far from being sterile, is often found eminently fertile, in consequence of the decomposing or "fallowing" action which has been exercised upon it by the atmosphere (¶357). In N. Marshall, especially, striking instances of this kind have often occured. In general, these washed surfaces require to be treated like subsoil fields (¶506).

As regards the cure of washes already formed, it is oftentimes by no means easy. It cannot always be done by simply filling them up, because the loose material thus introduced is liable to be washed away again by the first hard rain; unless, at the same time, an underdrain is laid at the bottom of the gully, so as to carry off the water rapidly, without allowing it to set the mass afloat.

629[1]. South of the waters of Wolf River, on the northern branches of Tippah Creek, in Tippah county, the land is generally much inferior to that of the "Table-land" region. The surface is much broken, and the covering of loam thin or almost entirely wanting on the ridge lands, whose soil is sandy, and timbered, chiefly with inferior Post Oak and Black Jack, at first only with occasional streaks of Pine, which gradually becomes one of the regular occupants of the soil; some Chestnut, also, is almost invariably present. The slopes towards the bottom, however, (as well as the latter themselves) are of good quality, and resemble the "Table-land" soil.

Very nearly the same condition of things obtains in TT. 5 and 6, R. 1 E., save that the lands often possess somewhat the character of the "Hills of the Flatwoods Region" (¶587); so that the country on the Ocklimita is an exact copy of that on the headwaters of Yockney—*e. g.*, the Potlockney, Otuckalofa, etc., and the same character continues E. of Tippah Creek, in Marshall county.

629[2]. West of Tippah Creek the country improves, being less broken, the Pine disappearing, the growth of the Post Oak and

Black Jack becoming better, and more mingled with Hickory, Spanish ("*Red*") and other oaks; while the loam stratum becomes thicker, and the soil in consequence less sandy.

South-west Marshall I have not personally visited, but its features are said to resemble altogether those of adjoining portions of Lafayette, and the country bordering on the M. C. R. R., viz: undulating oak uplands, whose soil-loam is somewhat paler in color than that of the N. Marshall "table-lands", a little lighter on the whole, and the stratum of less thickness; and interspersed at times with lighter ridges, where the soil is sandy and the timber correspondingly poorer.

630. In Lafayette county, a line drawn from the N. E. corner (the mouth of Pouskous Creek) to the head of Yellow Leaf, down that creek to its mouth, and thence nearly due S., will leave S. and E. of it the main body of the "Pine Hill" lands (¶607²), of the county.

N. and W. of it, but little Pine is to be found, the face of the country being either broken ridge lands with a very sandy soil, bearing an inferior growth, chiefly of Post Oak and Black Jack, commonly accompanied by the Scarlet ("*Spanish*") and more or less, by the Spanish ("*Red*") Oaks; or broad ridges less high and abrupt, forming uplands more or less undulating, composed of Orange Sand covered by a stratum 2 to 4 feet in thickness, of yellow loam. The Spanish ("*Red*"), Red ("*Black*", *in part*) and Post Oak, and Hickory, form the prominent growth of these lands; but according to their position in the scale of transition into the sandy ridge lands (¶606; 607²), more or less Black Jack and Scarlet ("*Spanish*") Oak is added to the above, and the shapes of the trees vary as before described. In some points (as on Clear Creek) the better class of lands, also, bear the Black Jack, of the same type as on the Marshall Table-lands, but this is rather the exception.

On the fine cotton uplands lying between the creeks forming the immediate confluents of the Tallahatchie, in N. W. Lafayette, the Spanish ("*Red*") and Red ("*Black*") Oak, together with occasional sturdy Post Oaks, are finely developed and together with the Hickory, characterize the best lands on Woodson's Ridge, the College Hill Ridge, &c., which are little inferior to the Table-lands of Marshall; and to which, although I have not as yet been able to analyze them, I have no doubt the same remarks will apply, in general, which have been made in reference to the former region (¶616, ff.). It is to be observed, however, that the stratum underlying the loam generally, is not loose sand, but reddish hardpan.

In this northern and north-eastern portion of the county, large bodies of fine uplands exist; they are always more or less interspersed, however, with higher and more sandy ridges, and even level tracts which the lank growth and whitish bark of the oaks, no less than experience, show to be of inferior fertility.

The dividing ridge between the Yockeney and Tallahatchie, on which Oxford stands, varies greatly in its character from place to place, viz: from that of Woodson's Ridge to that of the poorest Black Jack ridges. The bodies of good land are, therefore, small, and extend chiefly along the branch bottoms; and such is more especially the case on its southern slope, towards the Yockeney-Patafa River. Here as elsewhere, in general, the loam stratum increases in thickness and quality as we advance westward.

631. The uplands bordering upon the Yockeney-Patafa, in S. Lafayette, are generally very much broken, and although the lower hillside growth is often indicative of a good soil, the sandy summits of the narrow ridges offer little inducement for cultivation. It is chiefly the branch bottoms (which are generally narrow), the slopes, and bottom of the river itself (which is, however, subject to overflow) that are cultivated.

The same, precisely, may be said of the country on the waters of the Otuckalofa, and on the northern confluents of the Loosha Scoona, in Calhoun county, as well as of adjoining portions of N. E. Yallabusha; only that in general, the Short-leaf Pine is mingled here with the ridge Oaks. The bottom lands of these creeks are very fine, and heavily timbered, with trees denoting rather a heavy, though a fertile soil. The slope of the hills towards the bottom of Scoona is gentle, and forms a tract of rather heavy upland soil, timbered with Spanish ("*Red*") Post, and Red ("*Black*") Oak, and Hickory. The bottom lands of the Scoona, which are extensive (the bottom being 1½ to 2½ miles wide), and whose growth leaves no doubt of their being very fertile, have hardly been fairly tested as yet, on account of their being subject to overflow; and as the soil is, at the same time, somewhat heavy, it cannot be tilled early enough in spring, unless first reclaimed.

632. Of Yallabusha county, claimed by its inhabitants as being, in an agricultural point of view, the best of the upland counties of the State, I know from personal observation only the central portion, adjacent to the M. C. R. R.; which, however, is said to represent pretty fairly also the western portion. N. of Coffeeville it is a gently undulating region, with a yellow loam soil, oak growth, etc., much resembling the fertile oak uplands of N. Lafayette, and generally possessing a reddish hardpan subsoil, which not being very pervious, a good deal of injury is done to the lands by washing.

Here, also, a great deal of good would be done by deeper tillage, not only as a preventive of washing and injury by drouth, but also because of the evident identity of the whole loam stratum, with that forming the soil itself (¶616, ff.). Between Coffeeville and the Yallabusha River, also, there is generally a fine farming country, interspersed here and there, however, with Black Jack and Post Oak ridges of less fertility, and sometimes even with short Pine ridges (¶607[2]); the yellow loam soil is the same as above, save in that the stratum is generally thicker, and liable to washing.

The fine level farming region around Grenada, which extends on both sides along the Yallabusha and Beadupanbogue, is a second bottom or hommock, several miles in width, now almost entirely under cultivation, but originally timbered, with Post, Willow, Water, Chestnut White, and White Oaks, and Hickory; the soil being a light, yellowish gray loam, several feet in depth, easily tilled, and of great fertility. This level hommock land, which slopes off gradually into the bottoms proper, is bordered, and occasionally interspersed with, poor, sandy, low ridges bearing an inferior growth of Black Jack, Post, and Spanish ("*Red*") Oaks.

633. Pine ridges are, however, within sight of Grenada, a few miles to the eastward, and are said to extend into the fork of the Yallabusha and Loosha Scoona. The high ridge lands dividing Beadupanbogue from Big Sandy Creek, and further S. W., the waters of Hayes' Creek and other confluents of the Big Black, from those of the Yallabusha, are timbered with Short-leaf Pine, Black Jack, Post, Spanish ("*Red*") and some Scarlet ("*Spanish*") Oaks.

Up to the head of the Beadupanbogue the ridges are steep and narrow, their soil is very sandy and of little fertility, and often of a deep orange tint; beyond, as we approach Middletown, the ridges become lower and broader, the soil improves and the loam stratum becomes thicker, but is of a remarkably pale yellow tint; while the Scarlet ("*Spanish*") Oak is uncommonly abundant. Notwithstanding the considerable admixture of Short-leaf Pine among the Oaks, this soil "wears" very well even on the ridges, producing 900 to 1000 lbs. of seed cotton for 10 to 12 years. Near Middleton, and beyond, between Middleton and Shongalo, the pine is scarce or altogether wanting, the Oak growth Spanish ("*Red*") Post, Scarlet ("*Spanish*") the *true* Red, and an occasional Black Oak and Hickory, improve its character, and the soil increases in depth, as we advance southward; only occasionally there is a higher, sandy ridge, on which the Black Jack and Post Oak exclusively prevail.

Near Shongalo (¶183, ff.), we have gently rolling yellow loam uplands, well timbered with the growth above given, and sloping down rather gradually into the hommock of the Big Black River. of whose soils I shall speak later (¶660, ff.).

634. I have not personally examined the more westerly portions of Carroll county, but I am informed that their general features resemble very much those observed along the line of the R. R. until we approach within a few miles of the Mississippi Bluff; the surface being considerably broken.

The higher dividing ridges are of inferior fertility, while the lower are thickly covered with productive yellow loam, which seems not only to increase in thickness, but also in the amount of lime it contains, as we advance westward. It appears that the Big Black River in Carroll and Holmes is generally bordered on the W. within a few miles, by a gently rolling tract of yellow loam oak uplands (as those in which Emory and Richland are situated); beyond which, the country is more broken and in consequence, less convenient for cultivation, though not, in itself, less fertile. The Richland region in S. E. Holmes, on the Big Black side of the dividing ridge, is separated from the hommock lands of the latter stream, by a strip of hilly country, on which Pines are occasionally seen; north of Goodman Station, the Pine uplands remain constantly within sight of the R. R. nearly up to the Carroll line. Near Richland, the country is gently undulating, the yellow loam stratum 15 to 20 feet thick without much change from top to bottom; the timber large Post, Spanish ("*Red*") and Scarlet ("*Spanish*") Oaks, accompanied very generally by large Black Jacks, of the same type as that of the Madison loam lands. From the aspect of the loam stratum, and the indications of vegetation in all its different points, there appears to be very little difference between its upper and lower layers, provided the latter have been exposed to the atmosphere, and somewhat mixed with vegetable matter. In all respects, this soil resembles very much that of the Marshall county table-lands—it is at all events little inferior to them in thriftiness and durability (¶616, ff.). Fresh lands produce nearly a bale of cotton (1200 lbs. of seed cotton) per acre, and after 9 or 10 years incessant cultivation, will still yield about 750 lbs. of seed-cotton, with the usual shallow tillage.

The loam contains very little coarse sand, but enough of fine, to render it very mellow and easily tilled; hence subsoiling will be comparatively easy, and doubtless very effectual in renovating the soil, which is in many places becoming very much worn. The clay marls of Madison (¶281, ff.), could be used abundantly on this soil, without much danger of impairing its good physical qualities.

The same soil precisely prevails in N. E. Yazoo generally, save that the face of the country is rather more undulating than near Richland, and on the higher ridges, where the loam has had a chance to wash away, the stratum of course is thinner. Still further southward, especially along the Big Black River, the influence of the calcareous silt of the Bluff formation on the soil and vegetation, becomes apparent.

635. Such, according to L. Harper's account, is more especially the case on the W. slope of the dividing ridge between Big Black and Yazoo waters, which

lower down takes the name of Walnut Hills—a region of which, thus far, I have no personal knowledge. It seems that all along the Mississippi Bluff, from Horn Lake to Vicksburg, for a few miles inland at least, the calcareous silt of the Bluff formation (¶327, ff.), is occasionally seen, either in patches or forming ridges, and that the loam stratum overlying the same (unlike that forming the surface in the Southern River Counties, which see ¶681), is strongly impregnated with lime, so as even to contain white calcareous concretions. It bears, in consequence, a very vigorous growth of lime-loving trees, such as the "Poplar", Linn or Basswood, Sweet Gum, large Sassafras, (several feet in diameter) White Oak, and Post Oak. The growth indicates a soil of great fertility, but the country is so much broken—washed into high steep ridges and deep ravines, as to be inconvenient for the cultivation of ordinary field crops. Like the Cane Hills of the Southern River Counties, it could probably best be made available for the culture of the grape, and of fruit trees.

636. We now return to the Big Black River, and more especially, to the neighborhood of Shongalo. Besides the pale yellow loam which forms the usual soil of this region, we find in spots a more clayey soil of a deep orange-red—the same, obviously, as that of the clays accompanying the Shongalo greensand, in the R. R. cuts at and below Vaiden, and at Kirkwood's Ferry (¶183, ff.).

The portion of N. Attala seen on the Shongalo and Kosciusko road, up to Poukta Creek, is very hilly and broken, the soil thin and sandy, the timber chiefly Shortleaf Pine, Post and Spanish ("*Red*") Oak, with occasionally some Hickory. The bottoms, however, as well as the lower hillsides where the greensand strata come to the surface (¶276), possess a rich growth and light, productive soil.

There can be no doubt that with the aid of the greensand manure, so generally accessible in this region, many of the poor hills on the Zilfa, Sugar Creek, and upper Poukta, may be rendered very profitably productive; and the same probably is true of N. E. Attala, which I have not visited.

637. The uplands bordering on the Poukta, and no doubt some of those on the other creeks mentioned, are of a very different character. The soil is shallow and scarcely differs from the subsoil, which is a deep orange-red, stiff clay containing some sharp sand, and occasionally, vestiges of greensand grains; being evidently derived from the similar clays of the Tertiary strata seen at Vaiden and Kirkwood's Ferry.

The surface of the country where this soil prevails, is moderately hilly, and timbered with White, Black, Post and Spanish ("*Red*") Oak, and Short-leaf Pine. Cotton, Oats, and also Corn, are said to succeed well on this soil, which "wears well", but is somewhat difficult of tillage; there is perhaps no other cause than its heaviness for the want of success in raising on it wheat and (sweet) potatoes.

The fertility of the soil of these "Red Hills", which is found to within a mile of Kosciusko, is owing mainly, no doubt, to the greensand grains of the original material; and nothing could be better suited to its improvement, both as to heaviness and absolute fertility, than the sandy greensand manure found in that region. We find here, on the creeks, bluffs of the clay material mixed with greensand (¶183), but doubtless the sandy stratum is to be found higher up on the hillsides. It appears that the manuring qualities of the deposits of the creeks, which are rich in greensand, have already become known, by experience, to the inhabitants of this region; of their value, which depends on the greensand grains contained in them, it will be easy to judge by the eye. The soil of the "Red Hills" is generally very poor in vegetable matter, which ought to be supplied to it in any convenient shape, and would, no doubt, greatly increase the "safety" and productiveness of the soil.

I have been informed that similar heavy, red soils occur in the adjoining portions of Holmes, and even in the N. edge of Madison, I have seen patches of soil resembling it—regarding which, of course, the same would probably hold true, as in regard to those of Attala. Whether or not the red soil occurs in E. Attala, which is said to resemble, in general, the N. W. portion, just described, I am not informed.

638. The ridge on which Kosciusko is situated, is sandy, and timbered with Post Oak, Black Jack, Spanish ("*Red*") Oak, some (*true*) Red Oak, and Short-leaf Pine, the soil being rather inferior. Such, with the exception of the bottoms and hommocks, is the character of the soil of S. Attala and the N. E. corner of Leake, (the only portion of that county which I have visited); the surface being rather hilly and broken, and settled chiefly along the streams.

The slope from the hills W. of the Yockanookana towards the bottom of the latter is very gradual, and is well settled; its growth being the same oaks occurring further inland, but of a better character, and with more Hickory and less Pine; the soil, however, is very variable. On the upper portions of the slope, the subsoil is a pale yellow loam. Lower down, in what might be considered the hommock or second bottom of the river, the soil (and subsoil which is of the same aspect) is a gray, ashy silt with ferruginous dots, resembling not a little the light soil of the Chickasaw Flatwoods (¶572; 575, ff.), yet it produces well and is not liable to cause failure of the crops in extreme seasons; it is timbered with Beech, Hickory, White, Black, Scarlet ("*Spanish*") and Spanish ("*Red*") Oak, Elm, and *Bottom Pine*. The soil of the bottom proper is somewhat similar (¶662).

639. In N. Madison, on the heads of Siniash Creek, there is a tract of fine, gently undulating yellow loam uplands, where no Pine is seen; the latter tree re-appears, however, as we approach the Big Black towards Goodman, on the higher ridges, where the loam is thin, or almost wanting; while the general surface of the country, although hilly, is not too much so for cultivation, and possesses a fair soil. Southward, however, towards Canton, the ridges become lower and the country gradually assumes the face of the region S. of Canton, which will be described in another place (¶624, ff.).

640. We now turn back northward to the Loosha Scoona River, in Calhoun county, the hilly pine lands N. of which have been above described (¶631, ff.).

I have not visited the portion of Calhoun county lying S. of the same, which, while in general resembling the N. portion, has been described to me as being more fertile on the whole, than the latter. Its upland soils seem to resemble, in many localities, more those of the Hills of the Flatwoods Region (¶587, ff.), than those of the yellow loam. Such is the case in the S. E. corner, where alone I have myself examined them (¶589). The ridge soils retain their clayey character, and their timber of White Oak, Spanish ("*Red*") Oak, Hickory, and scattered Pine, alternating with Black Jack and Post Oak ridges, up to Tapashaw Creek, on the Houston and Bellefontaine road. The bottom lands of the Tapashaw are much praised, the timber and soil resembling that of the Potlockney (¶539), as is the case with the creeks of this region generally.

641. Beyond (S. of) the Tapashaw, the ridge lands are more sandy, and on the

dividing ridge, (between Big Black and Yallabusha waters) resemble closely that of the Pine Hills of Lafayette even as to the rocky knolls occasionally perched on top (¶11). Approaching Bellefontaine, however, the country becomes less broken and the soil improves—generally in proportion as the gray clays of the Lignitic formation approach the surface—as the yellow loam stratum becomes thicker.

S. of Bellefontaine, the pine disappears, until within a few miles from Greensboro'. The lands are rather broken, the higher ridges bear the Black Jack and Post Oak, and show bald spots of whitish clay—the soil being, of course, rather heavy in consequence. Generally, however, on the lower ridge lands, the Spanish ("*Red*") Oak prevails most frequently, mixed with some Hickory and Post Oak—the subsoil being a moderately heavy, yellow loam. This soil represents fairly the better class of soils of E. Choctaw, there being considerable uniformity, except where sand ridges intervene.

Thus Greensboro', like so many other county seats of Mississippi, is situated on a very sandy ridge, where Pine, Post Oak and Black Jack predominate over the Spanish ("*Red*") Oak. Between Greensboro' and Big Black, the Spanish ("*Red*") Oak again predominates; S. of Big Black, on the Bankston road, we first meet with sandy pine hills, then, near Bankston, a gently undulating region, with yellow loam soil, and timbered mainly with Spanish ("*Red*") Oak, with some Hickory, (*true*) Red, and an occasional Black Oak.

642. A similar alternation of soils characterizes the whole of Choctaw county, all of which is moderately hilly, without very high ridges, and without possessing (except along the streams) large continuous tracts of very fertile soil; the average production of the better class of upland soils, being from 800 to 1,000 lbs. of seed-cotton. The western portion (which I have not visited) resembles the adjoining parts of Carroll, above described (¶633, ff.).

The S. E. corner of Choctaw, while there are no high ridges, is broken up into a continual succession of small rounded ones; whose soil does not, in general, differ essentially from those of N. E. Choctaw.

643. The upland soils of Winston county, as far as I know them, are essentially of two different characters. The southern and western portion of the county possesses a shallow, pale soil, and a pale yellow, rather sandy, loam subsoil; the former often, the latter always containing more or less concretions of bog ore ("black pebble"). This soil is timbered with Short-leaf Pine, Post, Spanish ("*Red*"), and Scarlet ("*Spanish*") Oak, generally accompanied by some Hickory, Black Gum, and Maple—the whole growth disposed to be somewhat scrubby, and the soil of inferior fertility.

644. In the northern, and north-eastern portion of the county, there prevails a soil resembling in many respects that of the "Red Hills" of Attala (¶637), and probably formed originally of the same materials. It is not, on the whole, quite so heavy or dark colored—not, at least, on the surface; the deeper we go, however, the heavier and darker colored it becomes. This soil is characterized by a growth of White, Black and (*true*) Red ("*Black*") Oak, stout Post Oak, a good deal of Hickory, and sometimes, Short-leaf Pine; all these trees being stout and well proportioned. The average production of this soil is from 800 to 1000 lbs. of seed-cotton per acre, sometimes even more.

It is important to observe, that the red clay sometimes forms the subsoil, where the pale yellow loam (see above, ¶643), only appears on the surface. In this case, there is a corresponding improvement in the timber of the yellow loam, which is less disposed to be scrubby, and to which according to circumstances, the Hickory, Black and White Oak are added. Of course, deep plowing in such soils is to be highly recommended. Moreover, the red soil itself occupies the surface in patches and belts in N. W. Winston—as for instance, near New Prospect, on Mr. Coleman's land, S. of the Yockanookana, where a strip about 5 miles long by 1 wide, extends along the edge of the bottom. The main body of these red lands, however, is in the "Noxubee Hills", in N. E. Winston and S. W. Ocktibbeha.

The country it occupies is considerably broken, and the hillsides are steep: on them, as well as in the gullies, the "Poplar" and Ash occur. Occasionally, on higher ridges, we find sandy soils, ferruginous sandstone, etc., with scrubby Black Jack and Post Oak; but mainly, the red soil prevails, and whenever a space is afforded, settlements and plantations show the good estimation in which the land is held.—This soil appears about 3 miles E. of Louisville, and extends S. as far as the Winstonville neighborhood, on Allison's Ridge.

645. I have not myself examined the S. W. portion of Winston, but it is said to resemble the southeastern, which I have traversed on the Louisville and Summerville road. The neighborhood of Louisville is but slightly undulating, and the same features, with the pale yellow subsoil containing "black pebbles", and a somewhat scrubby growth as before described (¶643), continue for several miles on the Summerville road. Gradually, however, the soil deteriorates as we advance, and about 5 miles from the town, we see regular "Pine Hills" resembling those of Simpson and S. Smith, in all but the species of the Pine, which is the Short-leaf. To the depth of 8 to 10 inches it is of a very pale yellowish buff tint, and almost ashy—lower down, it gradually changes into the pale yellow loam with bog-ore pebbles (¶387). Probably the soil of the lower ridges is better than this of the main dividing ridge, which continues with little change to within a few miles of the crossing of the Nanna Wauya, where we find several narrow branch bottoms timbered with White Oak and Sweet Gum: the uplands between these are of a yellow loam rather more sandy than that of the Louisville neighborhood. The Bottom soil of the Nanna Wauya, also, like that of most of the tributaries of Pearl River, has quite a light, sandy soil; of a dark chocolate tint for 12 inches, then paler and still more sandy. This soil produces finely and is timbered with White and Chestnut White Oak, Sweet and Black Gum, Hickory and some little Wild Plum.

646. The lands E. of the Nanna Wauya though in general resembling the pale yellow loam lands of Winston, are better and keep improving as we advance towards Summerville, as is shown by the improvement of the timber; they become more and more sandy, and the "black pebbles" less frequent, until, near Summerville, the soil has totally changed its character.

The country is undulating, but with long slopes, well settled and fertile, notwithstanding that its soil is extremely sandy; of a brownish gray tint for about 8 inches, then deep orange-red, indurate, coarse sand down to 24 inches, and more. Still lower down, we find loose white and yellow sands. The timber consists of sturdy Post Oak, (sometimes with "runners") large high-trunked Black Jack, large upland Hickories; occasionally, some Black Oak, and on the sandiest points of the ridges, the Upland Willow Oak, (*Q. cinerea*). This soil is quite productive, "wears well", and does not suffer from drouth as severely as might be supposed, in consequence, no doubt, of its deep indurate subsoil, whose ferrugino-aluminous cement, between the coarse sand grains, is quite retentive of moisture and manures.

647. The sandy soil of the Gholson or Summerville Ridge (which skirts the

Flatwoods of Noxubee and part of Kemper, (¶563), is the type of a class of sandy, but productive ridge soils, which prevail to a considerable extent, and acquire considerable importance, in S. E. Mississippi. I shall mention them here, as far as I know them to exist, in connection with the yellow loam, whose place they evidently occupy; although they extend considerably beyond the limits of what I have placed under the head of the Yellow Loam Region.

The ridge soils of Kemper, W. of the Flatwoods, are generally very sandy. Those of the main dividing ridges especially in the northern portion, generally resemble that of the Summerville Ridge: but the lower ridges often greatly resemble those of S. Winston, and are of inferior fertility.

Such is the case, for instance, in the uplands between DeKalb and Scooba, timbered with a middle-sized growth of Hickory, Short-leaf Pine, Spanish ("*Red*") Oak, and scattered Red ("*Black*") Oak and Sassafras. The soil is yellowish, very sandy, and increasing in sandiness downwards, without the intervention (as on the Summerville ridge) of any retentive hardpan stratum; until, at the depth of 2 to 2½ feet, it is almost pure sand. Of course, deep culture would not only be useless, but positively injurious in such a soil, which would in any case wear out very soon; it is, however, but very little cultivated, the settlements being mostly confined to the creek bottoms, which have rather a heavy, "flatwoody" soil.

On the main ridge, we generally find at a certain depth, an indurate subsoil crust, which renders the soil capable of profitable cultivation, and improvement. This crust, the depth of which varies greatly in different localities (from 8 inches to 2 feet) ought not to be broken through on any account, since after that, the land must become absolutely useless (¶510, ff.). Local examination alone can determine, in each particular case, what is the depth to which the plow can safely go.

648. The bottom soils of the Yazoo, Patickfaw, etc., are exceeding sandy, although on the ridge dividing them, we see a good loam soil; as also on some of those south of Patickfaw, in whose bottom we find, on this route, the first Long-leaf Pine, which thereafter, onward to Daleville, alternates, in strips of poor sandy ridge land, with lands bearing the short-leaf Pine, in company with large Spanish ("*Red*") and Post Oaks, whose soil is a yellow, somewhat sandy loam, producing from five to 800 pounds of seed cotton per acre.

Near Daleville (¶178), we find on the uplands a stiff, red, clay soil, resembling in aspect that of the Noxubee Hills (¶644), but not equal in productiveness; it evidently requires deep tillage to make the crops safe. The same soil is seen southward of Daleville, where it resembles still more strikingly, even in its growth, the soil of the Noxubee hills, and also approaches it in productiveness; it is obviously derived chiefly from the white or gray clay which underlies, and sometimes even comes to the surface in what are, very improperly termed "prairie spots" (¶370, ff.).

649. Beyond Sowashee Creek, we again strike sandy land resembling that of the Summerville Ridge; then, high ridges with ferruginous sand-rock, timbered with Pine, Post Oak and Black Jack. At the town of Marion, we have a yellow, sandy, loam subsoil, several feet in thicknees, timbered with Post Oak and Short-leaf Pine, both short and sturdy, stout, good sized Hickory, some Spanish ("*Red*") and Black Oak; also Black Gum. This soil, which produces well, is of particular interest as having proved itself well adapted to the culture of the Catawba grape—a crop which is likely to become, in time, of the highest importance to the State (¶706, ff.).

In 1859, at the time of my visit, about 5 acres of vineyard had been planted near Marion. I was informed that in 1858, a tract of vineyard belonging to Judge J. B. Hancock (who was the first to introduce the culture) yielded 500 gallons of juice at the rate of 700 gallons per acre; and smaller quantities, at the same rate of production or nearly so, have been made by others. Estimating the product at only $1 50 per gallon (the minimum), it would seem that few other crops would be likely to yield equal profits on this soil. I have been unable to obtain information concerning the crop of 1859, but a large yield was anticipated. Drs. H. R. Wilson and D. U. Ford, of Marion have also entered with zest upon the culture of the grape; and it is to be hoped that the results of these interesting experiments will, at an early day, be communicated to the public.

650. About half a mile west of Marion, we find a strip, not more than half a mile in width, of sandy land of the character of the Summerville Ridges; the same is also met with about three miles south of Marion, and is there about three miles wide; it bears quite an assortment of oaks, to-wit: Post Oak with "runners", Black Jack, Upland Willow, and Barrens Scrub Oak (*Q. ferruginea, cinerea, Catesbaei*), all of which are here properly comprehended under the designation of Black Jacks; Spanish ("*Red*") and true Red ("*Black*") Oak, with some Hickory.

Southward of this belt of sandy land, we again see a tract resembling that at Marion; but further south, as well as west of the sandy belt near Marion, we soon enter the regular Long-leaf Pine Hills, which will be noticed elsewhere (see "Long-leaf Pine Region").

651. The sandy soils but just described coincide in every particular with those forming the ridges on the upper Tallahoma, and the north portion at least of the Paulding ridge, North Jasper (¶746). The same kind of soil appears, no doubt, on some of the ridges of Newton, and through that county, probably, is connected with the ridges of DeKalb and Summerville.

The peculiarities of this soil can nowhere, perhaps, be studied to greater advantage, than on the ridges of the Tallahoma, west of Garlandville.

The main body of the ridge consists of loose, sterile sands, while the summit is formed by a stratum six to eight feet in thickness, of a semi-indurate material consisting of coarse sand, loosely cemented by reddish- or grayish-yellow, clayey matter, so as to form a coarse sandy hardpan, which, when crushed, is readily separated into its sandy and its clayey ingredients, by mere dusting, as when we separate wheat from the chaff. Hence it is observed, that great injury is done to this soil when exposed in prominent points, to high winds *shortly after tillage in dry weather;* the fertile portion of the soil being thus litterally blown away and leaving the arid sand behind.

It has been stated that this stratum of soil or hardpan lies on the hill-*tops;* the hillside soil is a mixture of the washings of this summit stratum with the red and white sand underlying it, and cropping out on the slope. The sandy hardpan when once broken up, parts with its fertilizing ingredients as readily by the action of water, as by that of wind; hence, that portion of it which is washed down the hillsides, is of greatly inferior fertility, and inhabited chiefly by scrubby Post Oak with runners, and Upland Willow Oak; and the same character is assumed by the soil of the summit of the ridge, whenever the stratum of fertile hardpan, being thin, has been broken up, as is the case, to a considerable extent, in the tract of sandy soil south of Marion (see above).

652. The soil of the Tallahoma ridges in North-west Jasper (where the hardpan stratum is of sufficient thickness to allow of deep culture), has yielded fine crops of cotton and corn for fifteen to twenty years, before it was considered as "worn out"; to sweet potatoes, it is found to be peculiarly suited. Yet even

now, after the soil of the "turned out" old fields, of which there are many on the brows of these hills, has been much damaged by winds and washing, the judicious use of the subsoil plow would readily renovate it; and by careful prevention of washing, with attention to tilling only while the soil is somewhat moist, they might produce for many years to come, and would undoubtedly be susceptible of improvement by manure also, *so long as the hardpan stratum is not broken through*—which, in using deep culture, must be carefully guarded against (¶510, ff.); recollecting that what can be done with impunity and advantage on the *summits* of the ridges, may ruin the hillside lands. The use of the *marls* occurring at the foot of the Tallahoma and Paulding ridges, *conjointly with vegetable matter*, would be eminently useful on these soils, and might even reclaim the land where the subsoil crust is very thin or wanting. The white "shell prairie" marls (¶208; 288), *by themselves*, however, should be used with great caution—in quantities not exceeding one hundred to one hundred and fifty bushels per acre, for a trial; but since pine straw (¶790, ff.), is very available in these regions, for use in composting, it would seem advisable always to employ *it* at least, conjointly with the marl.

653. Rising, as these ridges do, rather suddenly, from the level regions of the "hogbed prairie" and shell prairie (¶746); affording, from their summits, extensive views over the wooded plains, they offer many tempting sites for residences. The great depth required for wells (80 to 100 feet), in the absence of springs, is somewhat of a drawback, but not greater, to say the least, than in many of the best settled regions of the State, where cisterns are used altogether. Moreover, it is very likely, from the considerable elevation of the country in Newton county, as shown by the railroad levelings, that in bored wells, tubed as far as the sand reaches, water could be procured to rise to within convenient distances of the surface (¶325). The improvement of these ridges, therefore, highly desirable as it is, is by no means as difficult as might seem at first sight. By the aid of the Rotten Limestone, or rather, perhaps, the lime made of it (¶147, ff.), similar improvements will be practicable with the similar lands of Noxubee, Kemper and Lauderdale.

Of the lands of Neshoba and Newton, I have but little personal knowledge. A large portion of East Neshoba greatly resembles that of Winston covered by the pale yellow, black-pebble loam (¶543), save in that the scrubby Black Jack is, perhaps, rather prevalent over the Post Oak. In West Neshoba there are said to exist some of the highest ridges in the State.

654. Bottom Soils of the Yellow Loam Region.—The Bottom soils of the smaller streams necessarily vary so much in conformity with the soils of the surrounding uplands, that it would be impossible to consider them specially under a distinct head, without continual repetition. They bear, as it were, the average character of the soils of the hills from which they receive their washings (usually with the addition of vegetable matter); hence that of the bottom soil of one stream will be changed to a certain extent, so soon as other streams, whose uplands are of a different kind, unite with the first, carrying with them, of course, their peculiar deposits, to mingle with those of the others, and to modify their character accordingly.

I intend, therefore, to give, under this head, merely general remarks on the character of the bottom soils of the principal streams and their tributaries. No analyses having as yet been made of any of these soils, all I can say regarding them refers to their extent of occurrence, their growth, physical properties, etc., as observed in the field. They are usually so fertile, that few of them have as yet begun to be worn out; and as there has been less demand for knowledge in regard to them, I have thus far directed my attention more especially to the uplands. Such bottom soils, in fact, as are annually overflowed, and are, therefore, always receiving a fresh supply of fertilizing ingredients from the uplands, will of themselves last longer than the latter, even though their native fertility may not be much greater.

655. It may be supposed that in a region whose surface is generally occupied by light loams underlaid by purely sandy strata, the bottom soils are also in general light and even disposed to be sandy. This is so far true, that the streams running through regions *exclusively* occupied by the Orange Sand, generally possess rather indifferent bottom soils; to which may be added that in such cases, the bottoms are usually very narrow, and often possess rather a hommock or second bottom character. Many of the smaller streams of S. Winston, W. and S. Kemper, and N. Lauderdale, and very frequently those of the Pine hills of North Mississippi, give evidence of this fact; and as the uplands are cleared, the sands washed down from them upon the surface of the bottoms render the matter still worse.

656. Most of the streams of the Yellow Loam Region, however, cut more or less into the clayey strata of the Lignitic formation (¶164, ff.), in different portions of their course. Whenever such is actually the case, the increased heaviness of the bottom soil usually evidences the fact clearly, a short distance below; and, since clay will remain suspended in water much longer than sand, the proper amount of clayey matter is thus very generally distributed throughout the bottom soils—much more so than, where bottom soils are prevalently clayey, the sand taken up at some few points will be distributed through them. Hence even in regions where the upland soils and the body of the hills are prevalently sandy, the bottom soils will often exhibit a much less extreme condition in this respect; their clayey portion being derived, perhaps, from a considerably distant point.

Thus, the influence of the heavy clay brought into the Tallahatchie by its tributaries heading in the Flatwoods, is perceptible for a long distance below; it remains perceptible longest, of course, near the main channels, the more sandy alluvium derived from the hills of N. W. Lafayette and S. W. Marshall (¶629[2]), gradually closing in upon it until, in the lower part of its course through the hills, its bottom soils are quite light and sandy, though always very fertile.

The Tallahatchie bottom is from a mile to a mile and a half wide between Marshall and Lafayette, considerably cut up with sloughs, and of course, subject to overflow; though, on account of the comparative lightness of the soil, the crops of the Tallahatchie bottom are less frequently injured by high water than is the case in the bottoms of the neighboring streams. It possesses a tall and vigorous growth of the usual bottom timber of N. Mississippi, when the soil is not very heavy. Cypress in the sloughs, on the higher ground, Water, Willow and White Oak, (the Chesnut White Oak is less common), both kinds of Shellbark Hickory, Ash, Box Elder, "Poplar", Sweet Gum, Black Gum, Elm, a good deal of Holly, Maple and Hornbeam, and on the sandier soils, the Beech. There is usually no hommock or second bottom of any extent; the loam hills generally come down in short slopes into the bottom proper, though in Marshall county, there is in some points a more gradual "hommock" slope.

657. The Yockeney-Patafa, so far as I know it (in Lafayette county, (¶631), bears throughout the character of a Flatwoods stream (¶592); its bottom being usually wide (one and a half to two miles), for a stream of its size, and its soils generally heavy and disposed to be "cold", and late in spring, in consequence of the slowness with which the water recedes after an overflow, and the great retentiveness of the soil.

In consequence of these inconveniences, the Yockeney, notwithstanding its fertility as demonstrated by its vigorous growth of timber (among which the Chesnut White Oak is prominent, while the Holly and Beech are not common), has not been cultivated very extensively in the upper portion of its course. Lower down in S. W. Lafayette, where the soil is lighter, it is better settled. The sluggishness of the current explains the fact that the bottom is but little cut up with sloughs. The Yockeney, also, has little or no hommock.—The soils in the bottoms of some of its tributaries (*e. g.*, the Potlockney), are rather sandy than otherwise, and very heavily timbered, so much so as to make the labor of clearing a serious drawback.

658. The Loosha Scoona River (¶631), is even more than the Yockeney, a genuine Flatwoods stream. It has little or no second bottom, for although the slope of the hills in N. W. Calhoun is rather gradual, and is occupied by settlements, this slope has essentially the upland growth, to the edge of the bottom proper.

The latter is of extraordinary width—two to three miles in Calhoun county—and its soil is gray and heavy like that of the streams in the Flatwoods proper (¶592), like which it forms, during the rainy season, a mire which for toughness and depth, has a well-merited reputation among those who have attempted to cross the bottom at such times. The sloughs, though so shallow that one might overlook them, require solid bridges more than many of five times their apparent width and depth, in other bottoms; for the quagmire is as deep in them, as the water is in the others. The sluggishness of the stream, and the tenacity of the soil may be judged of by the fact that after several weeks submergence, wagon-tracks previously made on the general level will still appear with sharp angles. The bottom is, however, finely timbered (the Chestnut White Oak being prominent among the trees), and the soil is undoubtedly very fertile; but the late spring overflows, together with the heaviness of the soil, renders crops somewhat precarious thus far, and in consequence, it is very difficult to obtain a stand. The first step in the reclamation of the Scoona bottom lands, therefore, must be to exclude the late overflows.

659. I am not acquainted with the features of the Yallabusha River, as exhibited in S. Calhoun; it appears however, from the sand-drifts which its banks exhibit in Yallabusha county, that its bottom soils must differ sensibly from those of the Scoona.

Its extensive, fertile hommock or second bottom, which gradually slopes down into the first, has already been mentioned (¶632). The Yallabusha is a rapid stream near Grenada, and like the Tallahatchie, has cut deep and extensive sloughs in its bottom, which is subject to frequent overflows; but from the comparative lightness of its soil (slightly heavier than that of the hommock) crops are not so frequently injured as on the Scoona.

660. On the Big Black, above the Cane Hill Region (¶674), we generally find a second bottom on one side at least, from which there is a descent of 3 to 4 feet to the first. The soils of both are

in general light and easily tilled; that of the first is usually the heavier of the two, and remarkable in the greater portion of the river's course, for its tall and vigorous timber. Notwithstanding the frequent overflows, the bottom soils of the Big Black are being appreciated, and as might be expected, are very fertile.

The hommock soils of the Big Black are as variable in their quality as in their extent of occurrence in different localities.—At the crossing of the Greensboro' and Bankston road, in Choctaw county, the hommock is about a mile in width, elevated, as usual, 3 to 4 feet above the first bottom; has a chocolate-colored, light, and very fertile soil, in which there is no perceptible change for 15 inches. The timber is large, consisting of Beech, Hickory, Ash, Elm, Hornbeam, Red-bud, etc.

On Dr. Vaiden's land near Shongalo (¶633), there is a tract of hommock land skirting the Big Black Bottom, quite level, and nearly destitute of timber; some large Post Oaks, occur in groups, and in low places, small Sweet Gum. The soil is light, but destitute of coarse sand, of a dark tint for 10 to 12 inches; and beneath, a subsoil of very fine, pale yellow sand evidently very unretentive in consequence of which, the land is liable to injury by drouth; produces good wheat, oats, rye and Irish potatoes, but very poor cotton or corn.—There must be some *chemical* defect in this soil, beyond that of an inferior subsoil, which analysis will probably detect. This land does not occur in a regular belt but rather in patches, on the edge of the Big Black bottom, into which, at other points, the hills come down with a decided slope. Spots of soil similarly timbered, and producing abundant crops of grass, but little else, occur in S. Yallabusha—*e. g.*, at Mr. Kirkman's on the waters of Okachicama Creek.

661. A soil somewhat similar in aspect to that at Vaiden's, but evidently more fertile, forms the second bottom (which is about ¾ of a mile wide), of the river opposite Goodman Station; it is there timbered with Post Oak, Willow Oak, and some Short-leaf Pine, with a dense undergrowth. Of the properties of this soil in cultivation, I have heard nothing.

Further S. at the crossing of the Benton and Canton road, we find on the E. side of the Big Black quite an extensive level hommock, with a whitish and somewhat ashy soil and subsoil (often interstratified, at some depth, with dark colored, and more clayey bands), which is complained of as being little productive and very liable to injury by drouth. On the whole, it resembles very much the light soil of the Chickasaw Flatwoods, and perhaps its ailments are the same (¶575). Its timber is Post and Willow Oak, with some Black Jack—all of scrubby and inferior growth. The Willow Oak especially, instead of being a tall graceful tree, is of the low, rounded, apple-tree shape which it is wont to assume in "crawfishy" soils. Here, as elsewhere, the "black pebble" or bog ore, which occurs more or less in the whole mass, becomes very abundant lower downward, where, moreover, the material becomes more clayey (¶387).

This soil is not confined to the immediate neighborhood of the Big Black River; it occurs, more or less, in all the level region N. of Canton, forming as it were the general level, above which the fertile, gently undulating loam lands rise, somewhat like the islands of red ridge soil in the Pontotoc Flatwoods (¶576). The same white soil, with bog ore pebbles, occurs in the bottoms or rather hommocks, of creeks between Jackson and Canton, and is quite common in the S. W. portion of the State—as will be mentioned hereafter (¶765[2]).

Generalities concerning the origin of these soils. have been given in the General Part (¶387, ff.). Not having as yet found time to ascertain their wants and the remedies, by analysis, I can now only say, that in all cases which have come to my knowledge, where they were well drained *and lime or ashes applied to them*, they have become very productive. The marls of Madison and Hinds afford abundant opportunity of testing the point in reference to the lands in question.

662. The bottom soils of the waters of Pearl River, outside of the Prairie Region, are characterized almost throughout, by very light soils, the sand contained in them being mostly fine, often so as to render them almost ashy. Pearl River itself, in the greater portion of its course, has a first bottom comparatively narrow, and often entirely absent, whilst the hommock or second bottom lands are very extensive—often 3 miles in width—and not generally very fertile. The tendency to form high sandy hommocks is also manifested very generally on its tributaries.

From Madison county, to N. Hancock, where I have examined the Pearl River flat or hommock in numerous points, there is considerable uniformity both in the aspect of its soil and its timber—all variations, as it were, of the same theme. The surface soils are very generally of a pale tint, and do not often contain much vegetable matter; they are mostly light, and without coarse sand. The subsoil varies from a pale yellow, moderately light loam, to a pale ashy sand with very little clay; and fertility seems to vary precisely in accordance with these changes, which frequently occur in belts of from a half to three miles width, running parallel to the tributaries and therefore, more or less, at right angles with the main stream. The Post, Water and Willow Oaks, and the Bottom Pine are, so to speak, the Key-note of the timber. Where the Pine is very prevalent, and the Oaks disposed to be scrubby, we find the pale ashy soil and subsoil above referred to, and the land is poor; where the yellow loam forms the subsoil, the Pine is scarce or wanting, the Oaks are tall and stout, and the Spanish ("*Red*"), as well as sometimes, the Black, and Scarlet ("*Spanish*") Oak mixes with them, as well as the Sweet Gum, Hickory, (upland); and sometimes, in the southern portion, the Magnolia. Near to the river bank, the Beech also is seen. [For further particulars concerning this portion of Pearl River, see (¶773, ff; 777, ff.].)

663¹ Above Jackson, to the mouth of the Yockanookana (where the flat is mostly on the left (E.) side of the river, the soil seems to be pretty generally considered inferior; below, down to Columbia, it is more frequently of good or average fertility, and at some points (Georgetown, Talley's Ferry, Rockport, Monticello) very productive.—None of the soils of the Pearl River Hommock have as yet been analyzed; but the almost entire absence of trees preferring even a moderately calcareous soil, seems to indicate that the use of the Pearl River marls would be particularly advantageous to them.

663² The white hommock soil of the Yockanookana, in S. Attala and N. W. Leake, has already been mentioned (¶638). The bottom soil *proper* is very similar—on the whole, perhaps, less "ashy" than the hommock soil, and from all appearance by no means deserving of the almost total neglect with which it has hitherto been treated; for it bears a fine, heavy growth of timber—a great deal of Hickory (both Pig-nut and Shell-bark), Elm, Sweet and Black Gum, Chestnut, White, Water and Willow Oak, and some Bottom Pine; with fine Cypress in the sloughs. Near the river banks, and on belts or "ridges", where the soil is very sandy and open, the Beech prevails largely. It has hardly yet been fairly tested in cultivation, Col. J. T. Donald, of Thomastown, being the only one who, to my knowledge, has attempted to cultivate it to any extent, and thus far with very satisfactory results. It is, of course, tilled very easily, and although frequently overflowed, its lightness and permeability greatly diminish the risk of injury to the crops from this cause. As in all the "white" soils, the subsoil, at a certain depth, contains a large amount of bog-ore pebbles.—Of the bottom soils of the Pearl River waters in Neshoba and E. Leake, I know nothing personally; they have been described to me, however, as being similar in general, to those of the Yockanookana and other Pearl River waters further S.; which, from the general resemblance of the surface of the country, seems very probable.

WATERS OF THE YELLOW LOAM REGION.

664. It would be difficult to give, in any shape but that of a lengthy catalogue, the extremely variable condition of the several portions of this region with reference to the supply of well and spring water, or to record the numerous analyses I have made of them; and since the limits of this volume forbid such enlargement, I shall cnofine myself in this place, to generalities; the more so as under the several heads of the "*Waters of the Orange Sand*" (¶75, ff.), "*Waters of the Lignitic Groups*" (¶314, ff.), and especially under "*Localities of the Northern Lignitic Groups*" (¶168, ff.), a great many data will be found (in addition to those incidentally mentioned in the special description of the region, just given) from which an attentive person can inform himself on this point.

665. As a matter of course, where the gray or black clays, sands, etc., of the Lignitic (¶164), appear on the hillsides, or in bluffs of streams, etc., it may be expected that the same will be struck in wells at the same level; that, if they are overlaid by Orange Sand strata (¶10), freestone water may be struck above them, if not at one point, perhaps at another (¶605²); and that, *within* them, if water be found it will generally be somewhat mineral—the less so, the lighter the color of the material found. All that has been said regarding the waters in the Hills of the Flatwoods region, will apply in this case.

666. Where the lignitic clays are absent, and the Orange Sand formation alone comes into play (¶75), the chances of obtaining water in wells may be judged of by observing whether or not, in washes on the hillsides, pipeclays (¶24), occur, and at what elevation. Where (as in the ridges S. of Oxford) springs break out at the *foot* of the ridges only, it may be expected that wells will be required to be sunk to the same level. And, so long as a well or bore remains within the characteristic materials of the Orange Sand formation (¶10, ff.), no rise of the water need be anticipated.

667. *Bored and Artesian Wells.*—The great depth to which wells in the Orange Sand often require to be sunk, and the uncertainty, frequently, of their supply during the dry season, has rendered the practicability of deep bored, and especially of *artesian* wells, W. of the Flatwoods, in N. Mississippi one of serious practical import; and its probable success has heretofore been discussed, with more zeal than knowledge of facts.

While in the absence of surface levelings in an E. and W. direction, it is impossible to say whether at Oxford or Holly Springs, for instance, water could be had to rise above the surface, so much can be said with certainty, that the geological structure of the formations is favorable to artesian bores, and that according to the regular westward dip, at the rate of about 30 feet per mile, of the cretaceous strata in Tippah and Pontotoc, which contain abundant veins of water, these strata would probably be reached at depths between 700 and 900 feet at Oxford, and at Holly Springs at a depth somewhat greater. At these depths water possessing a considerable rise would be certain to be obtained; but there are *chances* of water at a less depth, since the strata of the Northern Lignitic, in which veins of water are not scarce, probably possess a westward dip, similar to those of the Cretaceous.

668. It is impossible to make even an approximate guess as to the *relative levels*, on which the rise of the water depends, without further data; but since the rivers of N. Mississippi flow from E. to W., the expectation that the country

is highest eastward, is justified. The same applies to all the country within a similar distance W. of the Cretaceous formation (see map), as far S. as S. Calhoun. Beyond, until we approach the marine Tertiary (¶188, to 239), the chances are not so strong, though by no means hopeless. It seems possible that artesian wells might be obtained, not only on the whole of the territory of the Northern Lignitic (see map), but even in the Mississippi Bottom itself.

As to the practical difficulties likely to be encountered in these bores, they are not greater than those of the Jackson well (¶321); boring itself will be easy, but tubing may be required to considerable depths.

669. *Mineral Waters.*—As to the mineral waters of this region, generalities regarding them have already been given (¶75; 314). I subjoin, however, some detailed analyses made. They are chiefly three kinds:

A. *Alkaline* (*and saline*) *chalybeates*, containing essentially the *Bicarbonate of Iron*, with *Bicarbonates of Lime, Magnesia, Manganese*, and often *Soda*; also some *Common Salt*, and sometimes *Chloride of Magnesium* and *Potassium*; but few, or no Sulphates. Some free *Carbonic Acid*; sometimes a little *Sulphuretted Hydrogen.*

These waters are very abundant—generally originate *within the Orange Sand*, or at least, touch but lightly the strata of the Lignitic; are often temporary (¶75). The spring found, some time ago, on the M. C. R. R., 2 miles N. of Oxford, was of this character; so are *some*, at least, of the waters of the Lafayette Springs, which I have not as yet visited; and, in Marshall county, those on the land of Isham R. Frost, Esq., of Mt. Pleasant—situated in the bottom of Cold Water River; they contain about one-seven thousandth, by weight, of solid matter.

670. B. *Saline chalybeates containing chiefly Sulphates*, also some Chlorides, and generally some bicarbonate of Iron, and, very commonly, some Sulphuretted Hydrogen flow from the *lignitic strata themselves*, or are found in wells in the same. As a fair sample of a number which I have analyzed, I give the composition of the water of a spring near Dr. John Taylor's (Yockeney Depot, M. C. R. R.).

Reaction neutral when fresh, alkaline after boiling.
Sulphates of *Soda, Lime, Magnesia*, largely; of *Potash*, little.
Chlorides of same, smaller proportion.
Bicarbonate of *Iron*, smaller quantity.
Bicarbonate of *Soda?*
Silica.
Free Carbonic Acid.

A water of good medical properties, but too strong for daily use (¶601).

The water of Black's Wells, Choctaw county, according to an analysis by Prof. Shepard, has almost precisely the same composition. Concerning the sulphur water obtained at this place (see ¶176).

The Lauderdale Springs, in Lauderdale county, possess sulphureous and chalybeate waters of valuable properties, which seem to belong to this class.

671. C. "*Alum Waters*".—These are not as generally diffused as the two preceding; they occur associated with the fetid black clays of the Lignitic, which contain much iron pyrites. A strong water of this kind occurs near Grenada (¶182) and has already obtained some note in that region for its curative powers.

The "Artesian Springs", near Camden, Madison county, have attracted considerable attention, and comfortable arrangements have been made there for the accomodation of visitors. There are several springs at this place, differing somewhat in strength and composition. The analysis of the principal and best known spring of the four (marked No. 2) gave the following result:

Reaction strongly acid.
Sulphate of Alumina } (Alum.)
" " *Potash* }
" " *Magnesia* (Epsom Salt).
" " *Lime* (Gypsum).
Chloride of Sodium.
Bicarbonate of Iron.

The first four ingredients are contained in about equal proportions, the latter two in smaller quantities.—Spring No. 1 differs from this only in the absence of Iron; both are of considerable strength.—Waters of a similar character are occasionally struck in wells in N. Madison (¶180, ff.), where it is often difficult to obtain water fit for daily use.

The "Castalian Springs", in Holmes county, have also acquired some reputation. Of their character I am not informed.

672. There are numerous other mineral and especially chalybeate, springs and wells, which have acquired a local reputation; such as the chalybeate spring near Louisville, Winston county; another, and a mineral well near Pittsboro, Calhoun county; a chalybeate spring near Robina, Panola county; Dr. Stalehane's Chalybeate Spring near Grenada; Sulphur Springs, Madison county; and many others, which will be more specially mentioned in a future Report. Few neighborhoods in the State, in fact, are without a mineral spring or well, of some kind—good, bad or indifferent.

THE NORTHERN RIVER COUNTIES.

673. The territory comprised in the above head, viz: the region lying between the Mississippi River and its eastern bluff, above the City of Vicksburg, I have not as yet examined, my endeavor having been, in general, to attend first to those portions of the State where the comparative poverty, or exhaustion of the soil rendered the aid of science most immediately desirable. The soils of the Mississippi Bottom will, of course, receive due attention in the course of the Survey; for although now deemed by many inexhaustible, an examination of the several varieties, which seem to be quite numerous, promises, not only important information concerning their present treatment, but also the development of important general truths in regard to the culture of the staple which they produce in such luxuriant abundance. It is my intention to devote some time to the examination of this interesting region during the coming season, for which reason I prefer not to communicate the imperfect data at present in my possession.

THE SOUTHERN RIVER COUNTIES.

COMPRISING THE COUNTIES OF WILKINSON, ADAMS, FRANKLIN, JEFFERSON, CLAIBORNE, WARREN, AND PARTS OF ADJOINING COUNTIES.

674. *A.* SURFACE CONFORMATION.—The hilly region which borders the Mississippi River, from the Louisiana line up to Vicksburg, and thence extends upwards for some distance between Big Black and Yazoo Rivers, and known in part, as "The Cane Hills", is strongly characterized by the peculiarity of its surface conformation, no less than by that of its soil, and of the formation which, with few exceptions, immediately underlies the loam stratum which usually forms the subsoil of the uplands.

But a small part of the territory above alluded to, has been specially examined as yet; a general examination, however, has shown a considerable degree of uniformity to exist between (in the uplands at least) its several portions, so that specimens of the several strata which concern the agriculturist, severally taken in Wilkinson, Adams, Jefferson, Claiborne and Warren counties, are so nearly alike in appearance, that differences can only be perceived when the several specimens are placed side by side.

675. The leading characteristics of the surface conformation of this region, are produced by the deposits of calcareous silt* or loam, of an age comparatively recent, now generally known to American geologists, by the name of *Bluff formation* (¶327). The material of which this formation is here composed, and which but rarely shows any indications of stratification, has a tendency, when exposed to the action of water, to form steep and abrupt hollows; and where it forms the *surface material* of the ridges, these are usually very sharp on their backs. Most generally, however, the grey or bluff calcareous silt is overlaid by a stratum 3 to 10 feet in thickness, of solid *brown*, clayey loam (¶332), which in most cases forms the subsoil of the region, and from which, of course, the surface soil also is usually derived. Wherever this loam, which washes readily, forms the surface of the ridges, we have level plateaus, well adapted to agriculture in every respect, which break off very suddenly into deep and narrow gullies, wherever the washes formed sink so low as to penetrate to the calcareous silt stratum beneath.

676. The average thicknees of the calcareous silt stratum over the whole region, I should estimate at between 25 and 35 feet. It was evidently, however, deposited on a surface already very uneven, formed in most cases by the strata (of clays and soft sandstones) of the older tertiary; hence we find it in some places as much as 70 feet in thickness, while in others (as at Grand Gulf, and on the backs of the ridges of the Walnut Hills, above Vicksburg) the underlying rocks are covered by only a few feet of the material in question. For this reason very abrupt changes of its thickness sometimes occur; as in the City of Vicksburg, where the silt is 50 to 60 feet in thickness S. of the creek; while just N. of it, at the well-known bluff, its thickness is but 10 to 20 feet (¶270, Sec. 31).

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*The term "*silt*" implies a fine, powdery deposit, or with too little clay to deserve the name of *loam*.

The same is the case at Grand Gulf, where this material is seen in a vertical well of about 50 feet, at the S. end of the ridge which, a few hundred yards above, bears but a few feet of it on top of the rock—the Grand Gulf sandstone (¶232).

677. In steep, vertical, and even overhanging slopes, the calcareous silt resists the action of water remarkably well. The cause of this phenomenon is probably to be sought in the circumstance, that the loose silicious material, which by itself would be very readily carried off by water, is to some extent cemented by the lime contained in the mass. In fact we find in many cases, that the surface exposed to the atmosphere has hardened into a kind of crust, by the deposition of calcareous matter; which, of course, adds greatly to the stability of the slopes. When, however, the continuity of the mass is once broken, the loose material is washed away by the rains with great ease and rapidity.

678. This peculiarity is the cause of a phenomenon which at first strikes the traveller as indicating a very singular system of road engineering among the inhabitants. Whenever the road crosses a hill or spur of a ridge, we observe hillside cuts with vertical walls, which allow the vehicle to advance horizontally into the hill for some distance, when there is a sudden, steep ascent, rising up very nearly to the original summit of the hill; then we find on the other side of the sharp crest, a descent as steep as the ascent was. Of course, this is anything but an advantage over the original status, when there was a gradual slope all the way up; for the weight has to be lifted to the same height as was originally the case, while the sudden strain consequent upon the steepness of the slope, as at present existing, adds greatly to the labor of the team.

According to the accounts of the inhabitants, however, this state of things is brought about chiefly by the rain water during the wet season. The silt being broken up in the road by the wagons, is copiously washed away on the slopes, while on the summit, where the mass of water, as well as its velocity is small, it is to a great extent absorbed, and the worked up mass settles down again into its compact condition, so as to scarcely detract from the height of the hill. When subsequently the roads are worked, the loose material on the slopes is still further removed, and perhaps some more of it loosened to fill up holes; while the summit is left untouched, as no obvious obstacle exists there. Thus we sometimes find in these cuts, hillocks crossing the road, whose sharp crest almost touches the perch-pole of the wagon, while the front wheel is going down, and the hind wheel running up hill.

679. It might seem frivolous to treat with such speciality of a subject like this; but cases like the one just alluded to, where the removal of half a dozen cartloads from the crest of the hillock would lower it by several feet, are of such constant occurrence, as to make the labor which might be saved in so simple a manner, a matter worthy of serious consideration. Not a few persons appear to be under the impression, that after all there is *some* gain in being able to go horizontally for a greater distance, and having the slope shorter. But it is a principle of mechanics well settled, that the *height* to which a weight requires to be lifted, is the measure of the force required to accomplish the work. And it is just as well settled, that a steady strain causes much less wear and tear to everything, than a succession of jirks—such as are caused by these sudden rises and falls.

680. The denudations* of the calcareous silt in question are not, however, the only cause of the hilliness of this region. Two cases have already been mentioned, in which the greater part of the ridges is formed by tertiary rocks (Vicksburg and Grand Gulf); and rocks or clays of the same age are very generally found forming the lower portion of the ridges bordering the larger water-

*"Washing away."

courses, wherever there has been a "caving off" so as to remove the masses of detritus which usually form the lower part of the slope ("*talus*") of the hills. Blue, gray and greenish clays or clayey sands are most commonly found (¶231), and associated with these, not unfrequently, limited beds of calcareous clay marl; the localities of which, as far as known at present, have been mentioned in the Geological Report (¶295[2]). Analyses of these marls are also given there (¶297; 300; 302). The "Devils Back-bone", in Franklin county, between the Homochitto and Wells' Creek; and Loftus' Heights (and ridges connecting with it) at Fort Adams, Wilkinson county (¶236), are other examples of rock forming, not only the base, but the main portion of the hills.

Towards the interior, back from the Mississippi, the strata of the Orange Sand are frequently found underlying the silt, in place of the Grand Gulf strata. Wherever this is the case the Bluff formation tends to thin out; the lower loam on top gradually changes its color as well as its general character, and by slow degrees and transitions of which I shall presently speak, passes into the light, pale yellow loam of the Pine Hills.

681. In approaching this region from the east, on the Holmesville and Meadville road, a perceptible change in the character of the country occurs as soon as we cross the dividing ridge between the waters of the Mississippi and those of Lake Pontchartrain and Pearl River. The lands at the heads of Bogue-Chitto and Amite rivers, though much superior in fertility to those of the pine hill region further east, still bear, to a great extent, the general character of the latter, both as to vegetation and soil; the regular, rounded form of the slopes and hollows, also, are essentially the same. So soon, however, as we pass into the region tributary to the Homochitto, we find steep and narrow ravines; the hillside soil becomes very sandy, dark colored, and much more fertile than equally sandy soils on the other side of the ridge are usually found to be; Oak, Beech, and some Magnolia, occupy these hillsides, with but little Pine. On the ridges, which are quite narrow and high, Pine still prevails; but the long-leaved species is more and more replaced by the short-leaved. As an additional sign of improvement in the soil, the long-moss appears on the trees, not only in the bottoms, but on the very hilltops. Yet, in consequence of the brokenness of the surface, these Homochitto Hills can be cultivated to a limited extent only.

682. The character of the water courses is not less changed than that of the land. In the interior of the State, and even in the sandiest tracts of the Pine Hills, the streams excavate narrow channels, the whole breadth of which they occupy at a medium stage of water. But the several forks of the Homochitto, as well as most of the larger streams between them and the Big Black, appear to have sought to imitate the example of their great Father, in excavating for themselves wide, shallow, sandy beds, in which, at ordinary stages of water, they meander to and fro, from bank to bank, in secondary channels only a few yards wide at times, excavated in the loose, shifting sands. In times of freshet, when they fill and overflow their main channel, these streams are very wide, rising and falling very rapidly; and as their current is usually quite rapid (as compared with that of the streams E. of the dividing ride) they often carry with them vast masses of sand and driftwood, and as a consequence, continually change their channels.

This description holds good more especially for the upper portions of the course of these streams, before they enter fully upon the territory of the Bluff formation or hills of calcareous silt. This region usually extends from ten to fifteen miles inland from the Mississippi, forming the "Cane Hills" proper; and such streams as have their origin *within* this belt, are characterized by their deep, narrow channels with almost vertical banks, winding their tortuous course, in narrow valleys, from one steep slope to the other. The same is commonly the case with the larger streams, in the last few miles above their mouths; but those which rise in the sandy hills east of the belt mentioned, preserve their character, as above described, for some distance after entering the "Cane Hills" of the Bluff formation.

683. The latter, as a general thing, appear to be higher and more abrupt, the nearer we approach the Mississippi River; arising partly, no doubt, from the natural fall of the valleys, though this does not appear sufficient to account for the difference observed.

In some regions (as in N. E. Jefferson and S. E. Claiborne counties) there intervenes between the abrupt "Cane Hills" and the Pine and Oak hills inland, a gently undulating tract of brown loam uplands, up to ten miles in width, forming fine agricultural regions, which pass gradually into the Pine Hills. N. of the Bayou Pierre, between Willow Spring and Rocky Spring, however, the Pine Hills themselves closely adjoin the "Cane Hills". Further N. yet, in Hinds county, near the Vicksburg and Jackson R. R., we again find a fertile, gently undulating loam region, bordering on the east the calcareous hills of the Bluff formation.

In Franklin county, the hilly and broken, but otherwise fertile, yellow loam region of the Hamburg, and Homochitto Hills, on Wells' Creek and other tributaries of the Homochitto, intervene between the "Cane Hills" of Adams county and the Pine Hills of the interior (¶770, ff.). It is to be observed, that near to the channels of the larger streams, the lands of the "cane hill" character generally extend somewhat further inland, than is the case in the intermediate regions.

684¹. *A.* Soils of the Southern River Counties.—*Character and Composition.*—It has been stated above (¶675; see also ¶348, General Part), that the upland soils of the Cane Hill Region, as far as observed, are reducible essentially to two different kinds, and their intermixtures, to-wit: 1st. Those derived from the stratum of *brown, clayey loam* (¶332), which usually covers the surface (to the depth of from eight to ten feet), of the level or gently undulating uplands, bearing a growth consisting prevalently of Oaks [White, Chestnut White, Black and some Spanish ("Red")], Beech, Hickory, Sweet and Black Gum, mingled with more or less Holly, Linn or Basswood, Sassafras, Elm, Hornbeam and some Magnolia.

684². 2nd. Those derived from the *light calcareous loam silt* (¶327), which forms the main body of the hills; is commonly exposed on the upper portion of the hillsides; forms by itself alone most of the sharp and narrow ridges and summits; and not unfrequently inclined uplands.

It is distinguished from the loam first mentioned, by its buff or dun color; by its lightness, a lump of it being easily crushed between the fingers at all times; by the lumps and concretions of lime (carbonate) which it contains, as well as shells of the common snail, and allied species (¶330¹); all of which appear in the shape of white specks, whenever a smooth cut is made in the mass, and cause it to effervesce ("boil") when dropped in strong vinegar, or other acid. It forms the permanent vertical sides of the road cuts and bluffs (¶677, ff.), often covered over with short green moss, in consequence of the resistance of the surface to washing by rains; and the line between it and the overlying loam is often very sharply defined by a backward slope, formed by the brown loam which is carried away freely by rains and freezes. Finally, its presence on or near the surface is indicated by the frequent occurrence, among the timber above described, of the "Poplar", Sweet Gum, Magnolia, Mulberry, Linn, Honey Locust, and on the lower portion of the slopes, the Red Haw, Crab Apple, and Sycamore. Above all, the *Cane* is significant of its presence. Although at present, the cane on the hills has mostly been destroyed by cattle, it may sometimes be seen in protected spots, covering them from the foot to the summit—as was the case generally before the country was settled.

The trees but just mentioned, and among them particularly the "Poplar", Linn, and Sweet Gum, not unfrequently occupy the ground completely, to the almost entire exclusion of the oaks. The Beech, Horn Beam, and Holly, however, are nearly wanting.

685. The three specimens from this region, which have thus far been analyzed, were selected with a view to obtaining results fairly comparable, and representing as nearly as possible, the average composition of both kinds of soil. They were, therefore, taken on one and the same piece of ground, in different spots, on the land of Mr. James Watson, about five and a half miles north-east of Port Gibson, on the Raymond road. Here the brown loam is from eight to ten feet thick on the hilltops; in the cuts on the hillsides, the calcareous silt appears and approaches nearest to the surface about half way down the hill, the lower portion ("*talus*") of which is again formed by brown loam differing little, in its appearance, from that on the hilltops; but having evidently been washed down from above, it probably contains an admixture of the calcareous silt.

686. The specimens of soil and subsoil were taken on the hilltops, and a specimen of silt in the cut on the hillside, a few feet below the surface.

No. 332. Upland Surface Soil from J. Watson's place, five and a half miles north-east of Port Gibson, Claiborne county.

Depth: Eight inches.

Vegetation: That mentioned above, in the general description, (¶684[1].)

The soil, rather light, of a buff color; much less clayey than the loam subsoil. Saturated with moisture at 68.0 deg. Fahr., lost 5.182 per cent. at 400 Fahr. Dried at this temperature, it consisted of:

Insoluble Matter	87.573
Potash	0.458
Soda	0.124
Lime	0.244
Magnesia	0.545
Brown Oxide of Manganese	0.205
Peroxide of Iron	3.231
Alumina	4.842
Phosphoric Acid	0.105
Sulphuric Acid	0.028
Organic Matter and Water	3.073
	100.429

687. No. 233. Upland Soil from J. Watson's place, five and a half miles north-east of Port Gibson, Claiborne county.

Depth; Eight to twenty inches.

Vegetation: Same as the preceding.

A yellowish-brown loam, much heavier than the surface soil. The subsoil, saturated with moisture at 68 deg. Fahr., lost 9.221 per cent. at 400 deg. Dried at this temperature, it consisted of:

Insoluble Matter (as above)	79.477
Potash	0.741
Soda	0.248
Lime	0.238
Magnesia	0.830
Brown Oxide of Manganese	0.346
Peroxide of Iron	5.634
Alumina	8.849
Phosphoric Acid	0.092
Sulphuric Acid	trace
Organic Matter and Water	3.496
	100.038

688. No. 237. Calcareous Silt, from James Watson's place, five and a half miles north-east of Port Gibson, Claiborne county.

Depth: Was taken on the hillside, about four feet from the surface, and about ten feet below the highest point at which it is visible here.

Vegetation: Hillside growth similar to that described above, (¶684[2]); mixed with oaks.

Saturated with moisture at 68 deg. Fahr., it lost 4.118 per cent. of its weight at 400 deg. Fahr. Dried at this temperature, it consisted of:

Insoluble Matter	75.344
Potash	0.511
Soda	0.115
Lime	5.921
Magnesia	3.278
Brown Oxide of Manganese	0.252
Peroxide of Iron	3.272
Alumina	2.823
Phosphoric Acid	0.145
Sulphuric Acid	0.060
Carbonic Acid	6.729
Organic Matter and Water	1.231
	99.681

689. A comparison of the first two analyses shows the important fact, that the subsoil is considerably richer than the surface soil, in several important ingredients. It contains nearly one-third of a per cent. more Potash, twice the amount of Soda, an equal amount of Lime, one-third of a per cent. more Magnesia—the latter ingredient being, however, not deficient in the surface soil itself. With respect to Phosphoric and Sulphuric Acids, the advantage is on the side of the surface soil.

Were it only, however, for the large excess of potash contained in the subsoil, and the improvement of the physical properties which would be effected in the light surface soil by an admixture of the heavier subsoil, that alone would suffice to render subsoiling a very important improvement. The upland soils of the region in question have been esteemed very fertile, notwithstanding that the amount of Potash and Phosphoric Acid contained in them (if the soil analyzed be a fair specimen), is rather below that of a good average soil; and that in but a few cases as yet, the tillage has extended to a greater depth than that at which the above specimen was taken. It is probable, therefore, that although a large part of these upland soils is now considered as exhausted, or approaching exhaustion, the richest part of the surface layer within reach of the plow, has hardly been more than touched. It would appear also, from the productiveness of a surface soil comparatively poor, that the nutritive ingredients contained in it are, to a great extent, in an available condition.

690. As for the calcareous silt, (No. 237), the analysis shows it to possess an adequate supply of all the elements of a good soil; its peculiarity being the high percentage of the Carbonates of Lime and Magnesia which it contains, and a remarkable deficiency in Alumina. Its admixture of clay is so slight as to barely entitle it to the name of Loam, its main body being silex, in a state of fine division, with but a few per cent. of coarser sand. Hence the small amount of moisture which it is capable of absorbing, in view of which it is somewhat surprising that it should not be a remarkably drouthy soil. This is perhaps owing to its large dose of lime, the property of preventing injury from drouth being particularly claimed for that substance.

It seems, nevertheless, that injury from drouth is more frequently sustained on soils formed by this silt alone, than on those derived from the brown loam; owing probably to the absence of a more retentive subsoil, in the former case. For it must be recollected, that while the lightest soils overlying the brown *loam* are sure to have a clay foundation at no great depth, no such change ever occurs where the calcareous silt forms the soil. Vertical wells of 50 feet of the latter, will most generally show such a conformity of material, that specimens taken from the remotest portions of the mass, cannot frequently be distinguished from one another. When a drouth ensues after a heavy rain on well worked soils of the silt character, these frequently crack open to the same extent as the heavy soils of the prairies and Flatwoods (¶402[1]* to 404), causing great injury to the crops.

691. The analyses above given represent, probably, the extremes of both kinds of soil, such as they are frequently found on the level uplands and hilltops, and the silt soil on the upper portion of the hillsides. The lower portion (*talus*) of the latter, however, is commonly a mixture of the two, in variable proportions--a necessary consequence of their mode of formation, having been washed down from above. It is observable, however, that in the great majority of cases (and especially where the brown loam now occupies the summit level) the soils and subsoils of the talus differ but little in their appearance as well as in their agricultural properties, from those of the hilltops; though as a general thing, they are said to produce, rather more freely, and to last longer.

The relations between these several soils will be better understood by reference to the diagram (No. 6), which illustrates the progress, and different stages of denudation; the space ruled *vertically* representing the brown loam stratum; that ruled *horizontally*, the calcareous silt; and the *oblique* ruling, the *talus*, consisting of a mixture of the two, as washed down the hillside and appearing at the foot. In No. 1, of this diagram, we have a broad ridge or table-land, evenly covered with the brown loam, whereas the calcareous silt appears only on the upper portion of the hillside, and the talus is comparatively inconsiderable as yet.—In No. 2, denudation has progressed so far as to remove the greater portion of the loam stratum from the summit of the ridge, it being left only in depressions, and quite shallow; so that in places, the calcareous silt appears on the surface; the talus, at the same time, being of greater extent than before.—In No. 3, the removal of the brown loam from the summit of the ridge has been completed; it has all been washed down the hillside, intermingled with the silt, and the latter now imparts its peculiar character to the ridge, which has steep slopes and a sharp summit; as is the case in the ridges between Port Gibson and Grand Gulf.

[No. 6.]

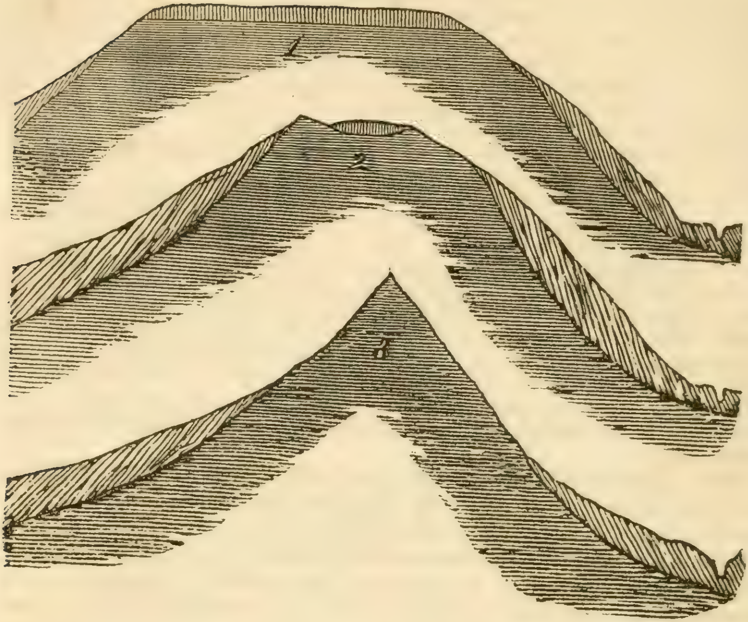

Diagram illustrating Denudation in the "Bluff Formation.

When we consider the great facility with which the brown loam is washed down from the hills, while the calcareous silt is but slightly abraded under the same circumstances, it cannot be surprising that the character of the former should be predominant in the soils of the talus. The constant renewal of their surface by the washings of the rich loam above, offers a ready explanation of their longer duration; while at the same time, the lime they receive from the silt stratum, if exposed above, serves as a stimulant, developing their fertility.

692. Cultivation of the Soils of the Cane Hills.—So far as my information goes, the upland soils of this region, whenever they are derived either *exclusively* or prevalently from the brown loam stratum, are not characterized by any very striking peculiarities; in most particulars, they greatly resemble those of the Table-lands of N. Mississippi (¶616, ff.). When fresh they will produce nearly or quite a bale of cotton per acre, and sometimes more; and a proportional amount (30 to 35 bushels) of corn. On the whole probably they are best adapted to cotton, which is now the prevailing crop; but the character of the soil is such as not to forbid the success of any crop suitable to the climate and to an upland situation; being, as a general thing, both "strong" and "warm". The brokenness of the surface, especially near the Mississippi River, constitutes a disadvantage without which, few portions of the State would rank higher as agricultural regions.

It would seem, however, as if even this circumstance might be turned to better account, than is the case at present.

693. It is a misfortune for this district, as well as for many other regions of the State, that the practice of circling or horizontalizing has not been introduced at an earlier day. In consequence of this omission, the brown loam stratum has been entirely removed from a great many ridges, leaving behind the calcareous silt, which, though by no means infertile, and even more easily tilled than the original soil, is not as safe, nor equally susceptible of improvement. In a great many cases, however, fields have been turned out as of little value, simply because the surface soil was removed, laying bare the brown or yellow loam subsoil. Now, the analysis of the latter proves, that it contains more elements of fertility than even the fresh surface soil; and is perfectly adapted to cultivation so far as its physical properties are concerned; hence, if it does not produce freely at first, this must be owing to the fact that its nutritive elements are not in an available form. Such is very commonly the case with clay subsoils, as has been mentioned in the General Part of the Agricultural Report (¶506, ff.), where the means of obviating this difficulty are also indicated, viz: the use of "*stimulant manures*", or *fallowing* (¶357). The same holds good, of course, when this subsoil has been brought to the surface by means of the subsoil plough, as has been recommended above.

694. The stimulant needed, fortunately, is close at hand almost everywhere in this region, in the shape of the *calcareous silt* often mentioned. The latter is, in fact, a *marl* (¶330), as truly as a great number of other materials recommended and employed as such, and is admirably adapted to supply the deficiencies, and in every manner improve the quality, of the subsoil in question. Nor is this a mere supposition based upon the analysis; for upon inquiring into the subject while in the field, numerous cases have come under my observation where the silt had either been washed down, or otherwise accidentally mingled with the loam subsoil; and in all of these, the land was reported to have produced "as if it was fresh".

It is likely, however, that in most cases, this silt-marl will act not merely as a stimulant. The analysis shows it to contain a considerable amount of potash, etc.; and as the lime has been in contact with the material for a goodly length of time, it is probable that a large part of this Potash, as well as other ingredients, is in an available condition (¶445). Hence it will act to a considerable extent as a *true manure.* (See General Part, (¶416, ff.).

695. In many cases, the transportation of the material in question can be effected to a considerable extent, by allowing it to be washed down on the land from the higher portions of the hills. It has been mentioned that it does not wash readily of its own accord, but does so very easily indeed, when once loosened—as is the case in the road cuts. It is so universally present, however, that its distribution by hauling or carting can rarely be very expensive. It can frequently be obtained in the fields themselves, on the surface, or at the depth of a few feet; and it is so commonly found on the elevated points and ridges, that the necessity of transportation *upwards* will rarely occur to any considerable extent. Whenever the material can be obtained at the surface, an excellent method of effecting its distribution on the large scale (suggested by Col. J. A. Ventress, of Wilkinson) would be the employment of the well-known Railroad Excavator-Cart, which shovels up and conveys away the loosened material in one and the same operation. A very small force could thus very conveniently effect the marling of a whole plantation.

696. In selecting the material to be used, which will easily be distinguished

from the brown loam, by the characters given above, (¶683[1]), it will be advisable, if there be any choice, to take by preference such as contains the largest amount of lime; which may be very readily judged of by the amount of white specks exhibited in a smooth, knife-cut surface of the mass in question. Sometimes, specimens much poorer in lime than the one analyzed, may be found; but richer specimens also occur with frequency, and I believe the one analyzed to represent a fair average.—No fear need be entertained of using *too much* of this marl; in favorable seasons it will bear fair crops by itself, and no dressing likely to be applied in practice, where transportation is necessary, will be apt to hurt the clay subsoil. It may be applied and turned under at any convenient time, after being spread broadcast.

Both the subsoil and the silt are very poor in vegetable matter, which ought to be supplied them—perhaps most conveniently, in this instance, by turning under a green crop. This would greatly increase the efficacy of the marling, and where the marl cannot be obtained, it will itself be a valuable promoter of productiveness—though not, of course, an improvement properly speaking (¶426).

697. It may be questioned whether, in cases where the calcareous silt underlies the loam soil within reach of the plough—say at 10 to 14 inches beneath the surface—it will be advisable to break up the whole of the loam stratum, even for the sake of turning up the silt, and thus effecting the marling in the simplest manner. I am not as yet sufficiently acquainted with the character of the silt as a subsoil, to form a decided opinion on this subject; but from the rapidity with which this material absorbs water and allows it to sink, I should think it undesirable to have it as a subsoil instead of the loam, where it can be avoided: for it is likely that it will allow manures to sink with equal facility as water, and thus the soil might cease to be susceptible of improvement by manures. Further investigations, and experience will have to decide this point; but at all events, the balancing of the advantages of deep plowing against the disadvantages which might arise from the circumstance referred to, must always, to a great extent, rest with the judgment of each individual in his particular case.

698. In the Vicksburg, Grand Gulf, and Petit Gulf or Rodney Hills, the removal by washing of the proper soil, or loam stratum, has taken place to a lamentable extent; and the same is probably true of most of the hilly country bordering closely on the Mississippi River, which has been settled for a long time. In these cases the calcareous silt or marl itself forms the only soil; and although I have not had opportunity sufficient as yet to study its vices and virtues, the frequent abandonment of these hills by the cultivators, and their complaints that "their soil is gone", show conclusively that it is not as eligible in its producing qualities as the original surface layer. This is perhaps owing, not so much to defects in its chemical composition (for it contains all the ingredients necessary to plants, and some soils equally limy are known to produce well) as to its physical defect of being drouthy. It may be, however, that it is to some extent in the condition of light soils excessively marled (¶460[2]); at all events, it is greatly improved, and rendered very productive, by the addition of vegetable matter, as may be observed where it forms terraces on the hillsides, allowing of the accumulation of vegetable matter. Here we generally find a most luxuriant growth of weeds and cane, as also where small branch bottoms, or ravines, *are formed by it*—though, in the latter case, one of its chief faults—drouthiness—is obviated by its position alone. A loose black soil similar to that now found in such localities, and often two feet in depth, originally formed the surface of the Cane Hills, but is now almost entirely removed by denudation. Vegetable matter, has itself a tendency to obviate drouthiness, and would effectually prevent the cracking of the soil in the sun.

699. Whenever there is any of the brown loam stratum left on the hilltops—as is frequently the case at the highest points of the

ridges, it ought, if conveniently practicable, to be distributed over the denuded surface of the silt. In short, as a general rule, it ought to be recollected that these two kinds of soil mutually improve each other, and ought to be mixed whenever this can be done cheaply, and with due regard to the influence which the change of subsoil may be found to exercise, in cases where deep plowing will reach the silt. (See above, (¶697).

700. *Lands Intervening between the Cane Hills and Pine Hills.*—Intervening between the Cane Hill Region proper, and the Pine Hills of the interior, we find, as before observed (¶683, ff.), a variety of upland soils intermediate between the two, and forming gradual transitions, both in the aspect of the soils and the character of their vegetation, from the one to the other. In some cases (as in the region between Willow Spring and Rocky Spring in N. E. Claiborne) the transition is quite sudden—from the rich brown loam to the pale yellow subsoil of the Pine Hills; while further south, and in Jefferson county, a gently undulating tract of loam lands intervenes between the Cane Hills and the Pine Hills. Further S. yet, in Franklin county, the broken, yellow loam ridges of the Hamburg Hills pass, on one side into the sandy hills of the Homochitto, and on the other, into the Cane Hills of Adams county. As none of these soils has as yet been analyzed, a few general remarks with reference to them must suffice for the present.

701. The sandy soil of the Homochitto Hills, though evidently fertile (as is proved by the vigorous growth of oaks and hickory laden with Long Moss, and the comparative scarcity of Pines) is cultivated to a very limited extent only, on account of the brokenness of the surface. Not unfrequently, a yellow loam subsoil underlies the sandy surface soil, and by careful horizontalizing and deep plowing, a great deal of land now lying idle might no doubt be made available. The sand which these soils contain, is generally much coarser than that of the Pine Hill soils and often pebbly; and some tracts, especially on the S. Fork of Homochitto, resemble closely, in soil and vegetation, the sandy ridges of East Mississippi, in Noxubee, Kemper, Lauderdale and Jasper counties (¶650, ff.). Here, too, the Upland Willow Oak, or narrow leaved Black Jack, is found, mingled with short sturdy Post and Spanish ("*Red*") and some White Oak, and Hickory.—In this region, at the present time, the bottoms and hommocks alone are extensively cultivated (see below, (¶711, ff.).

702. In passing from Meadville to Hamburg, we find between the forks of the Homochitto, moderately hilly uplands of tolerable fertility, and less sandy. After crossing the W. fork *the country becomes more hilly;* a good strong loam soil sets in, the pine becomes scarce, and Hickory, White, Spanish ("*Red*") and Black Oaks, together with the Cucumber tree, occupy the ridges, while on the hillsides, the Sweet Gum, Ash, and "Poplar" are also found. In exposures by washes on the hillsides, we find that there is uppermost a layer 18 to 24 inches in thickness of light brown loam, forming the soil and subsoil; beneath this, several feet of pale yellow, sandy loam, resembling that of the pine hills, and below this, the Orange Sand strata.

It is obvious that such a disposition of the strata must produce a great variety of soils from the top of the ridges down to their foot. The ridge soils are generally heavier than the hillside soils, and are very productive; but the ridges are generally very narrow, and the hillsides too steep to be readily cultivated, so that it is difficult to find large bodies of land of a convenient shape. A great deal of damage has been done to these lands by the denudation of the soil, which is now being prevented to a great extent by horizontalizing. Deep plowing will, no doubt, prove highly beneficial on these ridge lands, the subsoil of which is obviously the same essentially, as the surface soil itself.

703. The great and unusual frequency of the Cucumber tree, with its enormous leaves, is the prominent botanical feature of the Hamburg Hills, which

gradually disappears as we approach within five or six miles of Fayette. After this the tree is seen no more, even casually, until we come within about four miles of Port Gibson, where we find a tract of only a few sections with a light, warm "mulatto" soil, timbered chiefly with the two specimens of Magnolia, in their fullest development. Beyond this district, again, the Cucumber tree becomes extremely scarce, being only found in bottoms, occasionally; and it is said that the inhabitants of Natchez and neighborhood have failed in all their attempts to transplant it to their soil as an ornamental tree. The analysis of the soils referred to above will therefore be interesting as showing the peculiarities of soil on which the thriftiness of this tree depends.

704. The light brown loam of the Hamburg Hills, with its underlying stratum of pale material, continues to within a quarter of a mile (S.) of the town of Fayette, where both mixed together have been used in making brick. But as we leave Fayette on the Port Gibson road, the dark, umber-colored loam, such as we find overlying the calcareous silt of the Cane Hills (¶684[1], 687), is alone to be seen; and it is this chiefly, which forms the soil and subsoil of the gently undulating, agricultural region which in Jefferson county intervenes betwixt the Cane and Pine Hills. A change in the character of the loam, similar to that just mentioned, takes place as we pass from Willow Spring in Claiborne county, into the Pine and Oak ridge lands which here extend like a spur to the westward, into the Cane Hills themselves.

705. Near Rocky Spring (¶233), on the Little Sand, and particularly in Mr. J. F. Brock's neighborhood, a peculiar condition of things obtains in some tracts. Here, a gray, somewhat ashy soil, much resembling the surface soil of the Pine Hills themselves, overlies, to the depth of about ten inches on an average, a brown loam subsoil apparently identical with that of the Hills, and evidently fertile, as the timber is very large, while the smaller plants, whose roots are shallow, seem to indicate but an indifferent soil. The prevalent tree is the Beech; next to this, the Spanish ("*Red*"), White, and Chestnut White Oak, with a good deal of Holly, and some Short-leaved Pine; on the hillsides and heads of hollows, the Magnolia occurs, and large Grape vines are common both in the hills and valleys.

It is complained that this land (with the shallow tillage now practiced) is both unproductive in its natural condition, and will not be benefitted even by stable-manure; which does not seem to decay in the soil, but remains "raw", as also do forest leaves, etc. The Gouber pea and pea vine alone seem to flourish pretty well.

These circumstances corroborate what is indicated by the aspect of the soil: it is not sufficiently retentive either of moisture or manure, owing to the want both of a sufficient quantity of clay, and of vegetable matter; probably, also, the surface soil is naturally poor; while the subsoil, which is reached and penetrated by the roots of the larger trees, is rich in nutritive ingredients. The remedy is obvious: the subsoil must be brought up by subsoil plowing and mixed with the surface soil; thus improving it both physically and chemically; vegetable matter must also be introduced, and in order to facilitate the decomposition of the latter, as well as to stimulate the subsoil, lime, or a calcareous marl, ought to be used at the same time. The calcareous silt of the bluff formation, which is still found in places, in this region, may be used for this purpose. It may be observed, that in so doing we imitate what nature has done in the formation of the fertile hillside or Magnolia soils of the same neighborhood. The gray surface soil and leaves, in being washed down the hillsides, are first mixed with brown loam subsoil, then, lower down, with the calcareous silt; and it will be noticed that where the latter is entirely absent, the growth of the Magnolia is comparatively stunted, even in the valleys. Whether this is due to the direct influence of the lime as a nutritive ingredient, or to its stimulant action on the soil, remains to be determined.

706. Grape Culture in Cane Hills.—I cannot dismiss the subject of the upland soils of the Cane Hill Region, without expressing my conviction that they are most peculiarly adapted, both by their chemical and physical features, and by their surface conformation, to the successful culture of the Vine. This fact might be inferred from the circumstance alone, that the native grape-vines do not anywhere in this State flourish more luxuriantly—sometimes attaining enormous dimensions—than they are known to do wherever, in this region, cultivation and the ranging of cattle have not destroyed all but the larger timber.

The latter is, in kind, either the same, or substantially equivalent, to that which characterizes the best vineyard lands of Illinois and Missouri; for it appears in this State at least, that the same soils which, in the southern latitudes, are characterized by a luxuriant growth of Magnolia, bear large Sassafras and Linn, wherever the mean temperature is too low to favor the growth of the former. The analyses, also, are significant on the same point; a "warm", deep soil, containing abundance of *potash* and *lime*, and proper proportions of all other ingredients, is generally deemed to be peculiarly adapted to the culture of the vine. It might be doubtful whether the soils formed chiefly, or exclusively, by the calcareous silt of the bluff formation, would by themselves be suited to the purpose; but the hillside soils, formed by a mixture of the silt with the brown loam, would seem to be admirably adapted in all respects.

707. The cultivation of the hilly lands is necessarily more expensive than that of level tracts; great care must be bestowed on accurate and deep horizontalizing, and in many cases, nothing short of actual terracing will effectually prevent the denudation of the soil. These operations are too expensive to allow of raising cheap crops on large areas, wherever they are involved; we must attempt, therefore, to realize the highest profits on the smallest possible area, by keeping the land in a high state of cultivation, with crops of high value. In experiments made in this State, on uplands much inferior to those in question (¶649), the yield of grape-juice, from Longworth Catawba, was at the rate of seven hundred gallons per acre, the minimum market value of which may fairly be assumed at $1.50 per gallon. A higher yield, and a higher price also, may reasonably be expected to be obtained on a more generous soil, and it is plain that with crops like these, considerable pains may be taken in the improvement of the lands which bear them. In this manner, not only the hilly lands of the counties just treated of, but also the fertile, but broken lands bordering the Mississippi bottom further north, in Warren, Yazoo, and Holmes counties, and little valued thus far, might be doubtless made, not only available, but highly profitable.

708. The climate of South Mississippi is admirably adapted to the culture of the vine, closely approaching as it does in the features essential for this purpose, the climates of the Mediterranean coast. Rainy winters, not cold enough to frost the vines (as frequently happens in Missouri and Illinois); dry summers, with only occasional showers; and a warm, unclouded autumn sun to develop the grape into sweetness and maturity. Indeed, it may be questioned whether even the production of *raisins* might not be practicable in South Mississippi, depending as it does solely upon the occurrence of a fortnight's warm sunshine at the time of maturity.

I know of no reason, apparent at the present time, why these anticipations should not be capable of realization, and why, if there be no other analogy between the two, the hills of the lower Mississippi should not vie in *this* respect at least, with the vine-clad banks of the Rhine.

709. BOTTOM SOILS OF THE SOUTHERN RIVER COUNTIES—None of these have as yet been analyzed, wherefore a few generalities with reference to them must suffice for the present.

In the Cane Hill region *proper*, *i. e.*, where the calcareous silt forms the main body of the hills especially, the valleys of the smaller streams, as before observed, are generally narrow, and the hillsides steep wherever they are formed chiefly by the silt; whereas slopes more gradual are formed wherever the brown loam is of considerable thickness on the upland, and therefore forms the talus of the ridges. These valleys do not generally possess the character of bottoms proper, but rather of what, in the interior, is called *hommock* or second bottom (¶342, ff.). Their surface is generally even and but little cut up with slough; the main channel being usually so deep that overflows of the valley are much less common than is the case, in other portions of the State.

Such is the case with those streams which head within the Cane Hill Region itself. The soil of their valleys, being a mixture in varying proportions, of the brown loam and the calcareous silt stratum, is always light and warm, and very productive when cultivated. The bodies of land formed by them, however, are generally so small, and often so much cut off from convenient communication with the uplands by the steepness of the hillsides, that they are not nearly as generally in cultivation as their quality, when compared with the uplands, would justify; being very commonly turned out as pastures.

710. The larger streams, which head inland of the Cane Hill region, in the sandy uplands of the dividing ridge, possess, of course, a character different from that just described. The valleys of the Homochitto, Bayou Pierre, Cole's Creek, etc., possess a true bottom character and growth, for some distance after entering upon the Cane Hill region; yet for the last eight or twelve miles of their course these streams also assume more or less, on the large scale, the same character as the small streams which head within the Cane Hills. In this latter portion of their course, the soil of their bottom or hommock is less sandy than further above, and the Black Walnut, Sycamore, and Honey Locust become very prominent—all three indicative of the presence of a large supply of lime, and of a productive soil. Corn appears to thrive unusually well on these soils.

711. Higher up, the bottom soils generally become more sandy, and the Oaks, Beech, Hornbeam and Magnolia predominate; the latter tree, especially, attaining enormous dimensions. These sandy bottom soils are generally of considerable depth, of a dark color, and peculiarly adapted to the culture of cotton.

Thus, in the bottom of the Middle Fork of Homochitto (Franklin county), which is heavily timbered with Magnolia and Beech, together with the Chestnut White Oak, Sweet Gum, "Poplar", Maple, etc., there is scarcely any perceptible change in the aspect of the soil at a depth of more than thirty inches; and it is esteemed as being the best cotton land in that portion of the State. Notwithstanding their great sandiness, these soils wear very well; in consequence, no doubt, of the great depth to which the roots of the crops can, with facility, penetrate, without even the aid of the subsoil plow. Deep plowing is nevertheless, to be recommended, so long, at least, as the color of the material brought up is not a great deal lighter than that of the surface soil.

712. Level hommocks of considerable fertility, but differing in their growth and character of soil from the bottoms, are often found intervening between the latter and the hills; sometimes also they extend up to the very banks, to the exclusion of any bottom, for a short distance.

Such is the case on the South Fork of Homochitto, near Meadville; the hommock or second bottom is elevated from four to six feet above the first bottom, which has a rather light colored, sandy soil, about 2 feet deep, timbered as before mentioned; while the soil of the hommock is moderately light, of a buff color, about ten inches in depth, underlaid by a rather pale yellow loam, its timber being the Beech, White Oak, Hickory, Holly, Sweet Gum, Cherry, Sourwood, etc. This soil will, on an average, produce a bale of cotton per acre when fresh, and very good corn also; but there are portions of it which are from the outset unsuited to cotton, and others become so after a short period of cultivation, while they will still produce corn very well.—A similar complaint is made with reference to some of the hommock lands of the Bayou Pierre. It is hoped that comparative analyses of these soils will develop the cause, as well as the remedy of these defects.

While the average width of the valleys in this region is probably the same as usual in the interior of the State, the great width of the shallow sandy beds which the streams excavate for themselves, often diminishes seriously the amount of valley land suitable for cultivation. The smaller streams especially not unfrequently occupy in this manner, a large part, or even the whole of the space included between the slopes.

713. Tracts of superior bottom land are also found, to some extent, between the foot of the hills and the Mississippi River; they are mostly in bodies comparatively small, but of very great fertility, especially where the calcareous silt of the hills has been, and is being washed down upon them. The difference caused in the productiveness of the soil, by this natural marling process, is very marked, and should be a strong hint to those whose location enables them to produce the same effects by artificial means.

714. Springs, Wells and Mineral Waters.—The Cane Hill region *proper*, is on the whole poorly watered—a natural consequence of the entire uniformity of the material of which the hills are composed (¶675, ff.). It is only when the calcareous silt is underlaid by other, denser strata at or above the level of the drainage, that permanent springs exist. Even in this case, however, the water is usually very limy; and the same is true of the well water which may often be obtained, after passing through the silt, on the surface of the tertiary clay or sandstone strata. The water of the streams themselves, where the material of the Bluff formation forms their bed, is often very limy; as may be judged from the fact that many of them form calcareous incrustations and masses of tufa, where a log or a ledge of rock causes the water to drip, so as to aerate it. A striking instance of this kind has been mentioned in the Geological part of the present Report (¶330), while calca-

reous incrustations on leaves, sticks, etc., are very common. Nor is even the water obtained in the blue or gray clays, or between the sandstone ledges of the Tertiary, always unobjectionable. Some of the strata of the latter formation, as we have seen (¶231, ff.), are also calcareous, and so, of course, is the water derived from, or collected in them. More usually, however—and this is the most objectionable feature—these waters are magnesian and sometimes gypseous, generally with an admixture of common salt (¶316 ;) which ingredients render them, of course, unfit for daily use, although they impart to them medicinal properties (¶601, ff.). The characters just mentioned are almost invariably met with in the waters derived from the strata of the gritty, semi-indurate, sandy clays, or soft, "rotten sandstone", which generally occur beneath the hard ledges of the "Grand Gulf Sandstone", and underlie, or form the base of, a large portion of the hilly lands of Claiborne and Jefferson counties. Where these crop out, they may not unfrequently be found covered with incrustations or efflorescences of salt ; while as a general thing, we may expect to find good freestone water wherever the hard sandstones and loose sands prevail.

715. The nature of the salts I have generally found to be very nearly the same throughout the region in question. The waters contain the *Chlorides* of Magnesium, Calcium and Sodium, in variable proportions ; the salts of Magnesium and Sodium being usually predominant. A small amount of sulphates, also, is often present ; yet I have found the *chlorides* predominant over the sulphates in all the waters I have examined S. of the Bayou Pierre, and E. of the dividing ridge. To the eastward and northward, in the counties of Hinds, Rankin and Simpson, the reverse is commonly the case, the waters, when mineral being impregnated chiefly with *Sulphates.* It is owing to this difference probably, that the habitual use of the saline well waters of the Southern River Counties does not affect health as injuriously, as is the case with those of the other counties named.

716. In consequence of the inferior quality of the well waters, so unfrequently met with, cisterns have come into very general use for drinking and cooking in the Cane Hill region ; while for other househould purposes, the water of the wells may be (and is very generally) made available by the addition of some lye, which precipitates the lime and magnesia, so as to allow the water to be combined with soap. A little pearlash, or "sal-soda" (*not* so well the "soda" used in the kitchen, unless the water be boiled), will answer the same purpose. The same remedy will apply in the case of waters simply limy, derived from the calcareous silt ; though in this case, it is generally necessary to let the water boil, before it will take up the soap readily. Boiling alone will accomplish the same end, but requires a longer time. Waters of the latter class, only moderately impregnated with carbonate of lime, cannot be considered as of necessity injurious to health ; though they often are so to those unaccustomed to their use.*

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*For a ready method of distingushing limy from magnesian waters, and generalities concerning the same, (see ¶601 to 605[1]).

For the use of stock, the saline waters are probably unobjectionable. The clays from which they are derived, when exposed on the surface, are often greedily licked and eaten by cattle; and in some instances, considerable excavations have been the result of these operations. Such being the natural desire of the animals, it is not likely that the drinking of water containing a moderate amount of these same salts, should prove injurious. As for the limy waters of wells and springs, it does not appear that the cattle of the prairies suffer in any manner by the use of similar waters.

717. In dry seasons, however, the wells dependent upon the sipe water of the calcareous silt commonly give out, and even those obtained at inconsiderable depths in the Grand Gulf strata often fail. Hence the practicability of deep, bored, or artesian wells, in this region, becomes of considerable practical importance; data concerning which have been given in the Geological Report, (¶318).

Even should the water thus obtained in shallow bores prove somewhat mineral, it would relieve the scarcity of stock water, and the necessity of using the fetid, limy water of artificial ponds.

718. In the region skirting, to the eastward, that of the calcareous silt of the Cane Hills, where the latter formation thins out and finally gives way altogether to the sandy and clay strata of the Orange Sand formation, the supply of water is generally better both in quantity and quality.

Like the calcareous silt itself, the Orange Sand strata are here very commonly underlaid by impermeable strata of tertiary clay or sandstone, which shed the water and give rise to fine freestone springs, which flow out, of course, at the level where these strata appear on the hillsides, and to which, in general, wells on the ridges will require to be sunk. Thus in the Hamburg neighborhood, in Franklin county, where the impervious clays appear nearly at a level with the drainage of the country, while the ridges are formed of Orange Sand, wells do not reach water at less than 80 to 110 feet—the whole height of the hills; their lowest portion being, as usual in such cases, dug in variously colored pipeclays (¶70). If water can be obtained in these, it will generally be freestone; if the gray or blue clays are reached or penetrated, it may be more or less mineral, but will be less likely to fail in dry seasons.

The same remark holds true with reference to natural springs; those which issue *above* the *gray* clays, and are, therefore, dependent upon the overlying Orange Sand strata for their supply, are much less reliable than those which, like the Franklin or Wild-wood Springs, and others in the same neighborhood, issue from the water-bearing strata of the Grand Gulf Group (¶230; 314).

719. The remarkable spring just mentioned, which has attracted some attention both as a natural curiosity and for its curative powers, is situated in a narrow valley of the Hamburg Hills. It forms a basin varying from 8 to 12 feet in diameter, in a loose fine sand. The surface of the clear cold water is perfectly still, but at the depth of about two feet, there is an unceasing waving, ebbing and flowing motion, on the surface of a fluid mixture of fine white sand and water, caused by the rising of a powerful stream of water in a rounded channel, into which a pole can be sunk for 20 feet vertically—below this depth, it seems to turn sideways. A pole thus introduced is ejected by the current and its buoyancy, with great force; a man cannot sink below the armpits, being sustained by the current in a condition of very unstable, wabbling equilibrium. The water of this, as well as of a number of other similar, but smaller springs in the neighborhood, may be considered almost a "freestone", since the amount of mineral ingredients contained is very small—though of the usual, magnesian

character. The curative action exerted by the large Spring, when used as a bath, are probably owing more to the irritating effect on the skin of the fine sharp sand with which the body is scoured as it were, and the reaction following the cold bath (its constant temperature being 63.5 deg. Fahr.), than to the medicinal qualities of the mineral ingredients.

It has been claimed that these springs prove the practicability of artesian wells in the region of their occurrence. It unquestionably proves that *in that neighborhood*, such may be obtained *at the same level, i. e., in deep valleys*, but the water of the streams so obtained could not rise higher than the level of the basin of the Franklin Spring, which is precisely that at which, at present, water is obtained in wells on the ridges. It is only, like Hale's well (¶318) an indication of a favorable disposition of the strata at that point.

720. Where the hard white sandstones of the Grand Gulf Group prevail, as in some parts of the western Homochitto hills, the Backbone, and in N. E. portion of Claiborne county, and adjoining parts of Copiah and Hinds, springs are generally more abundant, and their water purer, than where the materials of the strata are soft. In S. W. Hinds, however, we soon find a change in the composition of the waters, in which the sulphates become predominant; they gradually assume the character of the water of Cooper's Wells.

THE CENTRAL PRAIRIE REGION.

Comprising, essentially, the portions underlaid by the calcareous Tertiary (see map), of the counties of WARREN, YAZOO, MADISON, HINDS, RANKIN, SCOTT, SMITH, JASPER, NEWTON, CLARKE *and* WAYNE.

721. The prairies characterizing the region I thus designate, are not generally the *prevalent* feature of its surface—not even to the extent to which this is the case in the North-eastern Prairie Region (¶527 to 560). They do not anywhere form such continuous or large bodies of land, as we find them occupying on the surface of the country underlaid by the Cretaceous formation, nor is the surface of the country so generally level or gently undulating.

The black prairie soil occurs in patches, of a few acres to several thousands in extent, intervening between elevated ridges occupied, either by the Orange Sand formation and its peculiar soils, or by soils derived essentially from the materials of the clayey, *non-calcareous* or *gypseous* stages of the Tertiary—forming, in the western portion of the belt, the lighter soils of the "Gypseous Prairie" (¶215; 723, ff.); in the eastern, the heavy, intractable soils of the "Hogbed" or "Hogwallow Prairie" (¶746, ff.). Both of these occupy, in general, positions *above* any contiguous "Black Prairie", the latter being in the more hilly portions of the region, confined to the slopes and bottoms of the streams, and essentially derived, as may be inferred, from the *calcareous, fossiliferous* beds of the Tertiary—for which reason they are often, in contradistinction to the other soils above mentioned, designated as "Shell Prairies", from the great abundance in which fossil shells, especially oysters (¶198), are sometimes found on them, accompanied, not unfrequently, by the bones of the huge *Zeuglodon* (¶207, 208).*

Unlike the cretaceous prairies, those of the Tertiary do not *generally* possess a subsoil stratum distinctly different from the underlying rock (¶124 ; 335, ff.) ; the soil seems, in most cases, to be a mere disintegration of the Tertiary material (¶202, 203 ; 207, 208), which in many points forms the immediate subsoil. The same is true, more or less, of the soil of the "Gypseous" and "Hog-wallow" prairies.

722. The ridge lands intervening between the several kinds of prairie lands, bear partly (in the northern portion of the belt) the character of the soils of the adjoining Yellow Loam Region, or (further S.) that of the Long-leaf Pine ridges. It is only, so far as I know, in the extreme East, in Clarke and Wayne, beyond the Chickasawhay--that the black prairie occupies the summits of the ridges to any great extent. For convenience sake I shall include in the description of this region, that of some lands adjoining it which, though not underlaid by the marl formations, are more nearly related in their agricultural features to those of the Prairie Region, than to any other.

723. WARREN AND YAZOO.--I am not aware to what extent the features of the prairie region are developed in these counties, whose surface conformation, so far as I am acquainted with it, resembles in general, most nearly that of the Southern River Counties (¶674 to 720), and, so far as N. E. Yazoo is concerned, of the Yellow Loam Region, which see (¶634, ff.). It is to be observed, however, that in an agricultural point of view, that portion of them which is underlaid by the blue and white marls and limestones of the Tertiary (see map), possesses a great additional advantage as compared with the counties possessing, as a fertilizer, only the calcareous silt of the Bluff formation (¶327, ff.).

724. HINDS AND MADISON.—There is a great general resemblance, amounting almost to identity, in the agricultural features of the adjoining halves of these two counties. Level or gently undulating uplands, possessing a fertile soil and deep loam subsoil resembling

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*The fossil monster called the *Zeuglodon macrospondylus* (or *Z. cetoides*) was a marine animal of the Whale tribe, but resembling in shape rather an alligator or lizard, than any Whale at present existing. Its total length (as seen in skeletons), often exceeded 100 feet. It has thus far been found only in Mississippi and Alabama, but no doubt exists in the corresponding portion of Arkansas, where huge bones are said to occur on the prairies. It is greatly to be desired that a complete skeleton of this ancient inhabitant of our State, should be secured for the collection of the State University at Oxford ; nor would this be a difficult matter, if gentlemen residing in districts where these bones occur, (especially in N. Smith and S. Scott, where they are so frequently laid bare by the plow, as well as by rains) would interest themselves so far as to communicate to the State Geologist, or the faculty at Oxford, the discovery of any apparently complete skeleton, protecting the same from being dismembered and scattered until measures could be taken to exhume it.

that of the Richland region (¶634), both as to color and the growth of timber it supports, but interspersed with patches of prairie, and modified more or less, in different localities, by the admixture of the calcareous, and mostly very clayey, materials of the Tertiary, and also, near the Big Black, with those of the Bluff formation, characterize both.

The yellow loam lands of Madison and N. Hinds are justly considered as being among the best uplands of the State—superior to the prairies as to "safeness" while little if at all inferior in productiveness, like the Marshall Table-lands (¶616, ff.), and about equally well suited, on an average, to corn and cotton.

Such, at least, *has* been the case and is now with fresh lands; but an improvident, exhaustive cultivation has nowhere in the State perhaps, shown its effects more clearly and threateningly, than in this early settled region, whose fertility, was once deemed inexhaustible, as that of the Mississippi Bottom is now—but whose crops dwindle more and more every year, both in quantity and quality, while valuable improvements are being abandoned by their owners in order to exchange their exhausted fields for that utopian soil which never gives out, said to exist somewhere to the westward.

725. The loam stratum which forms the soil of these lands, is evidently the same as that which forms the table-lands of Marshall, (¶616, ff.), and the best soils of the Southern River Counties (¶675, 684,[1] etc). It is therefore to be presumed that as in those cases, the subsoil loam is at least as rich as the surface soil. The only analysis which, thus far, I have made with reference to the soils of this region, goes to demonstrate this fact, and to show that the subsoil plow and stimulation are the one thing needful, for the present at least, to restore to these lands their productiveness, since they are not deficient in any of the ingredients of a good soil. No. 298. Yellow Loam Subsoil, from Dr. T. J. Catching's place, S. 2, T. 4, R. 3 W., Hinds county.

Depth: Nine to twenty inches.

Vegetation: Black Jack, Post, and Spanish ("*Red*") Oaks—all large and sturdy, with well formed tops; some tall Hickory; undergrowth of Dogwood and Persimmon.—A light, porous loam, easily tilled; color brownish-yellow.

The subsoil, saturated with moisture at 62.4 Fahr., lost 8.543 per cent. of water at 400 deg.; dried at which temperature it consisted of:

Insoluble Matter	80.788
Potash	0.634
Soda	0.185
Lime	5.921
Magnesia	0.266
Brown Oxide of Manganese	0.159
Peroxide of Iron	4.727
Alumina	8.940
Phosphoric Acid	0.151
Sulphuric Acid	0.076
Organic Matter and Water	3.239
	100.393

726. The beneficial effects of the fallow on this subsoil, where it has been exposed in washes, have often been noticed; the same effect would be produced in a shorter time, by *marling*, especially when aided by a supply of vegetable matter. But even without these, the effect of *deep plowing* or subsoiling, and especially of *underdrainage*, will be found to be highly favorable, not only as restoring productiveness, but also as preventing injury by drouth, which is so

severely felt in the current year (1860). No moderate drouth could injure lands constituted as are those of Madison, if tilled deeply, or underdrained; and a moderately attentive observer, in traveling through the prematurely withered corn-fields of that region, would suppose that in adjoining plantations there existed essential differences of soil, but for the fact that the *fences* mostly form the dividing line between patches of deep green corn which still resists, and others where the fodder has been cured on the stalk.

Yet on inquiry he will find that the difference was caused by nothing more than an additional mule before the plow. Another circumstance also may be very extensively observed this season, viz: that wherever, by washing or otherwise, the white marls (¶281), have been mixed with the soil, both the crops and the weeds resist the drouth, when all around is dead or dying. These are hints which ought to be sufficient to those who wish to improve their soil, although in ordinary seasons, these effects are not so noticeable.

727. The correction of the soil by drainage is especially necessary and beneficial where, as is the case, in extensive tracts on the Pearl River side of the dividing ridge, the heavy, bluish gray clays with white concretions (¶202, ff.), are near the surface and appear in washes. Such soils, in their natural condition, suffer severely with drouth; but will not, if by drainage, these calcareous clays, which are always moist, are rendered penetrable to the roots which, at present they force to remain near the surface.*

For the rest, most of what has been said with reference to the table lands of Marshall (¶516, ff.), will hold true also of the yellow loam lands of Madison and Hinds. There are, of course, many local varieties of this, and as has been hinted already, the soils on the Pearl River side of the dividing ridge appear to be quite generally heavier, and more frequently calcareous than those on the Big Black. These variations will receive closer attention and study hereafter; it would be to little purpose to discuss them specially at present, since the general fact, that they are soils of great native fertility, and may be greatly improved by the use of the subsoil plow and of marls close at hand, is true of them all.

728. The soils overlying the territory of the Vicksburg Group, in Hinds county (see map), do not seem to differ essentially from those just described, save in that they are somewhat light, *e. g.*, those of Spring Ridge, and gradually merge into the soils of the Pine Ridges of S. Hinds, which set in south and west of the line given on the map, as the south limit of the Vicksburg Group; and which in their turn, form gradual transitions into the "Pine Hill" soils of Copiah.

729. These ridges, which are timbered essentially with Short-leaf Pine and Post Oak, with more or less Black Jack, possess a sandy, but not unproductive soil derived in great part from the white sandstone ledges of the Grand Gulf Group, which underlie the hills and (as at Cooper's Well and Mississippi Springs), frequently appear on the surface. Where the heavy gray clay, which is often

*It is probable that thorough drainage would also serve to correct, to a considerable extent, the tendency of this clay to shrink, and, in dry seasons, to form large cracks (sometimes two and three inches wide), in the surface soil, which are not only injurious to vegetation, but seriously endanger the security of buildings—as has been the case for instance, at Jackson, where most brick and stone buildings not secured by anchors in the walls, or by a "concrete" foundation, are in the course of time traversed by cracks in all directions. This does not happen, however, where (as in the lower part of the city), this clay is overlaid by pebbles or sand, or (as near the Railroad Depot) is altogether wanting.

interstratified with the sandstone (¶231, ff.), contributes towards the formation of the soil, the Pine is generally wanting, and the Post Oak and Black Jack alone prevail. It is noticeable that almost over the whole of this region, the Long Moss floats from the trees—even from the Pines—which I have never found to be the case on infertile soils, however unpromising their aspect. Near Raymond also, Pines are sometimes seen on the ridges, but generally, the timber consists of the Spanish ("*Red*") and (*true*) Red Oaks, intermingled here and there with Post Oak and Black Jack. The soil has been very much washed, so that the original subsoil is now chiefly cultivated: hence a great lack of vegetable matter in the present soil, which is, nevertheless, quite fertile. In W. and S. W. Hinds the lands, though not underlaid by marl strata, but by the gypseous clays of the Grand Gulf Group (¶303½), are quite similar to those of N. Hinds and Madison, before described, and the country is thickly settled. It is very likely that some of the gypseous materials found in wells and bluffs (*e. g.*, Col. Dillon's neighborhood), would prove a valuable improvement to these soils, which, like those of Madison, are giving out under the same exhaustive system, and may no doubt be similarly resuscitated (¶726).

730. Of the extent and character of the prairies in Hinds county, I know but little from personal observation. They seem to be of small extent, and from the fact that crystals of gypsum, and oysters both have been found on them there would seem to exist here a similar diversity of soils, as will be below described in Rankin county (¶733, ff.). There is also the same complaint of "salty spots" in the fields, which seems in all cases to arise from the stagnation of the water where the gray, lignito-gypseous clays (¶214, ff.), which, among others, we observe in the gullies, and in the railroad cut at Clinton, are near the surface.

In this case, the water abstracts from them their salts, and evaporating on the surface, deposits them there, to the detriment of vegetation, which is "scalded" by their excess, although essentially, they contain the nutritive ingredients of plants in great abundance.

Nothing short of thorough-drainage can be expected to remedy permanently, this evil where it exists; it will no doubt, in the course of a few years, by itself remove every injurious excess of salts, leaving behind only those which are useful, and are therefore retained by the soil (¶378). The composition of the salts thus effervescing on the surface shows, however, that their injurious action can to a great extent be counteracted by the application of *lime*, or *marl*, or of *ashes*; and the use of these remedies even where thorough-drainage is at once resorted to, because they will aid in retaining in the soil, the nutritive portion of these salts.

An analysis of the latter, from a salty spot in Dr. Catching's field (¶725), showed it to consist chiefly of the *Chlorides* of *Sodium* (common salt) and *Magnesium*, with the *Sulphates* of *Potassa*, *Lime*, *Magnesia*, *Alumina*, and *Iron*.

The latter three, which are very prejudicial to vegetation, will be at once decomposed by *lime*, or *marl*. It cannot decompose the common salt, however, which must be removed by drainage—a moderate amount of the latter substance, however, is often purposely added to the soil, which it stimulates (¶435).

In another instance, a specimen of salts from a salty spot in Squire Batt's field, four and a half miles east of Brandon, gave the following result: *Chloride* of *Sodium* (common salt), *Sulphates* of *Magnesia* (Epsom Salt), Iron (Copperas), Alumnia (Alum); *Nitrate* of *Magnesia?* quite largely. Here, also, the remedies are evidently the same; the formation of saltpetre proves more strongly the stagnation of water, and the necessity of drainage. The lands so treated will afterwards, no doubt, prove of remarkable fertility: as in some instances has already been experienced.

731. Pearl River Soils.—The soils of Pearl River *hommock* have already been described, in general (¶662). Those of the portion of the river embraced within the Central Prairie Region do not exhibit any striking difference, as far as observed, save where, as near Jackson, the washings of the tertiary marls come down upon them, when they sometimes become quite stiff, though (as shown by the weeds growing on them), very fertile, and no doubt susceptible of great improvement by the use of the marls so accessible in the neighborhood (¶282). Like most hommock soils, it is very deficient in vegetable matter.

The soils of the bottom proper, where it exists, are usually light and sandy, often vieing, in that particular, with the Seacoast Hommocks (¶832, 850, ff.), and therefore somewhat drouthy.

The extensive sloughy bottom which skirts Pearl River on the west at, and for some distance above and below Jackson, exhibits a very singular soil, viz: a gray or yellowish, semi-indurate silt or hardpan, with but little coarse sand, which packs very closely, and approaches in character some of the heavy silicious soils mentioned (¶404). On roadsides, in washes, on the banks of sloughs, etc., it is seen disintegrated in rounded, nodular forms, like the Flatwoods Clay (¶165, ff.), and instinctively impresses the observer as though it were a very clayey soil; when wetted, however, it acts somewhat like the calcareous silt of the Southern River Counties (¶690), like which in times of drouth, it cracks open; becoming, however, of a stony hardness. Spots where this soil prevails characteristically, are almost exclusively timbered with small Sweet Gum.

Near the river banks, where the admixture of sand renders the material more open, these faults are to a great degree insensible, and the timber as well as the smaller growth testifies to the improvement. A great deal can no doubt be done for this soil by the simple admixture of sand, and also, of vegetable matter, in which it is very deficient; *the sandy marls occurring in the river banks* (¶205; 283), however, would undoubtedly be the most profitable material, improving the soil in many respects at once (¶417). As to the native fertility of this singular soil, analysis will show how far it can be improved by mere stimulation; its forest growth is fine, though sparse.

732. Rankin and Scott.—The portion of Rankin county lying S. of the line of the Vicksburg Group (see map) bears the character of the Long-leaf Pine Region, if we except the belt bordering on Pearl River, and the "Flatwoods" of lower Steen's Creek (¶772). In the N. portion of the county, however, we have a great diversity of fertile soils. In passing from Jackson to Brandon, after crossing the bottom and hommock of Pearl River, we ascend into a rolling, sandy country with a yellow loam soil underlaid by deeply tinted Orange Sand, and strongly suggestive of the second-rate ridge lands in Lafayette county. This belt is here about four miles in width, and skirts the hommock of Pearl River on the E., with a visible width, throughout Rankin, and a portion, at least, of Simpson county. It is timbered with Post, Spanish ("*Red*") and Black Jack Oak, and well settled, although the soil is rather sandy, and the loam stratum, here at least, is very thin; it is better developed, and forms large and fertile bodies of land, further S., on Steen's Creek, bordering the Pearl River Hommock.—It yields mostly freestone springs and wells.

733. Beyond, we find a more gently undulating country, possessing a thick covering (7 to 10 feet) of rich yellow loam, and a fine Oak and Hickory growth on the higher hills, while its depressions exhibit various soils formed out of the different strata of the Tertiary, which are given in detail in Sec. 30, p. 140. A glance at the great variety of materials mentioned in this profile, and their inconsiderable thickness, will readily explain the diversity of soils existing at different levels, on the hills and in the valleys which ascend and descend to all the various strata, at different points.

The lands which lie at and below the level of strata Nos. 2 to 4, are frequently of a "black prairie" character, and very productive—as, for instance, those lying at the foot of the ridge capped with white limestone and marls (¶224, 225). The soil, however, is not heavy—being simply the yellow loam of the hills which has been thoroughly marled in the course of time, by natural means. In view of the great productiveness of these lands, the fine effects observed by Mr. A. P. Miller, as following the artifical application of the same marls to his hill lands, cannot be surprising, and would no doubt have been greatly enhanced by the contemporaneous application of vegetable matter, in imitation of what nature has done in the valleys. A dressing of 200 to 400 bushels per acre, of marls similar to Dr. Quin's (¶285) has made the exhausted ridge soils produce as freely as when fresh, and after the lapse of twelve years, the effect still continues the same.

734. *Gypseous Prairies.*—Besides the two soils already referred to, two other chief varieties are found, *e. g.*, at Jos. Jayne's place, *viz :* a "prairie" soil (called so only because it bore no timber), appearing in depressions, which is quite light, of a brownish-buff tint, and produces finely ; and a pale, "crawfishy" soil, full of bog ore or black pebble (¶387), which is quite poor, though situated, with reference to the hills, precisely as is the "prairie" soil before mentioned.

The latter resembles closely, in its aspect, that of other, larger bodies of prairie existing further N., and especially that of "Barnes' Prairie", which skirts the Pearl River hommock in T. 7, R. 3 E. The surface soil of this tract, which is about 8 to 10 inches deep, is of a chocolate color when moist ; its subsoil, to the depth of about 4 feet, is a loam of yellowish buff tint ; neither soil nor subsoil are heavy, and the land is very productive ; its vegetation does not indicate any large amount of lime. Below 3 or 4 feet, however, the material becomes quite clayey, as may be observed in the bottom of washes ; and in digging cisterns, heavy gray clay with crystals of Gypsum is found.

Barnes' Prairie is very nearly on a level with the hommock of Pearl River, (¶663). Further inland (S.), we also find tracts of land destitute of timber, such as Hudnall's or Race Prairie, McRae's Prairie, etc., whose soil and vegetation at first sight greatly resemble that of Barnes' Prairie ; there being, however, this essential difference, that the soil does not produce well—it is drouthy, and —on McRae's Prairie, S. 17, T. 6, R. 4 E.—the spattering water during heavy rains seems at times to corrode the leaves of plants. Whitish efflorescences of salts sometimes appear in shallow washes ; in those of several feet depth we find (especially on Hudnall's Prairie, SS. 12, and 13, T. 6, R. 3 E.), heavy gray clays with abundant crystals of gypsum, the latter being sometimes observable in the subsoil at 15 to 18 inches. The soil of these prairies differing so essentially from that of the "black", "calcareous", or "shell" prairies, I shall distinguish them as the "*Gypseous prairies*" (¶215), according to their characteristic material. The following analyses will show some of the characteristics of these soils.

735. No. 187. SOIL OF GYPSEOUS PRAIRIE, from Mr. McRae's place, S. 17, T. 6, R. 4 E.

Depth: Eight inches.

Vegetation: Stunted Persimmon and Sumach (*Rhus copallina*), Grasses.

The air-dried soil, which is of a brownish-buff tint, and rather light, showed the following composition:

Insoluble Matter (as above)	82.558
Potash	0.339
Soda	0.023
Lime	0.432
Magnesia	0.513
Brown Oxide of Manganese	0.092
Peroxide of Iron	3.084
Alumina	7.424
Phosphoric Acid	0.076
Sulphuric Acid	0.058
Organic Matter and Water	5.322
	99.911

736. No. 301. UNDERLCAY OF GYPSEOUS PRAIRIE, from Hudnall's or Race Prairie, S. 12, T. 6, R. 3 E.

Depth: From 3 to 7 feet (as far as visible) below the surface.

Vegetation: Same as the preceeding.

A greenish gray, heavy clay, with numerous small white specks (of gypsum), and some round concretions of iron ore.

Dried at 400 deg. Fahr., it consisted of:

Insoluble Matter	67.027
Potash	0.518
Soda	0.414
Lime	5.695
Magnesia	1.233
Brown Oxide of Manganese	0.509
Peroxide of Iron	4.344
Alumina	10.751
Phosphoric Acid	?
Sulphuric Acid	5.751
Carbonic Acid	1.018
Organic Matter and Water	2.740
	100.000

737. According to the analysis, the surface soil, No. 187, is simply a poor soil, in which, although containing an adequate supply of Lime and Magnesia, the alkalies (Potash and Soda), as well as Phosphoric Acid, are sensibly deficient.

The underclay, No. 301, by itself, is rich in the alkalies, and other ingredients determined, but contains too much gypsum, and is too heavy, to form a safe soil. It disintegrates or "pulverizes" very readily, however, and washes into deep gullies. It is quite remarkable, that with a subsoil so clayey, and so rich in soluble ingredients, underlying it at so inconsiderable a depth, the surface soil should not only be quite light, but evidently very unretentive (¶401; 403), of the soluble salts contained in its subsoil—which it allows to be deposited partly on its surface, to the injury of the crops (¶734; see also, ¶730, ff.), partly to return to the clayey and retentive subsoil, which is evidently, also, responsible for the drouthiness of the land (¶514, ff.).

The means, therefore, which suggest themselves for the improvement of the Gypseous Prairies, are these: Firstly, when the heavy subsoil is as near to the surface as in Hudnall's and McRae's Prairies, *Drainage*, which will relieve the drouthiness (¶108), as well as the saltiness and corrosive action of the surface soil (¶734). Secondly, the light and unretentive soil may, no doubt, be greatly improved by the application to it, as a marl, of the *gypseous underclays*, such as No. 301, whose action would be greatly improved by the simultaneous use of some calcareous marl and vegetable matter. It would seem, and the natural growth of these prairies (among which there are numerous *leguminous* plants), appears to justify the expectation, that they would make better crops of red clover and field pea, than any other (¶436).

738[1] The patches of gypseous prairie are generally bordered by a low, but dense-topped growth of the Black Jack Oak. Further back, we find, undulating lands, with a rather lank, unpromising growth of Post, Black Jack and Spanish ("*Red*") Oak, mingled with Short-leaf Pine. In this land, although the surface soil is often white and ashy (being then occupied by huckleberry bushes, and very unproductive), the subsoil is generally a heavy, "joint" clay, of a pale yellowish gray tint, which is very intractable and drouthy, and under the usual alternations of wet and dry, often shrinks and cracks to such an extent as to seriously impair the security of buildings (¶727, note).

738[2]. Interspersed with these uplands and the gypseous prairies, there occur patches of true, black prairie soil, on hilltops and hillsides. It is a fine, productive soil, but drouthy and exceedingly hard to till; its subsoil at 10 to 12 inches, is a stiff yellow clay.

No shells are found on this soil, which is evidently formed by outcrops of stratum (No. 5 of Section 29, (¶215), and bears a vigorous growth of Black Jack and Post Oak, with an undergrowth of Wild Plum, Red Haw, etc. (¶296). Where this soil occurs low down on the hillsides, it is often of great depth, and almost jet black; bearing, at the present time, a dense growth of young *Sweet Gum*, with some Cherry, Ash, Mulberry, Muscadine, etc. These spots are generally quite limited in extent; one, not exceeding half an acre, occurs near Mr. John C. Parker's, not far from McRae's prairie (¶734), on S. 20, T. 6, R. 4 E., Rankin county; another extends along the bottom of the Okahay, in Smith county, at Mr. L. E. Cock's place; on S. 22, T. 3, R. 7 E., and on adjoining ones. Here also, it adjoins a soil closely resembling the gypseous prairie of Rankin; which is to a great extent overgrown with small, scrubby Post, Black Jack and Water Oaks, and some Red Elm, and produces fine corn, but invariably rusts cotton—as also does the black soil mentioned. In both, efflorescences of salts are sometimes observed on the surface. At Mr. Crock's, also, we find some black prairie, and a heavy clay soil, on the hills; the latter is here, however, of a dark orange tint, and very productive, though somewhat stiff and drouthy—a fault which could, no doubt, be greatly alleviated by the admixture of vegetable matter—green cropping or the like, in which alone it seems to differ from the black prairie.

739. *Do Gypseous Clay Soils Rust Cotton?*—From what I have heard, and the close correspondence of the great variety of soils at the two points mentioned, it appears that lands of a similarly diversified character occur throughout Rankin and Smith, and probably also in Jasper, near to the line, as given on the map, between the Vicksburg and Jackson Groups (¶215, 216); in Rankin, especially, S. of the Peelahatchie. In the absence, thus far, of further analyses of these soils, it would be unprofitable at present to dwell upon them; from their extreme characters, it seems likely

that analysis will at once throw light upon their proper treatment; the region in which they occur deserves, and will receive as soon as possible, a detailed examination. So much appears with great likelihood from observations I have made in this region, that while cotton will succeed finely even in very heavy soils which are simply *calcareous* (*i. e.* contain the *carbonate* of lime) and contain an adequate amount of vegetable matter, the presence of *gypsum* in heavy soils seems to prove fatal to its growth. Hence the distinction between the *gypseous* and the *calcareous* or black prairie, acquires considerable practical interest, and planters have it in their power to promote greatly the investigation of this important subject, by paying attention to this point and noting the results.

740. With the portion of Rankin lying N. of the Pcelahatchie, I am but little acquainted as yet. It seems that prairies resembling in part "Barnes' Prairie" (¶734), partly the black prairie of S. Scott, occur interspersed with hilly uplands which are mostly sandy, and timbered with a mixture of Oaks and Short-leaf Pine. Such, at least, is the case in T. 7, R. 3 E., and adjoining region.

741. The undulating oak uplands with yellow loam subsoil—interspersed, in the depressions, with patches of black (in the bottoms) and perhaps some gypseous prairie—which have been spoken of as occurring near Brandon (which itself is situated on a sandy ridge), and whose soil is so essentially improved by the use of the white marls of the region (¶733 : 285), seem to continue with little change, in the *southern* half (¶739), of the belt of Vicksburg strata (bluish-gray on the map), towards Polkville, and beyond. This tract I have not as yet visited ; it is described as being a rich agricultural region, and its marls will, it is to be hoped, receive timely attention (¶284).

Of Scott county, N. of Morton, I have as yet no personal knowledge. From specimens and information, received, both kinds of prairie seem to exist there, especially in the western portion (¶207).

The "Flatwoods" of some portions of E. Scott seem, according to descriptions given, to coincide in the main, with the "hog-wallow prairie" uplands of Smith and Jasper (¶746, ff.).

742. In S. Scott, on the head-waters of Leaf and Strong Rivers, we find patches and strips of black prairie, along the valleys and water-courses, whose bottoms possess to a great extent, the genuine prairie soil; the intervening ridge lands having a moderately fertile loam soil, are generally but gently undulating, and bear a growth of the usual upland oaks, mixed sometimes with Hickory, sometimes with Scarlet ("*Spanish*") Oak, or Short-leaf Pine, according to the quality of the soil. It is here, as well as in N. E. Smith, that the benefit of the intermixture of the sandy hill soils with the heavy prairie soil (¶419), is very commonly experienced. The latter, however, is not always heavy naturally, but sometimes quite mellow and easily tilled, and always very productive of corn—usually, also, of cotton. It seems, however, that wherever the heavy, bluish or yellowish matrix of the Zeuglodon bones (¶207, 208), is so close to the surface as to touch the plow, the cotton frequently shows a disposition to rust—as it invariably does, and very badly, where that material

forms the soil itself, and contains small grains of gypsum. In this case, the hills immediately bordering on the prairie sometimes show a very heavy, pale yellow subsoil, resembling that found near the gypseous prairies, and forming an evident transition towards the "hog-wallow prairie". Such is the case, for instance, at several points in the Nichols' neighborhood, Smith county (¶207).

743. SMITH AND JASPER.—The town of Raleigh, like Brandon, is situated on a ridge which forms the last spur, as it were, of the Long-leaf Pine Region, at this point. As we pass from Raleigh on the Garlandsville road, the soft white sandstone (of the Grand Gulf Group—(¶227, 243), which near the town forms terraces at the foot of the hills, seems to ascend, and finally occupies the hilltops; and on descending from the ridge to Shongalo bottom, we find low down on the hillside, outcrops of limestone (¶312), accompanied by prairie soil. The bottom of Shongalo Creek (on which, further above, at Austin's mill, marl crops out) though not of a prairie character, shows the increasing liminess of the soil in the prevalence of Mulberry, Ash and Poplar. Near the summit of the dividing ridge between Shongalo and Bowland's Creek, there is a terrace formed by limestone ledges, on and below which, for some distance, we see a deep orange-colored, clayey subsoil, containing rounded ferruginous concretions, (as does the Monroe prairie soil—¶336), with a thin covering of black prairie soil; while the summit of the ridge is formed by narrow and very sandy strips, (Orange Sand), perched on top of the limestone plateau.—This "ridge prairie soil" seems to be very fertile, but I have not seen it in cultivation anywhere; it is very stiff, but not more so than many others. The oak lands which form the lower portion of this ridge, and of themselves are by no means infertile, might readily be improved by the marls of which the body of this ridge evidently consists.

744. Similar oak lands intervene here, as well as further above, between Leaf River and its western confluents; on the E. side, however, we find, at this point, Long leaf Pine Hills, until we reach the Nichols' neighborhood (see above) The bottom of Leaf River here exhibits no prairie soil proper, but a growth indicating a calcareous and very fertile soil—which, however, is subject to overflow. Higher up, in TT. 4 and 5, R. 8 E., (on the territory of the Jackson Group), Leaf River and its heads (Hatchushe, Tallabogue, etc.), have black prairie soil in the bottoms and on the slopes towards the same. I subjoin an analysis of a specimen of this soil, which is very productive both of cotton and corn.

No. 199. LEAF RIVER PRAIRIE SOIL, taken at the crossing of the Paulding and Brandon road, in T. 4, R. 8 E., Jasper county.

Depth: Twelve inches.

Vegetation: Honey Locust, Crab Apple, Wild Plum, Red Haw.

A very clayey soil, almost jet black, crumbling readily on exposure, after wetting.

The soil, saturated with moisture at 70.7 deg. Fahr., lost 14.325 per cent. of moisture at 400 deg., dried at which temperature, it consisted of:

Insoluble Matter	63.435
Potash	0.796
Soda	0.127
Lime	1.815
Magnesia	1.112
Brown Oxide of Manganese	0.479
Peroxide of Iron	6.996
Alumina	16.127
Phosphoric Acid	0.232
Sulphuric Acid	0.085
Organic Matter, Water, and Loss	9.028
	100.000

745. This analysis seems to exhibit characteristically the prominent features of the black prairie soil of the Tertiary.

It is highly retentive of moisture; rich in vegetable matter, in lime, and in all the other essential nutritive ingredients of plants—with the exception, in this instance, of Soda, which seems to be deficient. The large amount of alumnia dissolved in this analysis, as compared with those of other clayey soils, indicates at once that the soil is in a highly decomposed state, in consequence of the action of lime and vegetable matter, and that therefore the constituents are mostly in an available condition. Hence little effect would be produced on it by marling, unless previously exhausted; but the further addition of vegetable matter and of sand, to promote its lightness—as well as drainage, are indicated as improvements.

746. Hog Wallow Prairie Region.—Beyond Leaf River, in Smith county, and in N. W. Jasper, on the (light blue) territory of Jackson Group, the arrangement of soils is a very simple and uniform one. The bottoms of the larger streams—Hatchushe, West Tallahala, Tallahoma, East Tallahala, and their larger confluents—as well as the lower portion of the (sometimes gentle) slopes towards them, are prevalently of the black prairie character. Above these, forming level or gently undulating upland tracts—or sometimes, as on the West Tallahala, a kind of second bottom—appears the "Hog-wallow", or "Hogbed Prairie" soil (¶216), timbered chiefly with Post Oak, of a lank growth and with tattered, open tops; Black Jack and Short-Leaf Pine, of a similar growth, often occupying it. The average level of the lands of this character is about twenty-five to thirty feet above the level of the creeks named; when the country ascends higher (in which case the "hog-bed" lands generally form a distinct, level terrace, on which the sandy ridges are perched), the Orange Sand formation and its usual soils set in, forming either Long-leaf Pine ridges, or (as on the Upper Tallahoma), the sandy ridge soils mentioned (¶651); or sometimes, oak uplands, with a medium soil, of yellow loam character (as on upper Leaf River, towards the prairies). According to the depth to which the drainage cuts into the surface occupied by the soils last named, either the "hogbed", or the "black prairie" soil appears on the slope; and where level tracts are occupied by the hogbed soil, at an inconsiderable elevation above the bottoms (as on the W. Tallahala in the N. E. quarter of T. 3, R. 10 E., and adjoining tracts), small spots of black prairie often appear in slight depressions.

747. The surface soil of the Hogbed or Post Oak Prairie is generally of a gray or brownish-gray tint, with numerous small dark brown dots of bog ore (¶387), to the depth of six to ten inches, where it is underlaid by a yellowish subsoil with reddish dots. Both the soil and subsoil are very heavy and clayey ; in dry seasons they shrink so as to form numerous, and often large (one to three inches wide) cracks in the surface. The next rain causes the edges of these cracks to crumble off into the latter, which in consequence cannot close up afterwards, when the soil receives a thorough wetting. The intervening soil is therefore often compelled to bulge upwards, and this, together with the crack, widened by washing and crumbling, imparts to the tracts occupied by this soil, the uneven surface to which they seem to owe their popular name.

The extreme "hog-bed" soil, where thus cracked in dry seasons, acquires an almost stony hardness, and cuts with a shining surface ; and a tract plowed in that condition, resembles very much a field of brick-bats. On the other hand, when plowed a little too wet, the result is scarcely better ; hence it is thus far, a very unsafe soil, on which it is exceedingly difficult to obtain a stand of any crop in extreme seasons. It is very inferior for corn, but will produce good crops of cotton when the season is favorable—the stalk being small, but well bolled ; the bolls open late. Owing to these difficulties in cultivation, and also to the *great scarcity of water* in the "Hog-bed Prairie" districts, they are but very thinly settled.

748. That the latter inconvenience can, almost beyond a doubt, be obviated by *bored wells*, I have already stated (¶324, ff.). As to the improvement of the soil itself, all that has been said in general concerning the treatment of heavy soils (¶402[1] , ff.) is applicable to it ; while as to the question of its native fertility, the following analysis gives some light.

No. 242. Hog-wallow Prairie Soil, from the level region east of West Tallahala, about three miles from the stream on the Raleigh and Garlandsville road, N. E. quarter T. 3, 10 E., Smith county.

Depth : Six inches.

Vegetation : Slender Post Oak with tattered tops ; Short-leaf Pine, and here and there a Spanish ("*Red*") Oak.

A very heavy clay soil, brownish gray, with minute dark brown dots of bog ore.

The air-dried soil lost 6.833 per cent. of water at 400 deg. Fahr., dried at which temperature it consisted of :

Insoluble Matter	76.758
Potash	0.525
Soda	0.190
Lime	0.424
Magnesia	0.674
Brown Oxide of Manganese	0.559
Peroxide of Iron	4.121*
Alumina	10.059
Phosphoric Acid	0.063
Sulphuric Acid	0.059
Organic Matter and Water	5.733
	99.100

749. This analysis represents the poorest of this class of soils, which in com-

*This amount is too small, an accident having happened in its determination —to which, also, the large aggregate loss (0.900) is owing.

position would seem to rank as of medium fertility. The region in which it was taken, is a continuation of the low, level hommock of the West Tallahala, which, nearer to the stream, possesses a pale, ashy soil, with a heavy clay subsoil. Where the "Post Oak Prairie" occurs at a higher level, as in the country dividing the E Tallahala and Tallahoma, on the Paulding and Montrose road, the timber is more vigorous, and the soil of a more yellowish tint. The composition of the soil analyzed approaches very closely to that of the underclay of the Monroe Prairie (¶518, ff), save in that it contains only half the amount of lime; it is almost entirely *deficient in vegetable matter*, which accounts for its want of thriftiness. The addition of the latter is probably, next to drainage (¶410), and deep tillage (¶503), the most essential condition of the reclamation of the "hog-bed" soil for profitable culture; and the use of the calcareous marls of the region (¶288), would no doubt, also be found a great improvement, since it essentially requires stimulation. It is deficient in Phosphoric Acid, which might be given it as bones, or superphosphate (¶433); plaster, also, would probably prove of essential benefit.

750. The wide bottom of the West Tallahala, in the region where the specimen of "Hog-wallow" soil was taken, possesses a heavy "black prairie" soil, timbered almost exclusively with the Chestnut White or Basket Oak; of great depth, and probably of exceeding fertility for corn at least; it has, however, scarcely been tested as yet, in consequence, it is said, of the unhealthiness of the region, but probably equally as much on account of the absence of water, the Tallahala not having water even in pools for several months. As there can now be little doubt that even *artesian* bores would succeed in this region (¶325), it is to be hoped that these rich lands will not long remain unoccupied.

It is on the whole but rarely that, in the region mentioned, the "hog-bed" soil is not found to a limited extent at least, intervening between the sandy ridge soils and the bottom prairies. On the upper Tallahoma, in T. 4, and N. E. corner of T. 3, R. 11 E., as also on Arehusa and Quatalya Creeks in N. ½ T. 4, R. 10 E., the hog-bed soil is but thinly represented, the sandy hills sloping down at once into a black prairie bottom; and the same is the case as, in West Jasper, we approach the line of the Vicksburg Group (see map). This portion of the county I have not personally visited, but according to the best accounts I have, the sandy Long-leaf Pine ridges are there interspersed with strips of black prairie along the streams; which in its intermixture with the sandy hill soil, forms small bodies of very fertile land.

751. East Jasper I have not visited: it is said to correspond closely, on the whole in its agricultural features to the western portion at the corresponding points of the formations, so that a general similarity of character is found in a N. W. and S. E. direction (see map).

On both sides of the Paulding ridge (¶651, ff.), the lands are, for a mile or two, of the yellow loam character, until we descend to the level, first of the "hog-wallow", and then of the "black" prairie. Near Garlandsville, on the extreme heads of the Suanlovey and East Tallahala (¶288), there is quite an extensive tract of calcareous prairie, both of the "black" and "bald" character; which is here, as in S. E. Mississippi generally, termed "shell prairie" in contradistinction to the "Post Oak" or "Hog-wallow" prairie. In the bottom of the Suanlovey, there are sometimes, where the upland prairie approaches the creek closely, tracts of a few hundred acres, of jet black prairie soil, two to three feet deep, and characterized by a growth of large Sweet Gum, Ash, Elm, Cottonwood, Maple and Water Oak; which, though no doubt profusely fertile, has hardly been tested yet. The upland prairies, also, are much praised; it is said that on the bald prairies, where the white "shell rock" (¶208), is near the surface, cotton "rusts"; this is, no doubt, to be considered as having received an overdressing of marl, and its defects will be remedied in a like manner (¶460)—simply, perhaps, by turning down a green crop. The uplands on which Garlandsville is situated, have mostly a sandy soil, timbered chiefly with Post Oak and Pine (Long- and Short-leaf); in places, however, it has a good loam foundation, and other Oaks, with Hickory, set in. The higher ridges possess a soil similar to that of the Tallahoma ridges (¶651). No prairies seem to occur north of Garlandsville.

752. Clarke and Wayne.—The northern portion of Clarke county, outside of the limits of the Jackson Group (see map), and especially east of the Chickasawhay, bears essentially the character of the Long-leaf Pine Region, so far as I have seen; differing little, in this respect, from the adjoining portions of Lauderdale (¶650). In T. 4, R. 16 E., the detritus of the chert, sandstones and claystones of the Silicious Claiborne Group (¶189, 190[1]), is often largely diffused through the soil, without influencing in any sensible degree its producing powers. Occasionally, also, we find tracts possessing a pretty good loam foundation, with a growth of upland Oaks, Black Gum and Short-leaf Pine (¶649).

The bottoms are not very wide, possess light soils, on which the Star Anise ("Stinking Bush"—*Illicium Floridanum*), and the Calico Bush, or Sheep Laurel (*Kalmia latifolia*) are abundant. A few miles north-west of Quitman we see one of those sandy ponds or marshes, which further south become so abundant, covered with a sward of long grass, and a thick undergrowth of the Candleberry or Myrtle (*Myrica Carolinensis*) and Bay (*Magnolia glauca*). Within about four and a half miles of Quitman on the Enterprise road, there is a tract of Pine Hills not differing very obviously in its timber from the rest, but possessing, under ten to twelve inches of ashy soil, a deep orange-colored subsoil, which is quite heavy, and if turned up would no doubt greatly improve the soil for cultivation; the marls of the Quitman neighborhood would, also, in this case, be freely used.

753. The Chickasawhay River in N. Clarke rarely shows much first bottom; its banks are generally high and steep, breaking off from a level hommock, whose total width varies from one to two miles, and sometimes more; it is generally timbered, prevalently, with Oaks, especially White Oak, mixed variously with Black Oak, Sweet Gum, Cherry, Hickory, some Bottom Pine (*P. taeda*), and Bottom White Pine. The soils, as may be supposed, are prevalently light (¶342), but produce well—in favorable seasons, as much as a bale per acre may be raised; as for instance, near Quitman, where the soil is somewhat heavier than usual, and when plowed wet will readily pulverize on drying. The gray soil generally possesses, at the depth of ten to fifteen inches, a good yellow loam subsoil, which is underlaid by loose sand at some three to four feet, and is therefore well drained; deep plowing and the copious use of the marls of the region (¶289, ff.), will sustain these soils for a long time.

754. Southward of Quitman, we again find Pine Hills with an inferior soil; the presence of the marls (which frequently crop out in the streams—¶290), being recognized only by the growth of "Poplar", Crab Apple, etc., on the lower hillsides and ravines. This aspect of the country continues with little change until, on the S. side of Coonupy Creek, we enter upon the prairies of the territory of the Jackson Group (¶196; 209, ff.).

The prairies which form plateaux or level ridges between the water courses, possess some peculiar features. The smaller portion only is really bare of timber, with only occasional clumps of Crab Apple and Honey Locust; their soil is usually much lighter than the soil timbered chiefly with sturdy Post Oak and Short-leaf Pine, thickly hung with Long Moss, and accompanied by an undergrowth of Crab Apple, Wild Plum, etc., which forms the greater part of the tract. It is a very heavy soil, producing, in rainy times, a fearfully tenacious mud; the black surface soil is 6 to 12 inches deep, then comes an equally heavy deep orange-tinted subsoil; and beneath this, at variable depths (3 to 10 feet), white, and generally clayey marls, resembling those of the McNutt Hills (¶282).

Both kinds of soil produce finely, but that of the open prairie is safer and more easily tilled. The other seems to stand intermediate, as it were, between the true black prairie soil and that of the "Hog-wallow" prairie, into the latter of which, further S., it shows a gradual transition. The sandy marls of Suck Creek and Trotter's plantation (¶210, ff.). would, no doubt, be found a great improvement on this soil, and like that of Garland's Creek (¶210; 292), are to be considered a *general* manure, applicable to almost all soils.

In the absence, thus far, of a more special investigation of the properties of these soils, I refer the agricultural reader, for the present, to what has been said concerning the treatment of heavy soils in general (¶402[1]), and of the Monroe Prairie soil (¶549, ff.). in particular. The main body of these lands lies S. of Garland's Creek, Gen. Trotter's plantation (¶211) being near its southern limit; another body or succession of patches, however, extends eastward between Coonupy and Garland's Creek, for a considerable distance. With the lands lying W. of the Chickasawhay, I am not personally acquainted; they are said to correspond in general, in a N. W. and S. E. direction, to those on the E. side; although there is less prairie.

755. On the slope towards the Chickasawhay, near Trotter's plantation, there generally is near the hilltops a terrace of about 6 to 10 feet, above the prairie soil proper; on this we find red claystone with fossils (¶212), and a heavy soil resembling the "Hog-bed" soil, timbered with lank Post Oak and Short-leaf Pine, Black Gum, and occasionally some Hickory; it forms a level terrace, elevated 70 to 80 feet above the river, into which it falls off in steep bluffs (¶212). A belt of this land, 2 to 3 miles wide, intervenes between the prairies of S. Clarke, just described, and the hilly but in part very fertile country of the territory of the Vicksburg Group (see map), in Wayne county, which is interspersed with small patches of upland prairie, especially in its southern portion; and also possesses a variety of productive "mulatto" and "hommock" soils, resulting from the intermixture of the calcareous materials with the light surface soils, which by themselves alone, on the *tops* of the ridges, are indifferent, or absolutely poor. Hence the hommock of the Chickasawhay, and the slopes of the ridges towards the same, are very fine and safe soils, especially for cotton; and the same is true of the bottoms, hommocks and hillsides on the smaller streams, both E. and W. of the Chickasawhay; and the abundance of fine marls found in this region (¶229; 294, ff.), insures the continuance of their productiveness. The fertile hommock terminates, however, in the latitude of Waynesboro', near Dr. E. A. Miller's (¶229). Thence southward both the river hommock and the uplands assume the character of the Long-leaf Pine Region, as will be noticed hereafter. On the Buckatunna, which I have not personally visited, the condition of things, at corresponding points, seems to be the same as on the Chickasawhay.

756. WATERS OF THE CENTRAL PRAIRIE REGION.—The generalities given in the Geological Report (¶319 to 325), in regard to the waters of the formations occupying this region, are sufficiently expressive of the fact, that on the whole it is, thus far, but poorly supplied with that essential fluid, except where sand ridges exist. Natural springs are scarce or wanting; the water (when any is obtained) of dug wells of moderate depth, is very generally mineral, and either—as at Canton—undrinkable—or at least, too strong for daily use; such being especially the case where, instead of being simply limy, the water is derived partly or wholly from lignitic clay strata, which impart to it magnesian salts—the constant and daily use of which, is, of course, highly debilitating and

injurious to health. It is not, therefore, without good reason that, so long as deep bored wells have only been attempted, cisterns should be so very generally in use.

Without entering into lengthy detail I can add but little to the generalities given in the place above quoted. On the territory of the Jackson Group (see map), *when there are no Orange Sand ridges* sufficiently extensive to furnish freestone wells, no water is generally obtained until we reach the underlying lignitic strata, whose waters are always more or less mineral and particularly, magnesian.

757. The undrinkable saline waters of shallow wells at Canton have already been noticed ; the city of Jackson, also furnishes a good example of the condition of things in this region. Cisterns are chiefly used, although water can be abundantly obtained in wells, especially in the western part of the town—there being, however, a great variety of composition. Thus, Mr. H. E. Sizers' well (100 feet deep) is a chalybeate (containing Bicarbonate of Iron) with but a small amount of Chloride of Magnesium and a little Common Salt ; very little Lime, no Sulphates ; some odorous bituminous matter.

A well at Mrs. Nichols' residence, West Jackson, yields strong sulphur water.

A singular trio of wells is situated on the property of Capt. A. Mizell, in the hommock of Dry Creek. One of these, which has already achieved for itself some reputation, and has become a favorite resort for the inhabitants of Jackson and neighborhood, is 23 feet deep, the water being obtained in a bed of marl (No's 4 and 5 of Sec. 27, p. 131) ; it is of great strength, and the qualitative analysis (first made by Prof. Riddell) gave the following result :

Bicarbonate of *Lime* and *Magnesia*, largely.
The *Sulphates* and *Chlorides* (seemingly in about equal proportions) of
Magnesia, largely.
Potash, "
Lime,
Soda.

(The bases being named in the apparent order of their prevalence). Besides these, there are small quantities of

Silica,
Free Carbonic Acid.

The other well (of the same depth, and about 40 yards distant from the first), whose water was obtained below the shell-bed, in bluish sandy clay (No. 3 of the section quoted above) contains the *Sulphates* of

Alumina,
Lime,
Magnesia,
Potash,
Soda,

And a smaller proportion of the *Chlorides*, probably of the latter four.

The water of this well is somewhat weaker than that of the first well, but nevertheless a strong astringent, and has an acid reaction ; while the former is purgative, and its reaction alkaline. When the two waters are mixed, they become turbid, the Alumina of the "Alum water" being precipitated.

A third well, dug about 60 yards from either of the former, found no water in the lignitic clays at 26 feet; freestone sipage-water, however, comes in from above, and the well exhales at its mouth a strong order resembling naphtha, or coal gas.

758. The waters of the Mississippi Springs* and of Cooper's Wells, though

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*The site of Cooper's Well, as given on the map, is in reality that of the *Mississippi Springs*. The Wells are situated two miles S. of the point given, on N. E. ¼ S. 35, T. 4, R. 2 W.

originating in the gray clays and sandstones of the Grand Gulf Group (¶230, ff.), may find their place here, where readers will expect to see them mentioned. The water of the Mississippi Springs, (which issue at the foot of a ridge composed of white and partly "rotten" sandstones—¶233; 241), are impregnated with Sulphuretted Hydrogen; they do not seem to contain much solid ingredient.

The principal one of Cooper's Wells (both situated, within 50 yards of each other, at the foot of a narrow, steep ridge composed of white sandstone alternating with semi-indurate, gray, sandy clay) a little over 100 feet deep, is dug chiefly in sandstones alternating with ledges of gray clay. The water, a very strong one (105 grains of solid matter per gallon), is a saline chalybeate, which according to Dr. Lawrence Smith's analysis (Wailes' Report, p. 295) contains as its chief ingredients the *Sulphates* of *Lime*, *Magnesia*, *Soda*, and *Alumina* (named in the order of their prevalence), with smaller amounts of the Chlorides of *Sodium*, *Calcium* and *Magnesium*; of *Peroxide* (and *Bicarbonate*) of *Iron*, *Silica*, *Crenate* of *Lime* and *Sulphate* of *Potash*; with some free *Carbonic Acid.*

The reputation of this water is already very extensive, and as a pleasant and healthful place of resort, Cooper's Wells vie with any in the Southwest.

The water of the other well is powerfully impregnated with Sulphuretted Hydrogen, being a "white Sulphur" water. Its fixed ingredients have not been investigated; it contains much less of these than the chalybeate well.

A few shallow wells at Jackson possess *freestone* water, or nearly so. In some (as in one dug by Capt. L. Julienne) no regular stream of water has been struck at 100 feet and more.

759. The mineral waters of the Brandon neighborhood will be mentioned in connection with the Long-leaf Pine Region (¶797, ff.). Wells with saline and sometimes fetid waters occur more or less, in N. Rankin, Scott, N. Smith, and Jasper, as has been mentiond; but no prominent mineral water is known to me as occurring on the territory of the calcareous Tertiary, until we reach the waters of the Chickasawhay, where we find a number of minerial springs, partly saline, partly chalybeate and sulphureous; thus near Enterprise; in the bed of Suanlovey Creek, near Garlandsville, where there is a strong "white Sulphur" spring, yielding a copious supply of water, which may contain other important ingredients also; and about a mile S. of Quitman, Clarke county. The latter ("Smith's Spring") has attained some note in the neighborhood; a qualititative analysis (made by myself, in 1855) showed it to contain essentially the *Bicarbonates* and *Sulphates* of *Potash* and *Lime*, with small amounts of *Magnesia* and *Common Salt*. The water has a reddish tint, owing to some organic matter (Crenic Acid?) held in solution by the potash. It is slightly impregnated with *Sulphuretted Hydrogen.*

At Quitman (¶194), and on the territory of the calcareous Claiborne Group generally, shallow wells obtain water, more or less limy, in the tertiary sands and marls (¶190, ff.); as also, on the sand ridges, freestone water in the Orange Sand (¶75, ff.). The latter condition of things also obtains at Garlandsville, where excellent freestone water is obtained in wells on the sand ridge, before reaching the white marl or "prairie", as it is here called, which lies 35 to 40 feet beneath the surface (¶208).

THE LONG-LEAF PINE REGION.

EMBRACING MOST OF THE TERRITORY GIVEN ON THE MAP AS OCCUPIED BY THE GRAND GULF GROUP (¶230), LYING SOUTH OF THE "CENTRAL PRAIRIE REGION", (¶721 to 759), EAST OF THE "SOUTHERN RIVER COUNTIES", (¶674 to 720), AND NOT INCLUDED WITHIN THE "SEA-COAST COUNTIES" (¶804 ; 884).

760. Extensive as is the district circumscribed as above, it exhibits, nevertheless, a great uniformity of character both in its surface conformation, its soils, and its vegetation ; and its prominent traits may be briefly stated. The surface is generally undulating, not unfrequently hilly, especially where the uplands fall off towards the larger water-courses ; between these, however, we frequently find dividing plateaus or table-lands, which are but gently undulating or almost level—such being the case more especially where the Orange Sand formation, (which forms the surface of the whole region--¶77) is composed only of pervious sand with no water-shedding strata, in consequence of which, most of the rain-water sinks into the ground, instead of (as elsewhere) washing out deep valleys and ravines. The surface soil of the uplands is almost throughout, very sandy—partly pebbly or intermixed with coarse sand, or, more generally, a fine, grayish-white, "ashy" material, very silicious and unretentive. The depth of this soil varies, on the dividing plateaus of Simpson and S. Smith, for instance, from 10 to 18 inches, at which depth it is generally underlaid by a yellow sandy loam ; at times, when the land is very poor, by the strata of the Orange Sand directly.

761[1]. The prominent forest tree of the region is the Long-leaf Pine—(*Pinus australis* MICX, *P. palustris L.*), which near its borders, occupies only the higher ridges (¶648), but gradually descends until we find it on the very verge of the bottoms, although it very rarely occurs in the latter themselves. It is accompanied, in the uplands, by the Post Oak and Black Jack (either or both), and almost invariably, especially on the hillsides, by some Black Gum (*Nyssa multiflora*) ; also, most generally, by some Dogwood (*Cornus florida*).

761[2]. The frequency, size and shape of these concomitant trees (as well as, though less markedly, that of the Long-leaf Pine itself), mark the variations in the fertility of the sôil where, as in the most southerly portion of the region, the Short-leaf Pine (*Pinus rigida*) is absent. In its northern portion, however, the partial or entire replacement, on the ridges, of the Long-leaf Pine by the Short-leaved species, is the most common intimation of an improvement of the soil, which generally consists in the nearer approach to the surface, of the sandy loam subsoil before mentioned. In this case, simultaneously, the Black Jack and Post Oak increase in frequency and improve in aspect, and the Spanish ("*Red*") and Scarlet ("*Spanish*") Oaks also often appear ; and it is chiefly in patches of this character, which vary from a few acres to several sections in extent, that in the Long-leaf Pine Region, we find settlements of any extent in the uplands. Where the Long-leaf Pine alone prevails, the soil is generally so poor, that cultivation is altogether confined to the hillsides and bottoms.

762. The latter are generally very narrow (those of Leaf River, Okatoma and Okahay, in S. Smith for instance, rarely exceeding ¼ of a mile); on the larger streams, as on Pearl (¶653, ff.), Leaf and Pascagoula (¶806, ff.) Rivers, they are often skirted by hommocks of equal or greater width, inferior in fertility to the first bottom, but still in general superior to the Long-leaf Pine uplands. The soils both of the bottoms and hommocks are, of course, very light in general, the only exceptions known to me being the first bottoms of Pearl and Pascagoula Rivers, within the Sea-Coast Region (¶780; 809). The bottoms are productive, notwithstanding the great sandiness of their soil, because of the great depth to which the roots of plants can penetrate in the loose material; and the bottom soils of the streams which, like Strong River, the Okahay, Leaf River, the Tallahalas, etc., head in the Prairie region, are of very superior quality for some distance beyond the line of the formation (see map), being of a chocolate color and very light, and resembling not a little the Homochitto soils (¶701, ff.).

Among their timber, the Beech generally forms a very prominent ingredient; besides, the Magnolia (*M. grandiflora*) the Bottom Pine (*P. taeda*) and Black Gum are rarely wanting, the undergrowth being formed by Witch Hazel, Calico Bush (*Kalmia latifolia*), Star Anise (*Illicium floridanum?*) various species of Black Haw (*Viburnum*), Bay (*Magnolia glauca*), Bay Galls (*Laurus Carolinensis*), etc.

763. The herbaceous vegetation and undergrowth of the Long-leaf Pine Region is hardly less characteristic than the timber. Whenever the regular burning of the woods, such as practiced by the Indians, has not been superseded by the irregular and wasteful practice of the later settlers, the pine forest is almost destitute of shrubby undergrowth, and during the growing season appears like a park, whose long grass is often very beautifully interspersed with brilliantly tinted flowers.

The prevailing grasses are of the Brown Sedge tribe (*Andropogon, Erianthus*), and next to these the *Paniceae* (grasses resembling the Millet, *Paspalum, Panicum*) in numerous species; *Agrostis juncea* is highly characteristic; and so, in the more southerly portion, is the curious "Toothache Grass" (*Monocera aromatica*). Among the flowers there are conspicuous in Spring: *Ceanothus Americanus* ("New Jersey Tea"), *Tephrosia Virginica* ("Devils Shoe-string"—which in S. Mississippi rarely bears perfect flowers), *Phlox pilosa, Hedyotis purpurea, Rudbeckia hirta, Coreopsis lanceolata, Silene Virginica, Viola palmata, Delphinium exaltatum* (the bright blue Larkspur), *Penstemon pubescens*, and the beautiful *Malva Papaver*, whose flowers closely resemble those of the red Poppy of the gardens. Somewhat later, two small species of *Cassia* (*C. chamaecrista* and *nictitans*—sometimes called Sensitive Plant), *Lobelia glandulosa, puberula*, two species of "St. Andrew's Cross" (*Ascyrum crux Andreae*, and *stans*) the white Morning glory (*Ipomaea pandurata*) and a kind of wild Lettuce (*Hieracium Gronovii*; also *Pycnanthemum linifolium*, become very prominent. Thereafter, the autumnal flora consists of many plants of the Sunflower tribe (*Helianthus angustifolius, occidentalis; Chrysopsis sericea, mariana*, etc.); of the Golden Rods (*Solidago odora, altissima, leptocephala*), many species of *Aster* (among which *A. coneola* is characteristic); *Sericocarpus tortifolius, Diplopappus ericoides; Eupatorium rotundifolium* ("Wild Hoarhound"), *parviflorum*. Several species of *Liatris* (*L. odoratissima* ("Vanilla Plant"), *pycnostachya, gracilis, squarrosa, scariosa* ("Rattlesnakes Master"); *Gnaphalium margaritaceum*; and other *Compositae*. Numerous *Desmodia* and *Lespedezae*, among these especially, *Desm. Marilandicum* and *laevigatum; Lesp. Stuvei, capitata, violacea, hirta*. Of the Mint tribe, *Monarda punctata, Hyptis capitata, Pycnanthemum incanum* are prominent, while *Gerardia pedicularis* and *Herpestis nigrescens*. and sometimes *Gerardia purpurea*, represent the *Scrophularineae*. The further we advance southward, the more numerously, various species of Huckleberry and Whortleberry (*Vaccinium*), most of which flower early in spring, are represented among the undergrowth; and in the same manner the Gallberry (*Prinos glaber*) and Candleberry (*Myrica cerifera*) increase in frequency in a southward direction, until near the Sea-Coast, they become very abundant (¶821; 824, ff.; 831).

764. Where strata not very pervious to water underlie the soil at no great depth, wet places, terminating in little branchlets, which afterwards often sink into the sand, are often formed. In these "Pine hollows" we find a flora somewhat resembling that of the Pine Meadows of the Coast, such as the Candleberry (*Myrica cerifera*) Cord rush (*Eriocaulon decangulare, villosum*), the Yellow Star-grass (*Aletris aurea*), the *Xyris, Pinguicula*, Sundew (*Drosera brevifolia*), the *Mitreola sessilifolia, Rhexia ciliosa. Eryngium virgatum;* and in the southern portion, the Side-saddle Flower (*Sarracenia purpurea*), Pitcher-plant (*Sarr. variolaris*), and Gallberry (*Prinos glaber*). The wet, dark-colored soil, or muck, of these Pine hollows, is not unfrequently used for the improvement of lands; and where they are not too wet, the hollows themselves are cultivated by preference.

Such being, with a considerable degree of uniformity, the main features of the Long-leaf Pine Region, it becomes necessary, in describing it, to mention the exceptions rather than the rule. Several of the counties embraced within it, I have not as yet examined specially at any point, *e. g.*, Copiah, Jones and Perry; and in the rest, my explorations have thus far been by no means exhaustive. I shall not therefore, for the present, enter into detailed descriptions to any great extent, since without the corresponding analyses of soils, etc., these could not be of much practical import.

765[1]. As we advance westward from E. Marion county towards the Mississippi River, we observe, up to the dividing ridge between the Amite and Homochitto (¶681), a pretty regular increase, in clayeyness of the subsoil, and a nearer approach of it to the surface; keeping pace with a pretty steady improvement in the fertility of the uplands, and a gradual change of the forest growth as above described, to that of the Southern River Counties.

The Oaks become more frequent, and are joined by the Spanish ("*Red*"), Scarlet ("*Spanish*"), the (*true*) Red, and Black Oak, and some Hickory and Sweet Gum; while the Short-leaf Pine gradually becomes predominant over the Long-leaf, which, in E. Franklin appears only in belts or ridges, and a few miles W. of Meadville disappears altogether.

765[2] On the headwaters of the West Amite, in T. 5, R. 4 E., we find the uplands bearing a mixed growth as above described; the surface soil, which is still somewhat ashy, but of a pale yellow tint, is 6 to 8 inches deep; below it lies a good yellow loam (almost always containing some "black pebble"—¶387), which is sufficiently heavy to be improved by the admixture of sand, as has been experienced. Such land (*e. g.*, near the plantation of Jos. Coten, Esq.,) produces about 705 lbs. of seed-cotton per acre, and lasts pretty well. This region is remarkable for the frequent occurrence, both in uplands and bottoms, of white, "crawfishy" tracts; characterized as usual by a Huckleberry and Post Oak growth in the uplands, where it is very poor, the cotton running to weed without bolling. The white bottom soil, however, characterized by an admixture with the usual bottom growth of the region, of Bottom Pine and Water Oak, and the absence of the Magnolia, produces a small, but well bolled cotton stalk, but is entirely unsuited to corn, as is equally the case in the uplands. This land, of which considerable bodies are said to occur lower down the stream, certainly requires drainage in the first instance, and vegetable matter in the second; what may be its other necessities, analysis will probably show (¶660, ff.). The prevalent, chocolate-colored bottom soil of the Amite closely resembles that of the Homochitto (¶711, ff.) and is very productive.

766. Thence eastward to Summit, and from Summit towards Holmesville, the "Pine Hills" character becomes more and more predominant; the Hickory, the Short-leaf Pine, the Spanish ("*Red*") Oak become less frequent, and the country more hilly. At Summit, where a good deal of stout Post Oak, with occasionally a Spanish ("*Red*") and (*true*) Red Oak, still mingles with the Pine, the ashy surface soil is 7 to 9 inches deep. and beneath it lies a good (so far as its physical properties are concerned—¶510, ff.) yellow loam subsoil, several feet in thickness, resting on a sandy hardpan.

Analyses of the soil and subsoil of the pine uplands, taken at Summit, gave the following result:

No. 218. Pine Upland Soil, from Summit, Pike county.

Depth: Nine inches.

Vegetation: Long-leaf Pine; Post, Spanish ("*Red*"), and (*true*) Red Oaks.

Somewhat ashy; color yellowish-buff.

The soil, saturated with moisture at 69.1 deg. Fahr., lost 4.106 per cent. of water at 400 deg., dried at which temperature it consisted of:

Insoluble Matter (chiefly fine sand)	889.801
Potash	0.218
Soda	0.076
Lime	0 034
Magnesia	0.806
Brown Oxide of Manganese	0.072
Peroxide of Iron	2.402
Alumina	3.783
Phosphoric Acid	0.036
Sulphuric Acid	0.038
Organic Matter and Water	3.446
	100.202

767. No. 222. Pine Upland Subsoil, from Summit, Pike county.

Depth: Nine to twenty inches.

Vegetation: Same as preceding.

An orange-yellow, rather sandy loam.

The subsoil, saturated with moisture at 69,1 deg. Fahr., lost 10.0 per cent. of water at 400 deg., dried at which temperature it consisted of:

Insoluble Matter (clay and fine sand)	77.931
Potash	0.266
Soda	0.072
Lime	0.152
Magnesia	0.352
Brown Oxide of Manganese	0.091
Peroxide of Iron	5.456
Alumina	11 870
Phosphoric Acid	0.043
Sulphuric Acid	0.035
Water and Organic Matter	3.261
	99.934

768. These analyses show, 1st. That both the soil and subsoil are considerably below the average in native fertility, *i. e.*, the absolute amount of nutritive ingredients contained in them ; 2dly. That there is but a small difference in this respect, between the soil and subsoil ; being, neverthless, decidedly in favor of the subsoil, especially with regard to lime, in which the surface soil is unusually poor. There is one important difference, however, in the *retentiveness* of the two materials, the surface soil being defective in this particular, while the subsoil possesses the property in a degree somewhat unusual in materials of equal lightness.

These facts offer very important suggestions concerning the improvement of these soils. They show that *stimulant manures* (¶416), alone will be of little avail on this soil, which, being naturally poor, will require *nutritive manures* (*ib.*) to supply deficiency. They show that these manures will be but slightly retained in the surface soil, but powerfully so in the subsoil ; hence deep plowing and subsoiling (¶503), will be necessary in order not only to increase the retentiveness of the surface soil, but also to make the subsoil accessible to the roots—thereby diminishing, also, the liability to injury by drouth ; thus treated, the land will be susceptible of profitable improvement to any extent. Without deep plowing, the manure will, to a great extent, be carried beyond the reach of plants.

769. In stating, however, that stimulant manures by themselves will in general be of little avail on these soils, it is not meant to imply that the use of *limes*, and especially, of the *calcareous marls* of the State will not be highly advantageous. Lime, as has been stated, produces other important effects besides stimulation (¶438), which will be highly beneficial, especially in conjunction with the use of the natural fertilizer of the Long-leaf Pine Region—Pine straw (concerning the use of which, see below—¶790, ff.) ; and the marls contain other nutritive ingredients besides lime (¶444), which are very much needed in the "Pine Hills" soils. So far as the region immediately under consideration is concerned, the marl beds at Byram (¶223 ; 280), afford an excellent opportunity of obtaining a supply of that valuable fertilizer.

770. Between Summit and Holmesville, the Pine Hills are characterized by an abundant growth of the Black Jack among the Pine ; the soil being partly underlaid by the loam seen at Summit, in part directly by the reddish hardpan underlying the latter, which is in its turn underlaid by loose sand and pebbles, often causing deep washes on the slopes. At the foot of the hills, and in the hommock of the Bogue Chitto (½ to 1 mile wide), at Holmesville, we find a stratum of light, brownish yellow loam, 2 to 3 feet thick, which forms a fertile soil bearing a stout Oak and Hickory growth ; while in the lower hommock and bottom proper, there is a chocolate-colored, mellow soil, unchanged for a depth of some 2 feet, and of great fertility and durability ; whose timber may serve as an example, being the same as on the Tangipahoa, East fork of Amite, and the larger streams of this region generally ; to-wit : Magnolia, Sweet Gum, "Poplar", Sassafras, Shell-bark Hickory—all very large, stout trees ; some Beech, Horn-

beam, Ironwood, Black Sumach (*Rhus typhina*—"*Staghorn Sumach*"; here called "White Sumach", a name more generally given to the poisonous *Rhus venenata*, whose bark is really white), White, and Chestnut White Oaks and Holly.

771. Eastward of Holmesville, we still find in the Pine Hills, for several miles a good loam subsoil, resembling that on the Bogue Chitto, and near enough to the surface to be reached by the plow; especially wherever the Black Jack prevails—such land being selected for cultivation by preference (¶347[2]). But the nearer we approach Pearl River, the deeper becomes the ashy surface soil, and the narrower the bottoms of the creeks and branches—which, with the hillsides, are chiefly cultivated.

The same changes in general as just described in passing through Central Pike and Franklin counties, are said to occur to the northward and southward of that line in Amite, and in Lawrence and Jefferson; save that while North Pike, for instance, is quite hilly and broken, the southern portion of the county becomes less and less undulating, gradually passing into the level country bordering on the Louisiana lakes, and resembling that of middle Hancock (¶873, ff.). Amite county seems to be about equally divided, in its east and west halves, between Long-leaf Pine Hills and loam lands like those of West Franklin. Of E. Jefferson, W. Lawrence, and Copiah, I know but little from personal observation; but from what I have heard, changes of soil corresponding to those just described, occur there also, on the same meridian, or a little further east.

772. East of Pearl River, in the Long-leaf Pine Region proper, cultivation is thus far, with few exceptions, confined chiefly to the bottoms and second bottoms or hommock, whose greater or less width at present determines the availability of the region for agricultural purposes.

The Short-leaf Pine and Oak uplands intervening, in S. Hinds, between the Long-leaf Pine Hills of Copiah and the Prairie Region, have already been described (¶729, ff). Similarly we find, in S. Rankin, the Long-leaf Pine reaching only to within seven miles south of Brandon, the intermediate region being hilly, timbered with Short-leaf Pine, Post, Black Jack, Spanish ("*Red*") and Scarlet ("*Spanish*") Oaks, and of inferior fertility. On the waters of Steen's Creek, there is quite a variety of upland soils, resembling in part, those of S. Hinds (¶729), partly bearing a "Flatwoods" aspect (¶561, ff.), being immediately underlaid by, and formed of, the gray clays and sharp sandstones of the region (¶241). These "Flatwoods" are quite productive at some points, *e. g.*, on the main Steen's Creek, near Dr. H. C. Evans', at others, where they bear Huckleberry bushes, extremely poor. The hilly, sandy, yellow loam region intervening here between them and Pearl River hommock has already been referred to (¶732), and generalities concerning the hommock bottom lands of Pearl River have been given before (¶662, ff.). The "Pig Woods" of S. Rankin are generally but slightly undulating, and interspersed (as at Cato, and on Campbell's Creek generally), with patches of Short-leaf Pine (see above, ¶761[2]). The creek bottoms are narrow, but productive, and their light soil not liable to injury by wet.

773. Almost throughout Simpson county, which is covered with Long-leaf Pine from one end to the other, cultivation is at present restricted to creek and branch bottoms, and the lower hillsides; affording fertile, but (outside of Pearl and Strong River hommock), small bodies of land, somewhat inconveniently scattered for cultivation on the large scale. The hommock of Strong River (for it generally runs in a deep channel, and has little or no first bottom), not usually subject to overflow, is one to two miles wide, timbered

prevalently with Post Oak and Bottom Pine (*P. taeda*), with some Spanish ("*Red*"), Scarlet ("*Spanish*"), Black, and (*true*) Red Oaks, and Hickory. Its soil is generally light, gray, with pale yellow subsoil; it is peculiarly well adapted to sweet potatoes, but also yielding good average crops of cotton and corn.

The luxuriant growth of wet-meadow plants (*Xyris*, *Eryngium*, *Hydrocotyle*) in some of the fields of this flat shows a want of drainage, owing doubtless to the heavy gray clays ("Soap-stone"), which underlie, and crop out in the bank of the river near Westville and elsewhere (¶240). The soil of Strong River Hommock seems to improve as we approach Pearl River, the fertility of whose hommock near Georgetown, Talley's Ferry, and Rockport, has been mentioned (¶662).

774. On the Copiah side especially, the high hommock, timbered chiefly with upland Oaks, Bottom and Short-leaf Pine, Hickory, and Sweet Gum, often possesses a fine yellow loam subsoil, and has given rise to large plantations; its entire width, on both sides of the river, being from three and a half to four miles.

775. In the interior of the county, patches of Short-leaf Pine sometimes occur on the ridges (¶761[2]); in its eastern portion, as near Old Hickory, P. O., on the headwaters of Bowie, the Oaks and Hickory sometimes become quite prevalent among the Long-leaf Pine, forming moderately productive upland soils; while the bottoms are very fine, though at times (as on the Okachicama Chitto, and O. Iscatina, or "Big" and "Little Goodwater"), there are heavy silicious soils (¶401), requiring drainage, and destitute of vegetable matter.

776. Lower down on the Bowie, however, cultivation is again restricted almost entirely to the bottoms and hommock, which are of moderate extent, but very fertile; the residences being very generally in the hills adjoining. Mt. Carmel is surrounded by Long leaf Pine Woods; southward of the same, however, on the waters of White Sand Creek, in W. half T. 7, R. 19 W., we meet rather unexpectedly a tract of uplands several miles in extent, timbered to a considerable extent with Oaks, and possessing a subsoil of a deep orange red, sandy hardpan, which is several feet in thickness; the soil produces good cotton and very fine corn, and lasts well. How far this land extends to the westward, I am not aware; the dividing ridge between the Bowie White Sand posseses a very sandy soil. Lower down towards Pearl River, again, the creek bottoms only are cultivated, the uplands being Pine Hills possessing, in part, a good loam subsoil at a depth of eight to twelve inches.

777. In passing from Westville to Monticello, we find, on the ridges dividing Silver Creek from Crooked Creek (which otherwise bear the "Pine Hill" character), some "bald hilltops" covered with a growth of long grass and stunted Long-leaf Pine, whose soil can hardly be termed any thing else than a potter's clay, formed out of the materials of the Grand Gulf Group (¶230, ff.); and higher up still there appear ledges of whitish sandstone (¶238). As we advance southward, this clay stratum seems to descend from the top of the ridge, around which it forms a level terrace, to which we come down by rather an abrupt descent from the sandy hills, on the Monticello road. From this terrace, which bears the same stunted vegetation as the hilltops above mentioned, a gradual slope brings us down into the hommock of Pearl River (¶662), which opposite Monticello is about two miles wide, timbered with Bottom Pine, Sweet and Black Gum, Water and Willow Oak, Elm, etc. Its soil is productive, of a pale gray

tint, quite light, but possesses a heavier subsoil, which will retain manure; this again is underlaid, at fifteen to twenty-four inches from the surface, by a loose, whitish, sandy material with spots of bog ore, to which, in cultivating this soil, it will be important to prevent the plow from penetrating, since it could not thereafter sustain any improvement.

778. The soils of Pearl River flat below Monticello, are extremely variable (¶662). North of the mouth of Silver Creek they are generally underlaid, at depths varying from eighteen inches to six feet, by tenacious gray clay, which is seen in the beds of the branches. This condition of things frequently superinduces a great lack of drainage, and we find numerous wet, "crawfishy" spots and tracts, the surface soil being quite light, but its character variable on account of the drainage. It is best where it is underlaid by yellowish loam subsoil, and not by white bog ore materials.

Between Silver and Green's Creek, the drainage is less defective, and a good loam subsoil generally underlies, which even forms bluffs—*e g*., at the mouth of White Sand Creek. South of Green's Creek, the gray impervious clays again approach nearer to the surface, until, at Mr Barnes' place (¶299), they rise in high bluffs on the opposite bank of the river. The soil of the hommock is nevertheless very sandy, especially near the river, where it is most productive—and elevated, usually, about twenty feet above low water.

779. It seems that between Columbia and Monticello, the greater part of the flat is generally on the east side of the river, the hills sloping off into it rather gradually; while on the west side the ridges approach within a short distance from the bank, reaching it at Barnes' White Bluff (¶299). Lower down we find it two hundred to three hundred yards back, but then ascending very steeply, and forming, at the "Red Bluff" (¶301), the highest point, probably, within sight of Pearl River, in its whole course—at two hundred and fifty, but probably nearer three hundred. feet above the water, and affording a very extensive prospect over Marion and East Lawrence. At the foot of the deeply colored walls of the sand and pebble deposits, which form the upper portion of this bluff, there issue numerous springs, which, united into a lively creek, form a succession of cascades in a narrow channel excavated in the gray clays, on the densely wooded hillside, down to the river level; while on the summit, the Long-leaf Pine forest extends to the brink of the bluff. Taking all this, with the opportunity for fishing and boating afforded by the river, few spots in Mississippi unite as many natural elements for a pleasant summer residence or place of resort. A mineral spring, likewise, is said to exist in the neighborhood.

780. With the region between Barnes' and Columbia. I am not acquainted. Below Columbia, the soils of the hommock become still more sandy and sometimes acid, approaching in character those of Chickasawhay and Pascagoula in the same latitude (¶809), though generally more productive; they vary in belts running parallel to the tributaries (¶662), I have collected the soils of this region with considerable care and detail, but as yet none of them has been analyzed—the timber, above Spring Cottage P. O., generally consists of Bottom Pine, Water, Willow and Spanish ("*Red*") Oaks, and more or less Sweet Gum and Hickory, according to the quality of the lands.

The ridges forming Burnett's Bluff and others in that neighborhood throw the hommock and bottom, (which begins here, as also does the Live Oak), on the Louisiana side—as is mostly the case south of the base line; the dividing ridge between Pearl and Habolochitto, running quite close to the former stream.

The *first* bottom now becomes of considerable width; in the northern portion of T. 2, RR. 17 and 18 W., near Mr. Tate's, it is on the Mississippi side, about a mile wide; and its soil, like that of the Pascagoula in the same latitude (¶809), is quite heavy—timbered with a very large growth of Sweet Gum, Shell-bark Hickory, Water, Spanish ("*Red*"), Chestnut White and Black Oaks, Holly, Ironwood, Hornbeam, some Mulberry and Magnolia. A very productive soil not as difficult to till as its aspect would lead one to anticipate; but on account of its heaviness crops are often belated by the overflows.

The hills skirting the hommock at Spring Cottage P. O., (James Ford's), possess a sandy soil, somewhat resembling that of the Tallahala ridges (¶647, ff.), but here timbered with tall, graceful Willow Oaks, mixed with some Spanish ("*Red*") Black, and (*true*) Red Oaks, and Hickory. The soil is fertile but does not last long; it forms a very narrow belt along the Pine Hills of the interior, in which near this point the Short-leaf Pine (*P. rigida*), is seen for the last time, as we approach the coast.

South of Spring Cottage P. O., the Long-leaf Pine descends into the river hommock, and the uplands, though sometimes still interspersed with patches of loam soil, gradually approach in character the Pine Hills of the Bay St. Louis (¶866). About four miles north of Habolochitto bridge, there is a sudden descent, which at once brings us into the Pine flat of the coast (¶874, ff.).

781. We now return to East Simpson county (¶755). The soil of Okatoma Bottom, east of Old Hickory P. O., is light gray or white, powdery, with a subsoil still lighter, yet possessing a fine bottom growth. Its hommock, also, has a very light soil, but containing more vegetable matter, and quite productive.

Smith county, south of the line of the Vicksburg Group, as given on the map, is likewise entirely of the Pine Hill character. The country dividing the streams bears the character of plateaus or table-lands rather than of ridges, is not, on the whole, very hilly; but the soil is inferior, and cultivation confined chiefly to the bottoms, hommocks, and lower hillsides; though occasionally we find here, also, patches of Short-leaf Pine on the ridges, denoting a better soil—as is also the case where the Black Jack appears in force amid the Long-leaf Pine.

782. The soil specimens, of which analyses are given below, were taken on the level Pine lands dividing the Okatoma from Okahay, in the N. ½ of T. 10, R. 16 W., Smith county., and were selected with the special object of obtaining a fair average sample of soil and subsoil of these uplands.

No. 206. Pine Hill Soil, from N. ½ T. 10, R. 16 W., Smith county.

Depth: Five inches.

Vegetation: Chiefly Long-leaf Pine; some scattered Post Oak, Black Jack, and small Hickory.

An ashy soil, of a *pale buff* tint. The soil, saturated with moisture at 67.6 deg. Fahr., lost 2.484 per cent, of moisture at 400 deg. Fahr.; dried at which temperature, it consisted of:

Insoluble Matter (as above)	93.257
Potash	0.259
Soda	0.065
Lime	0.129
Magnesia	0.180
Brown Oxide of Manganese	0.146
Peroxide of Iron	1.251
Alumina	2.?56
Phosphoric Acid	0.030
Sulphuric Acid	0.024
Organic Matter and Water	2.330
	100.497

783. No. 212. PINE HILL SUBSOIL, from the same locality as the preceding.
Depth: Five to eleven inches.
Vegetation: Same as the preceding.
A *pale yellow*, sandy loam.—Not yet analyzed.

No. 209. PINE HILL UNDER-SUBSOIL, from same locality.
Depth: Eleven to eighteen inches.
Vegetation: Same as the preceding.
An *orange-colored* loam, heavier than the preceding.

The loam, saturated with moisture at 67.6 deg. Fahr., lost 7.691 per cent. of moisture at 400 deg.; dried at which temperature, it consisted of:

Insoluble Matter (clay and fine sand)	83.030
Potash	0.485
Soda	0.061
Lime	0.075
Magnesia	0.519
Brown Oxide of Manganese	0.153
Peroxide of Iron	4.145
Alumina	8.871
Phosphoric Acid	0.022
Sulphuric Acid	0.021
Water and Organic Matter	3.117
	100.497

784. These analyses show very important differences to exist between the surface soil and the underlying loam, the latter being not only calculated to improve the former in its physical properties (¶501, ff.), as shown by the larger amount of moisture which it absorbs, but also much richer in several of the important nutritive elements; so that, if at the surface, it would constitute a soil of average fertility. The stratum analyzed, it is true, lies mostly below the reach of the plow, but the subsoil proper (No. 212), is manifestly but the transition from the surface soil to the orange-colored loam, being intermediate in character.

Here also, therefore, deep plowing is indicated as the first step towards the improvement of these lands; it will increase not only the retentivenes, but also the native fertility of the soil, by mixing with it a more fertile subsoil. The chief deficiencies of the soil thus formed will be in phosphoric and sulphuric acids, and lime; also soda. Superphosphate of lime would seem, therefore, to be the manure specially indicated; but the soil, after being rendered retentive by the admixture of its subsoil, will bear almost any improvement, save that merely stimulant manures (¶416), will be of little avail on it.—The loam stratum being rarely more than 3 to 4 feet thick, and then underlaid by loose sands, the land may in general, be considered as being naturally under-drained. Where the Post Oak, Black Jack, and Hickory prevail to any extent, this loam may generally be expected to be within available distance of the surface; but where the Long-leaf Pine alone, with stunted Black Gum and Dogwood, is to be seen, the ashy surface soil (No. 206), generally extends to the depth of 12 to 18 inches, and is then often underlaid only by arid sand. Such soils will hardly pay for improvement on the large scale; they require to be "made" altogether, and in analogy to the sea-coast hommocks, this might perhaps be best done by the joint application of lime or marl, and vegetable matter, where (as near R. R. Stations) the value of the land is such as to render similar improvements practicable. It must be remembered, however, that in these cases, *nutritive manures* (¶416), alone can be relied on for permanent productiveness.

785. The bottom and second bottom of Okahay* in S. Smith, though narrow (rarely much exceeding ¼ mile) is very fertile, its soil differing considerably from that of Okatoma--though light, and with occasional white "crawfishy" spots, it is generally of a full brownish gray tint, and bears a heavy growth of White and Chestnut White Oak, with Beech, Hickory, Sweet Gum, Water Oak, Magnolia, etc. The soil is evidently influenced as yet by the prairie region in which the stream heads (¶738); and the same is true of Leaf River bottom near, and above Taylorsville, which possesses a growth similar to that of the Okahay, just mentioned; being from ½ to ¾ mile in width. These bottoms are, of course, subject to overflow, but the lightness of their soil prevents this from forming a serious obstacle to their cultivation. The "white soils" of the bottom are considered as being the best adapted to cotton.

The hommock of Leaf River, however, is far inferior in fertility to the first bottom. Near Kees' bridge, (S. 8, T. 1, R. 9 E.), it is elevated 3 to 4 feet above the latter, all on the W. side of the bottom, 1 to 1½ mile wide, perfectly level, and timbered almost exclusively with Long-leaf Pine and Hickory; its gray and somewhat ashy soil, (which does not change much down to 18 inches), yields fair crops for a few years, but then gives out entirely. It approaches in character to that of the hommock of the Chickasawhay and Pascagoula in Greene and Jackson counties (see below, and ¶804, ff.), and resembles them even in that the Gallberry (*Prinos glaber*), appears in dense patches in its low spots. It seems that on lower Leaf River, this flat or hommock gradually closes in upon the stream on both sides, as is the case with the Chickasawhay.

786. Of the counties of Jones and Perry, and the adjoining portions of Covington, Greene, and Marion, I know but little from personal observation--so far as I have seen, and according to all accounts I have received, the same general features as just recorded of Simpson and S. Smith—viz: the "Piny Woods"—prevail there also.

787. The soils of S. Wayne county, outside of the hommock of the Chickasawhay, resemble in general those of S. Smith; on the whole, perhaps, they contain rather more coarse sand, and the country is more level, sloping down gradually into the Chickasawhay hommock.

The only fertile spots in these level lands are the wet "ponds", overgrown with the Sweet Bay (*Magnolia glauca*) Calico Bush (*Kalmia latifolia*) Black Haw (*Viburnum—cassinoides*, and others) and shrubs of the Whortleberry tribe (*Vaccinium*, *Leucothoe*, etc.). These patches, however, are very small, and very wet.

The hommock proper of the Chickasawhay, above the mouth of the Buckatunna, is moderately fertile, and possesses a subsoil rendering it capable of good improvement; sometimes (as at Col. Sam. Powes', S. of Winchester, it is very sandy, so as to resemble and assume the growth of the soils of the Tallahoma ridges (¶647, ff.). I have been informed also, that on the dividing ridge between the two streams, there are upland soils of rather a clayey character, and producing good crops They are, perhaps, similar to those observed further S., to the eastward of Cross Roads P. O. (¶807) —The soil of Buckatunna bottom, near the R. R. bridge, is quite heavy, of a brownish-buff color for about ten inches; then becomes heavier, and of a paler tint. It is timbered with Sweet Gum and Short-leaf Pine.

The soil of the second bottom, elevated 2 to 3 feet above the first and quite extensive, is similar, somewhat lighter, with an admixture of Oaks and Elm to

*This stream is often, for brevity's sake, termed "Cohay" by the inhabitants —which name seems properly, however, to belong only to a western branch.

the Cotton growth; and though little settled at present, would seem very suitable for cultivation.

788. Below the Buckatunna, the soil of the Chickasawhay hommock (whose width varies from one to three miles) seems gradually to deteriorate, and is cultivated chiefly near the river banks, where it possesses a clay subsoil. The bottom proper is sometimes almost wanting, usually narrow; at some points (as at W. P. Averas', SS. 25, and 36, T. 5, R. 6 W., Greene county), there are tracts of high bottom land, with a mellow and very productive soil—corresponding, no doubt, to the "second bottom" near Mr. Davis' (¶809). Most of the bottom, however, is low and sloughy, with heavier soils; and it does not become very extensive until near and after the junction with Leaf River—*i. e.* on the Pascagoula. At and near Vernal P. O., Greene county, the high level, river hommock is of very inferior fertility, being little different from that of the "Pine Hills" further inland; the bottom proper is alone cultivated to any great extent. Not far below, the acid "Gallberry soil" (¶804), takes almost exclusive possession of the river terrace; aside from which, and the slopes descending to it, Greene county, like those adjoining it, is essentially covered with Pine Hills—valuable chiefly for their turpentine, and pine timber.

IMPROVEMENT OF THE SOILS OF THE LONG-LEAF PINE REGION.

789. The chief defects of the Long-leaf Pine soils, as demonstrated by analysis, have been mentioned in connection with the latter (¶766, ff; 782, ff.). We have seen that as a general thing, these soils are naturally poor in the nutritive ingredients of plants, and that, therefore, nutritive manures (¶416), must be relied on for their improvement, provided only that the subsoil be such as to give promise of *sustaining* that improvement (¶510, ff.). The question then arises, what are the materials most accessible to the inhabitants of the region, and what are their respective values?

790. Among these, in a practical point of view, PINE STRAW—the leaves of the Long-leaf Pine—deserves a prominent place, for the convenience with which it can be obtained in large quantities. A great difference of opinion exists, however, as to its value as a fertilizer; while some praise its effects exceedingly, others report having found it little better than useless, or even injurious. With a view to determining, in the first place, its intrinsic value as to the mineral ingredients it may furnish, the following analysis was made.

LONG-LEAF PINE STRAW, freshly fallen; collected, about the first of October 1858, on the dividing ridge between Okatoma and Okahay (¶782), T. 10, R. 16 W., Smith county.

The straw, carefully freed, by washing and beating, from adhering impurities, yielded 2½ per cent. of the air-dried substance, of white ash, yielding to water, besides alkalies, a good deal of *caustic lime.*

The analysis of the dry ash gave the following result:

		Without Carbonic Acid.
Silica, with a few grains of sand	61.071	65.242
Potash	5.118	5.530
Soda	0.390	0.416
Lime	13.004	13.860
Magnesia	4.886	5.208
Brown Oxide of Manganese	1.577	1.681
Peroxide of Iron	0.132	0.141
Alumina	4.299	4.539
Phosphoric Acid	1.083	1.154
Sulphuric Acid	0.839	0.894
Chloride of Potassium	1.388	1.479
Carbonic Acid	6.328	
	100.148	100.148

791. This analysis shows the Pine Straw to contain notable quantities of all the mineral ingredients required by useful crops, there being a remarkable deficiency only of Soda. The conclusion is therefore inevitable, that by means of Pine Straw properly applied, we can replace the drain on the soil caused by crops. Taking for instance, the ingredients withdrawn from the soil by a 400 ℔ bale of cotton lint (¶490), we shall find that the potash and phosphoric acid contained in the latter will be returned to the soil in about 1400 pounds of Pine straw, while of the other ingredients, except soda and chlorine, even a surplus will thus be given back. It would therefore appear that the producing powers of a field for cotton could be sustained, and the soil even improved, if for every bale of cotton raised we should return to it 14 to 1500 pounds of Pine Straw, and a few handfuls of common salt ; *provided only*, that the stalk and seed be conscientiously returned (¶490, ff.).

792. The replacement of the drain caused by cropping with *corn, wheat*, and *oats*, would require a somewhat larger amount of straw, and the addition, besides the salt, of 10 to 25 pounds of *superphospate of lime;* while the replacement of the ingredients of the *sweet potato*, to which these soils are found to be best adapted, would be effected by straw with a larger dose of common salt than that required by cotton—say ten or twelve pounds to each ton of straw ; the quantity required for replacement being, however, in all the cases mentioned, considerably greater than in the case of cotton, when the seed and stalk are returned (¶490)—it being understood in all these cases, that the freshly fallen straw is referred to ; for that which has lain on the ground, exposed to the weather for a length of time, has already lost a portion of its nutritive ingredients.

793. *Mode of Applying Pine Straw to Land.*—A great deal of the disappointment experienced in the use of Pine Straw, has no doubt been owing to the manner of its application. The analysis shows that the idea current with some, that Pine straw renders soils more sandy, is unfounded ; the 65 per cent. of silex which the ash contains, could produce no effect of that kind in a soil containing 93 per cent. of the same (¶782). It is very evident, however, that in the light, unretentive soils of the Long-leaf Pine Region, raw, undecayed straw turned in, and that too by shallow plowing, will not be under circumstances favorable to its decay, and may increase the openness of the soil to an injurious extent, while unable to promote its fertility by decay. The remedy, then, is very simple ; the straw must be allowed to decay, before being plowed in, on the compost pile ; and such substances as will promote decay, and among these especially lime, or calcareous marls (¶468), ashes, and the like (but not plaster of Paris in any large quantity) ought to be mixed with it. Pine-hollow muck, marsh-mud, such clays as those at Burnett's Bluff (¶302), etc., will also be useful in composting.

794. The ingredients furnished by the decayed Pine straw being in an available or soluble condition (¶426), it is desirable to render the soil as retentive as possible, in order that these substances may remain within the reach of plants. Wherever there is a clay subsoil, therefore, this ought to be mixed with the surface soil. This consideration would seem to afford a clue to the *transient* productiveness of the Pine Hill soils; when first taken into cultivation, they often produce quite vigorously for 2 to 3 years, then suddenly give out altogether. It is more than probable that this is owing to the supply of soluble nutriment furnished to the surface soil by the Pine straw; and with a retentive soil, it would seem that the fertility of the surface layer would be constantly on the increase, through the annual access from the fall of leaves. But the ashy Pine Hill soil is unable to retain a supply of soluble nutriment greater than will be appropriated by a few years' crop; what is over and above, goes to the subsoil and is thence once more absorbed by the roots of the Pines.

It will be perceived, therefore, that in making use of the Pine straw as a manure, we can concentrate on a small space the fertility of the soil and subsoil of a large tract, which is thus collected for us by the Pines. It is manifest that it will be better policy for the "Piney Woods" planter, to keep one quarter-section in a high state of cultivation, by means of the straw collected from the remaining three-quarters, than to till the whole section (¶480), exhausting the small supply of nutriment contained in the surface soil, within a few years. The Pines will bring up for him, in an available condition, the fertility of a subsoil stratum which his plow could never reach.

I do not mean to say that such a method would be rational for all time to come. The withdrawal of the nutriment contained in the leaves would finally cause the Pines themselves to languish, by exhausting the soil. This, however, is centuries ahead, and it is to be hoped that before that time, a general system of rational agriculture will render less important the resort to the forest leaves as fertilizers.

795. PASTURAGE IN THE PINE WOODS.—In their natural state, as received from the hands of the Indians, the Pine Woods were one great pasture—as, in thinly settled regions, they still are. Nor is it, generally, the ranging of cattle which has destroyed the pasturage in other regions, but simply the injudicious burning of the woods, at seasons when the fire would destroy not only the dry leaves, but also parch the *heart* and the *roots* of the grasses. It would seem that in a region comparatively poor in agricultural resources, the maintenance of pasturage should be considered a matter of national importance. The Swiss, being unable to cultivate profitably their mountain slopes, have converted them into pastures; these form the basis of their national wealth. Why this should not be so with the inhabitants of the Pine Woods, I have been unable to discover; it is certain, however, that the pasturage of that region is disappearing before the fires at a fearful rate, and that those who heretofore have relied on the range, during all but a few weeks in winter, for the support of their cattle, will soon be compelled, as many are now, to raise feed for them on their poor soil, which, at present, will but just furnish comfortably the prime necessities of life for the population itself. The beautiful, park-like slopes of the Pine Hills are being converted into a smoking desert of pine trunks, on whose blackened soil the cattle seek more vainly every year, the few scattered, sickly blades of grass, whose roots the fire has not killed.

796. It is not the province of this Report to suggest municipal regulations by which the burning of the woods at improper seasons might be prevented, or at least, rendered of less general occurrence; the evil, however, is a crying one to the mind of every candid observer, and the destruction of national wealth caused by it is so enormous as to deserve no less attention certainly, than the improvement of soils. However convenient and effectual may be the burning of the dry gras in order to render the young growth accessible to cattle, that advantage is certainly purchased very dearly at the cost of its total destruction within a few years—a policy little better, in fact, than cutting down a fruit-tree for its fruit; and which appears more especially irrational when we consider how easily the advantage could be reaped without incurring the enormous waste, by a regular system of burning at times when, as after the first autumnal rains, and more especially in early spring, the ground is too wet to allow of injury to the roots, while yet the grass and weeds may be burnt off low enough to serve all practical purposes, and to destroy, at the same time, the Black Jack and Post Oak undergrowth, which is equally fatal to the range, with the fire itself. For the latter purpose, the burning in early spring, when the sap is rising, would be the most favorable time.

797. Waters of the Long-leaf Pine Region.—In a region of such vast extent, a considerable variety in the conditions of the supply of natural and artificial water, may be expected; and it would be tedious as well as unprofitable to reord, in this place, more than the general features in this respect, of the districts examined.

The streams deriving their supply chiefly or altogether from within the Long-leaf Pine Region, generally maintain a brisk and almost even current throughout the year. Even heavy rains do not, in general, affect them nearly as much as is the case elsewhere, in consequence of the great perviousness of the sandy soil and Orange Sand strata (¶77), which occupy the surface of the region, and greatly diminish the surface waters—even so that branches below a certain size are rarely met with, or are very short; because the water on the ridge lands sinks and then causes copious springs and large streams to form at once, at the foot of the hills, or where an impervious stratum arrests the waters; while the hollows in the uplands are of a shallow, rounded form, and mostly without a water channel (¶32; 77).

As remarkable instances of springs furnishing an unusually large supply of clear, cold water, one near Old Hickory P. O., on S. 8, T. 10, R. 17 W., Simpson county, which forms a branch of the Okachicama Chitto; and another near Mr. James Wethersby's, on S. 7 or 8, T. 8, R. 20, Lawrence county, which forms a short branch of Crooked Creek, may be cited. Similar springs are mentioned as existing in Marion and Covington counties. While, however, there is no lack of spring water at certain levels, these are often very far below the hilltops, especially on the dividing ridges; and wells require to be sunk to great depths to reach water.

798. Such is more particularly the case east of the waters of Pearl River, on those of the Bowie, Okatoma, and Leaf River; where the water of wells is generally freestone, being obtained in the colored clays of the Orange Sand (¶32). In the *bottoms* and *hommocks*, however, the saline clays of Grand Gulf Group are often struck—thus near Jaynesville, and Leaf River (¶243); the waters are then saline and magnesian (¶314, ff.). The same often happens on the Chickasawhay and Pascagoula (¶244, ff.), yet on the whole, mineral springs

and wells are less frequent in this S. E. portion of the State, than in almost any other. A mineral spring, pretty strongly charged with Bicarbone of Iron, with some Chlorides of Sodium and Magnesium, and a trace of Sulphates, occurs about 3 miles N. E. of Vernal P. O., Greene county; and near Cross Roads P. O., Jackson county, similar springs are said to exist.—On some of the ridges near Raleigh, saline waters have been obtained (¶227), but at the place itself, wells 25 to 30 feet deep, find freestone water.—At Westville, wells 35 to 50 feet, in Orange Sand and colored clays; freestone water. At the saw-mill near town there is a mineral spring, containing Bicarbonate of Iron and a little Sulphuretted Hydrogen; also a little Chloride of Magnesium and Sodium.—At Mt. Carmel, Covington county, wells 40 to 80 feet deep, according to position; freestone water, shed by red or pipe clays (¶70).

799. On Pearl River, however, as well as on many of its confluents, mineral waters are very abundant, from Jackson to Columbia, Marion county. The inconvenient abundance of mineral waters in the Brandon neighborhood has already been mentioned. They are chiefly of two kinds: 1st. *Saline purgative* waters, containing a large amount of *Epsom Salt* and *Gypsum*, with more or less *Glauber Salt* (Sulphate of Soda) and *Common Salt*, and *Sulphate of Potash.* Such are the waters of Mr. John R. Jackson (35 feet deep), Mr. Langford, and Judge Wm. H. Clarke (15 feet deep). The waters of Mr. Jourdan A. Jackson's well differ from these chiefly in containing some *Bicarbonate of Soda*, and a larger amount of *Chlorides*—probably in the form of *Common Salt* and *Chloride of Magnesium.*

All these waters are entirely too strong for daily use, although possessing valuable medical properties; and the same is true of most of the mineral waters found in wells W. of the meridian of Cato, in S. Rankin county, which are generally of a similar character.

800. The other class, which is on the whole much less common, is that of the *Acid Alum* waters. Of these, one already well known is that of Mr. Baugh's Well, in the S. part of the town of Brandon. The well is 27 feet deep, and the basin is in dark colored clays containing Gypsum and crust of Yellow Iron Ore. The water is a very strong one, so that the precipitation of the alumina turns the water thick; it possesses a bituminous, but not a sulphureous ordor. A qualitative analysis gave the following result:

Sulphate of Alumina ("Alum"), largely,
" " *Lime* (Gypsum), largely—a saturated solution,
" " *Potash*,
Chlorides of Sodium and Magnesium,
Silica, dissolved in,
Free Carbonic Acid.
Iron, a small amount.

The water of Mr. Holland's well, on S. 35, T. 6, R. 3 E., differs from this essentially in containing somewhat less of the *Sulphate of Alumina*, less *Magnesia*, but more *Soda*, and *Potash*, and *Chlorine.*

A very remarkable water of this class has been quite lately brought to my notice; it occurs in a well 17½ feet deep, at Col. Danl. Allen's place, S. 2, T. 4, R. 4 E., Rankin county—on the dividing ridge between Steen's and Richland Creek. It is not only powerfully astringent, but so acid with Sulphuric Acid, as to set the teeth on edge almost immediately. The result of the qualitative analysis might be thus stated:

Sulphate of Alumina ("Alum"), very largely,
" " *Lime* (Gypsum),
Bisulphates of *Soda* and *Potash*, largely,
Chlorides of *Calcium* and *Magnesium*, largely.

Great caution will be necessary in the use of this water, whose strength is equal to that of any mixture which a physician would be likely to prescribe to a patient. It is almost too strong for use in chronic cases, but would probably be very effectual in acute dysentery, diarrhœa, "red flux", etc.

801. Further S. we find strong mineral waters, charged chiefly with Epsom Salt, Glauber's Salt and Common Salt; generally with some Gypsum, and often with more or less Sulphates of Alumina and Iron, at Mr. Tom. Bass', S. 13, T. 3, R. 2 E.; at Mr. Chapman's; and in the Harper settlement, S. W. Cato. These waters are so strong as to render their daily use positively pernicious—as is amply proven by their effect on those who persist in using them otherwise than as a medicine (¶315; 601). Similar waters oftentimes impregnated with Sulphuretted Hydrogen and bituminous matter also, exist on lower Steen's Creek; and none of the well waters obtained in the gray clays or white sandstones of S. W. Rankin (¶241), are free from these ingredients; although they are not always so strong as to render their use very objectionable. The population ought always, however, to be on their guard against the debilitating effects of these waters, which are especially noxious to those suffering with, or recovering from, fever and ague. Wherever sand ridges afford chances of freestone wells, these ought to be used even at some inconvenience in preference to the saline waters; and cisterns ought to be considered a matter of necessity, where waters like Mr. Bass' are alone obtainable in wells.

802. In W. Simpson, also, waters of this character are sometimes obtained; but the greater prevalence of the Orange Sand renders their use a matter of choice. Whether or not similar waters exist in Copiah, I am not informed, though it is most likely. They are very abundant in Lawrence county, near Pearl River; and especially so near Monticello, where a considerable variety exists; though at the town itself, shallow wells, with almost freestone water, are obtained in sand, above the salty clays (¶238). In this region, however, the waters generally contain none, or only a small amount of sulphates, the salts present being almost entirely chlorides and bicarbonates. Hence it is, probably, that effects on health by their use are not nearly as frequently perceived.

The water of "St. Andrews' Well" (35 feet deep), on S. 29, T. 7, R. 11 E., about one mile S. of Monticello, showed the following composition:

Chloride of *Sodium*, *Magnesium*, and *Potasium*, largely,
Bicarbonates of *Soda ?*, *Magnesia*, *Lime*,
Small amounts of *Chloride* of *Calcium*,
Proto-carbonate of *Iron*, } Held in solution by *Free Carbonic Acid*.
Silica, }
Alumina.

This water is of considerable strength. The water of "St. Ronan's Well", about 4 miles S. W. of Monticello, differs from this chiefly in the presence of *Sulphuretted Hydrogen* and some bituminous oil, the predominance of *Lime* over Magnesia, and the presence of a little *Sulphate* of *Potash*.

A mineral spring near Mr. Neglan's, S. 35, T. 7, R. 10 E., contains *Bicarbonate* of *Iron* with a little *Lime* and *Magnesia*, and *Common Salt*.

A strong chalybeate spring issuing from a bluff near Mr. Maxwell's mill, S. 9, T. 6, R. 11 E., contains the *Bicarbonates* of *Iron*, *Soda* and *Magnesia*, with a little *Common Salt*.

From the great variety of mineral waters in the Monticello neighborhood, it would seem that it might be made a place of resort, if easy communication were established.

803. In Marion county, also, mineral wells and springs exist. Stovall's Springs, above Columbia, have in times past been a place of considerable resort; I am not aware what is the nature of the water. At Columbia, shallow wells obtain freestone water in sand and gravel, the level being dependent upon that of the river; in one, however, mineral water was obtained in "blue mud" (¶237), at 25 feet. Similar wells have been obtained on Pearl River in S. Marion.

In Pike county we mostly find freestone wells in Orange Sand—except as mentioned in (¶237.) On high ridges, as at Summit, for instance, wells require to be sunk to great depths, to the level of the drainage—70 to 80 feet.

As regards the practicability of deep bored and artesian wells in the Long-leaf Pine Region, (¶318), it is highly probable, that in most cases the scarcity of water suitable for daily use in the bottoms and hommocks of this region might be relieved by bored wells, tubing out if necessary, the strong mineral waters. Whether wells of moderate depth would find pressure enough to elevate the water to the higher ridges (as at Summit, for instance), is uncertain, since some of these seem to be equal in elevation to any S. of the Chickasaw Survey ; yet the experiment deserves to be tried.

THE SEA-COAST COUNTIES.

EMBRACING THE COUNTIES OF JACKSON, HARRISON AND HANCOCK.

804. In approaching the sea-coast on the Chickasawhay and Pascagoula route (¶787, ff.), the first decided change of the inland vegetation towards that of the coast itself, occurs shortly after passing Leaksville, in Greene county. From Winchester southwards, as a general thing, the sandiness of the soils is regularly on the increase; the sands themselves assume a lighter tint, and more of an evenly fine and sharp grain. The Gallberry or Inkberry (*Prinos glaber*), which on the upper Chickasawhay and Leaf rivers, appears only in isolated patches, is constantly on the increase in the flat or hommock of the Pascagoula River, as we advance southward, and whenever it does appear it indicates a sour and sandy soil.

805. The feature which, at the point mentioned, recalls to mind a prominent peculiarity of the Sea-coast Counties, is the appearance of shallow upland ponds, with water strongly colored by vegetable matter, in which plants peculiar to the coast region appear for the first time. (*Hypericum fasciculatum, Polygala corymbosa, Drosera longifolia, Eriocaulon decangulare and villosum.*) These ponds or bogs are generally surrounded by a small growth of the Bay, and Bay Galls; and so are the branches, of the region whose channels become shallow and wide and often very boggy; *their* water, also assuming a browner tint, and carrying larger quantities of sand,—a circumstance which renders the crossing very changeable and sometimes dangerous.

806. The road s mainly in the level river hommock, (on the east side) which is of very variable width, and has a gradual ascent into the hills. It is elevated from six to ten feet above the first bottom of the river; at times it has the character simply of level Pine Woods, its timber being the Long-leaf Pine, with an occasional Black Jack and Post Oak, and here and there, some Dogwood and small Hickory. Where this is the case, the subsoil is generally somewhat heavier than the surface soil, of a yellow tint, and might bear some improvement; but whenever the Gallberry prevails, we find at a depth of from five to eight inches, a subsoil of pale yellow sand, which, in spring, is saturated with water, showing a want of drainage.

807. The bordering Pine Hills, which, as a general thing, have a very sandy soil, oftentimes possess a very heavy subsoil, of a

yellow or gray clay, which evidently originates in the underlying clay strata of the Tertiary (¶245, ff).

Of these, I found an outcrop containing some indication of Lignite, on a hillside at M. McCaun's place; and its presence in these generally is indicated by numerous mineral springs, of a chalybeate, magnesian character, which come to the surface at some elevation, usually about half-way up the hillsides. While the hilltops bear the usual growth of Long-leaf Pine, with only an occasional Black Jack and Post Oak, vigorous specimens of the two last named are frequently seen on the slopes, and in the hollows and branch bottoms there appears a growth of Sweet Gum, "Poplar", Cucumber-tree, and Hickory, indicating a soil very different from that of the hills, and mainly derived, no doubt from the tertiary strata. These bottoms are quite fertile, but the bodies of such land are very small.

808. The description just given applies to the country bordering on the river hommock, east and north-east of Cross Roads P. O., or Fairley's Ferry. As we leave the hills, approaching the river, we find at first, rather a sandy soil (with Gallberry, etc.), in which the Pines invariably show a disposition to grow lank and thin; nearer the river, a gray, clay subsoil gradually approaches the surface, in many places the Gallberry becomes scarce, the timber indicates a better soil, and merges into a kind of bottom growth. Such is the case on the plantation of Mr. John Davis (Cross Roads P. O., S. 12, T. 2, R. 8 W.), which borders on the river bottom.

809. There is a very striking difference between the soil of the bottom proper, which is subject to overflow, and that of the second bottom. The former is very stiff and heavy, and no less so is its subsoil, a stiff, gray clay. Its timber is prevalently of Chestnut White Oak, Sweet Gum, Spanish ("*Red*") Oak and Magnolia, with a good deal of Holly, and some Bottom White Pine (*P. mitis*).

The oaks are very large, and the characteristic habit of the Spanish ("*Red*") Oak, which it assumes when growing in bottoms, can be studied here to advantage.—This soil, Mr. Davis informs me, is a fair specimen of the first bottom soil of the Pascagoula generally; it is very productive in favorable seasons, but like all heavy soils, it is unsafe, and particularly so in consequence of being subject to overflow The great difficulty of working this soil in unfavorable seasons, and the frequent drowning out of the crops by overflow, have induced most of the settlers of this neighborhood to abandon its cultivation, and restrict themselves to the second bottom, which is not subject to overflow, and is also very productive. This hommock is the very opposite of the first bottom soil—very light, soil dark colored, about ten inches deep; underlaid by a subsoil of pale yellow sand. It is elevated four to six feet above the first bottom, the soil of which it evidently overlies; its timber is the common White Oak, Bottom White Pine, Magnolia, Water Oak, Chinquapin, with some very large Black Sumach (*Rhus typhina*); also some Holly and Iron-wood.

810. None of these soils has as yet been analyzed; but there can be no doubt that the first bottom soil is very rich, and well worthy of reclamation by levying; especially as the bottom is nearly three miles in width.

Mr. Davis speaks well of the effect of applying some of the heavy subsoil clay of the bottom to the sandy land which forms the transition from the second bottom soil to the poorer portion of the hommock. These effects have been owing chiefly, no doubt, to the action of the clay as a mechanical manure, in improving the physical condition of the sandy soil; but while it may be doubtful whether the hauling of the bottom clay for this purpose would pay the planter, there can be no doubt that wherever a heavy subsoil is near enough to the surface, it ought to be mixed with the soil by deep plowing. The growth of the bottom as well as that of the hollows, proves these clays to be rich in mineral nutritive ingredients; and they will very essentially improve the physical condition of the soil.

The banks, and the portion of the bottom immediately contiguous to them, are quite sandy; it seems that all the deposits now formed by the Pascagoula river, are of this character. It might be practicable therefore, by judiciously regulating the overflows, to improve the heavy soil by allowing the sand to spread over it, which might then be mixed in by deep plowing.

811. Crossing at Judge Fairley's Ferry, we find the hills on the right side coming close up to the bank, without, however, forming a washed bluff. Yet, on the ascent, we find about half way up, an outcrop of heavy gray clay (¶245), which might be suitable for pottery. It overlies, no doubt, the strata of the lignitic tertiary; and is in its turn overlaid by yellow sands of the Orange Sand formation (¶6), to which these clays themselves seem to belong (at present), being as they are without any definite structure. The hills immediately bordering the river, on which Judge Fairley's plantation is situated, bear a stout growth of the Long-leaf Pine, mixed with a good deal of Spanish ("*Red*") Oak and Scarlet ("*Spanish*") Oak. This land is moderately productive, and had a good looking corn crop when seen by me. But the intermixture of the oaks with the pine lasts scarcely more than ¼ of a mile inland; and then, as we proceed on the Ocean Springs' road, dreary Pine Hills with scarcely an occasional scrubby Black Jack or Post Oak, intermingling with the Pine, reign absolute.

812. The road runs on the dividing ridge between Black Creek and the Pascagoula at the distance of several miles from the edge of the bottom, in which the river meanders to and fro, most generally, however, keeping near the W. side. Steep hollows, filled with a growth of Bay and not unfrequently, Magnolia also, fall off from the ridge towards the river bottom. These hollows frequently contain copious springs, which issue from the hillside, generally 20 to 30 feet below the top of the ridge; they are evidently shed here, at a level nearly uniform, by the impermeable clays of the tertiary.

813. The pines on the ridge, up to about 4 miles below Fairley's, are stout and vigorous, and would afford fine timbers. But as we pass on, approaching Black Creek, the road diverges further inland; the ridge flattens, and ponds appear on its very summit. The quality of the pine timber rapidly deteriorates, the trees becoming slender and stunted in height, especially in the neighborhood of the ponds. The first of these are pretty deep, showing small but clear sheets of water, bordered by a poor growth of rushes. But further on, they become shallow, until at last they turn into mere wet flats or bogs, covered at times with a rank growth of grass, sparsely timbered with the poorest specimens imaginable of Long-leaf Pine—with trunks 15 to 25 feet high, and 2½ to 4 inches in diameter; their leaves also sharing the general degradation, being in sparse tufts scarce 6 inches long.

814. Others of these ponds, or bogs, whose soil is almost a pure, white, wet sand, bear no grass, but a scattered growth of peculiar herbaceous plants, among which several beautiful red blossomed *Orchideae*, the Side-saddle flower, (*Sarracenia purpurea*), Pitcher plant or Wild Poppy (*Sarracenia variolaris*) the curious long-leaved Sundew (*Drosera filiformis*) with its long, spirally coiled, wiry leaves, covered with glandular hairs, and two species of Cord-rush (*Eriocaulon decangulare*, and *villosum*) as well as the common Sundew (*Drosera brevifolia*), are the most prominent. But the most singular feature to a North

Mississippian, is the association, in these ponds, of the Cypress with the Long-leaf Pine.—The Cypress trees are scarcely better looking, in comparison with their brethren of the river swamp, than the diminutive pines are when compared with their giant brethren on the ridges and hommocks of Perry, Marion and Greene counties. Here, these seemingly incongruous trees are found side by side, both sadly worsted, it appears, by their mutual concessions. The shallow channels or depressions through which the surplus water of these bogs finds an outlet, are skirted, and sometimes entirely overgrown with thickets of the Bay, together with the Carolina Laurel or Bay Galls (*Laurus carolinensis*) and two or three other species of small trees. The boggy soil of these thickets is covered with peat-moss (*Sphagnum*), several kinds of small rushes (*Eriocaulon, Xyris*) and sedge grasses, and likewise produces some pretty flowers (*Pinguicula pumila, Utricularia biflora, Drosera longifolia, brevifolia*, etc.), but in an agricultural point of view, look most unpromising.

815. An abrupt descent of 15 to 20 feet, brings us down into Black Creek bottom. On the hillside, about 4 feet below the surface of the upland, a deposit of yellow sandy loam crops out; it is too deep, however, to be reached by the plow for the improvement of the uplands, which are very sandy, and said to be extremely poor. The country, however, is so thinly settled, that even this cannot be positively asserted as a general rule.

The bottom soil of Black Creek is extremely sandy, and on the N. side of the stream, at Mr. Bird's Ferry, is scarcely anything more than sterile white sand, in which nothing but the dwarf palmetto (*Sabal minimus*), and other plants of similar habits, can sustain themselves. The water of the creek, like that of most streams in this country, is of dark tint. On the S. side, the soil is somewhat better, although still very sandy; it bears a growth of sweet gum and bottom oaks, which do not attain to any large size. This land produces corn pretty well for some years; cotton has never been tried on it; it is, however, subject to overflow, and when this happens after tillage, a large portion of the soil is often carried off.

816. The ridge dividing Black Creek from Red Creek, is of a character similar to that of the uplands N. of Black Creek, save that the pond or "meadow" character is still more pronounced, and the soil still more sandy; the Dwarf Palmetto and Gallberry form its chief undergrowth, mixed, in marshy places with a singular dwarfish variety of the Bay, which forms low scrubby bushes, much attacked by rust; in these we find some shoots, not more than a foot high from the ground, bearing a single terminal flower, and blooming considerably in advance of the larger trees of the same species. The dense thickets of sombre foliage formed by the latter, skirting the bogs and their outlets; the stunted Pines and Cypress sparingly scattered over their surface with the rigid bushes of dwarf Palmetto on the higher ground, form a landscape as dreary as it is singular.

817. The bottom of Red Creek resembles very much that of Black Creek; its growth being of middle-sized Sweet Gum, Magnolia, and Water Oaks. The soil is very sandy, and not of any considerable depth; the subsoil is a pale yellow sand. This land is said to produce corn well for five or six years, after which it gives out entirely. In fact, sand forms such a large portion of this soil, that lasting fertility is not to be expected. When once exhausted, it will probably require nothing short of stable manure to make it produce again. Deep plowing ought to be avoided.

I am not informed, as yet, how far inland the same character of bottoms and uplands continues; the country being so thinly settled, and in the interior almost destitute of roads.

818. Red Creek ferry is about 7 miles above the mouth of the creek, on the S. side of which, at this point, we find a wet glade about half a mile wide,

which bears the vegetation found on all the "Pine Meadows" further south, differing from that heretofore seen on these lands, in the presence of the singular *Dichromena latifolia* (which though a grass, seems to bear large white flowers, the petals of which are tipped with light green awns), and the "Weed-grass" (*Conostylis Americana*) with its panicles of golden yellow flowers enveloped in white woolly furze. For the rest, the Pitcher-plants, long-leaved Sundew, bright-colored *Orchideae*, and the Cord-rushes crowned with their white buttons, with the never failing Gallberry, form the bulk of the vegetation.

819. In traveling from Red Creek ferry to Dwyer's ferry on the Pascagoula River, by the "river road", we pass almost entirely through Pine Hills of the same character as those seen near Fairley's ferry. A belt of this hilly pine land, about 3 miles wide, generally skirts the river bottom, thus intervening between the latter and the wet pine-meadow lands; the latter, however, extend closer to the river along the creek bottoms.

At Dwyer's ferry (¶246), as at Fairley's, the hills on the right hand bank fall off steeply towards the river; and the portion immediately contiguous to the bottom, sometimes as far as half a mile inland, is very fertile, but unfortunately very much broken. The soil is of a chocolate color, and very light; resembling closely that of the sea-coast "hommocks", as also does its growth; at the depth of about 6 inches, it becomes of a paler tint and more sandy, so that subsoiling would be unadvisable. It bears a vigorous growth of timber viz: Post, Spanish ("*Red*"), White, Willow and Red ("*Black*") Oaks; Bottom White Pine, Cucumber-tree, Sorrel-tree, Dogwood, Hickory, Stag-horn Sumach, Black Gum, also Grape-vines and Green-briers (*Smilax*); on the hillsides, the Magnolia is common.—This soil is very productive, and lasts pretty well. As we recede from the bottom, the Long-leaf Pine gradually mingles with the other growth, and by degrees the rich hommock soil passes into that of the Pine Hills.

But few of the settlers in this region raise corn enough to supply their wants, and those who do so, generally cultivate the river bottom, on the opposite side. Mr. Bryan C. Rice, an intelligent planter of this neighborhood, informed me that the character of the bottom here is very similar to what I found it at Fairley's, and of an equal width. He finds the soil productive, but it is to some extent subject to the inconveniences before mentioned (¶809).

820. The outcrop of the tertiary, gray, lignito-gypseous clays, which forms a high, abrupt bluff, a few hundred yards below the ferry, has already been described in the Geological Report (¶246). It is probable that some portions of the material forming this bluff might be profitably employed as marls for the sandy hommocks which they underlie; a question which must be decided by analysis. The locality is an interesting one, both as being, so far as known, the outcrop furthest south of the tertiary strata of the Grand Gulf Age (¶230); and still further, as proving the cause of the stagnation of the water in the upland "Pine Meadows". These lands, although extremely sandy in themselves, can drain off the rain water but very slowly, because the impervious clays of the Tertiary, which underlie at no great depth, prevent the percolation of the water in a vertical direction; and the fall being very slight, it takes a great while to drain sideways.

821. Passing on from Dwyer's ferry towards Pascagoula, we recede from the river and soon strike the "meadow lands" (¶818), again. These are here somewhat undulating, and distinctly divided into upland and lowland, the latter being the sandy bogs with a growth of lank, dwarfish pine, some cypress, and Pitcher-plant (*Sarracenia*), the long-leaved Sundew, the larger species of Cord-rush (*Eriocaulon decangulare*) the *Dichromena*, the *yellow* Star-grass (*Aletris aurea*), etc.; while the uplands bear a growth of sturdier pine, and the ground is covered with a grassy sward, formed chiefly by the smaller species of Cord-rush (*Eriocaulon villosum*), *Xyris*, and the *white* Star-grass (*Aletris farinosa*); the Gallberry, and stunted bushes of the Carolina Wax-myrtle (*Myrica carolinensis*) form the undergrowth. The soil of these lowlands is scarcely anything more

than white sand, made to cohere by the roots of the plants; that of the uplands, for about 5 inches from the surface, is very sandy, but still a *soil;* lower down, however, there is a pale yellow sand, which, like that of the lowlands, is drenched with water; at least at the season at which I saw them (May).

822. Such, with but little change, is the character of the land up to Big Bluff Creek. Occasionally, there is a tract of Pine Hills of the usual character, and then we sometimes find, on the hillsides, a stratum of yellow sandy loam, similar to that seen at the descent to Black Creek ferry (¶815). Whenever this occurs, there is a visible improvement in the hillside growth; the Long-leaf Pine is tall and vigorous, and a small fruited variety ? of the Pawpaw, together with Dogwood (*Cornus florida*) forms the undergrowth. This loam stratum is mostly, however, from 5 to 8 feet below the level of the uplands, which have the poor sandy soil of the pine hills; it is, therefore, chiefly the hillsides which might be susceptible of profitable culture. Very few settlements have been made in this region, and the diminutive patches of inclosed land which we see near the settler's cabins, prove that they do not rely on agriculture for their supply of provisions.

823. Big Bluff Creek has scarcely any bottom; its coffee colored waters flow in a sandy bed, which is immediately bordered by the hills, which come down to it by a gradual slant on the N. side, while on the S. it is bordered by a range of rather abrupt hills, the foot of which has been so washed by the creek (which makes a sudden bend here) as to exhibit the geological strata. The lowest, 4 to 5 feet, consists of a stiff, gray potter's clay, quite impervious to water; it is overlaid, to the top of the hill, (about 30 feet above the creek) by sands of a light orange tint, of the Orange Sand character. There can be little doubt that the same clay underlies all the wet meadow-land seen further N. as well as that which intervenes between Bluff Creek and the Sea-Coast (¶820).

824. *Pine Meadows.*—After ascending the bluff, we strike a level meadow-land, in which there is scarcely any distinction into upland and lowland. The ground is densely covered with a growth of sedge-grasses (*Cyperaceae*) Cord-rushes (*Eriocaulon villosum*) and a small species of *Xyris;* in the shallow depressions, both species of *Sarracenia* (Side-saddle flower and Pitcher-plant), the larger *Eriocaulon* (*E. decangulare*), the *Dichromena*, the long-leaved and the short-leaved Sundew, several species of bright-tinted *Orchideae*, and some larger species of sedge-grasses and Pond-rushes (*Juncus*) are seen; and with these, occsionally, the Milkweed of the sea-coast marshes (*Asclepias paupercula*) with its bright orange flowers. The undergrowth is formed exclusively by the Gallberry, which does not grow to the same height that we find it in Wayne and Greene counties, but is on the other hand, so overcrowded with blossoms at the proper season, that the leaves entirely disappear beneath them. The timber is formed altogether by diminutive Long Leaf Pines, averaging about 25 feet in height by 2½ to 4 inches in thickness, which stand at considerable distances (40 or 50 feet) apart, so that their sparse tops scarcely interfere, with the view of the observer.

825. The first appearance of these glades, when seen in a bright spring sunshine, with their green carpet variegated by bright colored flowers, is decidedly pleasing to the eye; and it is difficult at times to dispel the illusion that it is a park laid off by human hands that we are traversing. Almost the only living being, however, which inhabits this region at present, is the prairie-lark; settlements are few and far between, and no attempt is made to cultivate the soil, the raising of stock being the only occupation of the inhabitants.—As far as the eye can reach, the level plain extends with dead uniformity, and we search in vain for a landmark whereby to distinguish the spot in which we may find ourselves from any other seen for miles around. This sameness very soon

becomes tiresome, and in the spring season, the team goes splashing along, with the wheels deep in mud, which fortunately is not very tough. One is much tempted at times to leave the miry road and travel on what seems to be a solid greensward; but the experiment is often dearly paid for, the false soil giving way under the feet of the stock, bogging them up to their bellies where the ground seemed most secure.

826. At long intervals, the uniformity of the landscape is broken by small thickets of the Bay, skirting shallow depressions, through which the coffee-colored waters of the region slowly make their way into larger channels, like that of Little Bluff Creek. Here, where two very gradual slopes from the surrounding plain meet, the waters have excavated deep, narrow channels, which are, however, continually shifting in consequence of the accumulation of sand in them. Fording these creeks during a wet season, is therefore often dangerous, the more so as even an attentive observer is liable to be grossly deceived as to the depth of the brown, but perfectly clear water. Where he expects to find it ankle-deep, he will suddenly find himself immersed up to the hips, and perhaps sinking in quicksands besides. The splendid trout which inhabit these waters, will often seem to be within easy grasp, when the full length of the arm falls short by several feet of reaching them.—Like the waters of the flatwoods of N. E. Mississippi, these streams rise and fall very slowly, and the traveler, when once water-bound, is likely to have his patience put to the test.

Lower down, the water-courses are bordered by low hills, on which the Pine grows larger than on the plain above, and the same improvement gradually becomes sensible as we approach the Pascagoula River. The timber, however, is very poor at best, and fit for little else than coal-burning; which is, I believe, the chief use thus far made of it, especially nearer the coast, where tracts of several sections are frequently found stripped of all their timber, for the sake of coal.

827. So far as I have learned, the description just given of the lands on Bluff Creek, applies with more or less accuracy to most of the lands lying south of Red Creek and east of Biloxi River, always excepting those lying within about ½ to one mile of the coast. The lands bordering on the water-courses (or *Bayous*, as they are generally termed in the coast region), are usually of a better quality and are cultivated profitably; their timber also, has been of considerable value, but greatly reduced already by cutting, so that it is rather the refuse, lank and thin which now occupies these tracts. But so soon as we recede from the main stream, the meadow lands set in, partly of the character of those south of Big Bluff Creek, partly such as have been described as lying between Big Bluff and Red Creek (¶817 to 823).

828. But one specimen of the soils of this region has as yet been analyzed. It was taken in T. 6, R. 7 W., a few miles south of Little Bluff Creek, in "meadow" lands now used as pastures and timbered with the stunted pine growth before described; the ground being covered with a dense turf of small sedge-grasses, the smaller Cord-rush (*Eriocaulon villosum*), small *Xyris*, and short-leaved Sundew (*Drosera brevifolia*). For about 12 inches, the soil is uniform, of a gray color, very sandy; lower down, pale yellow sand, drenched with water.

Depth: Twelve inches.

The soil, saturated with moisture at 71.2 deg. Fahr., lost 1.870 per cent. of water at 400 deg.; dried at which temperature it consisted of:

Insoluble Matter (fine sand)	95.592
Potash	0.061
Soda	[illegible]
Lime	[illegible]
Magnesia	[illegible]
Brown Oxide of Manganese	0.015
Peroxide of Iron	0.459
Alumina	[illegible]
Phosphoric Acid	0.021
Sulphuric Acid	trace
Organic Matter and Water	2.277
	99.443

829. The soil, as might be expected, is very poor; no grain crop could be grown on land like this, without [illegible] manure or its equivalent. But the greater portion of any such manure would be thrown away on a soil so extremely sandy, and having no subsoil of [illegible].

At best, this land can be of use only as pasture; and the question arises, whether its present growth of sour grasses might not, with little expense, be changed into one of sweet grass.

The brown colors of the waters draining from these lands, proves that the soil is in an acid condition (¶406); the remedy for this property, as has been stated (Agricultural Report, General Part ¶539, ff.) is *lime* or *ashes*. The former substance would probably be most available, and in the present instance, it would be best to use it in the freshly burnt state, and to sow it broadcast on the surface, during a moderately wet season.

Ashes have been mentioned as an alternative, for the same purpose. The effect of their application in the present instance, is well illustrated by the fact, which is very apparent even to a superficial observer, that wherever the dead grass has been burnt off (and consequently its ashes given to the soil), the Cord-rush and *Xyris* have almost disappeared, while a soft, appetizing growth of good grass now covers the ground. The effect of lime would probably be similar, and more lasting.

830. Along the water courses, where the soil is heavier (sometimes, probably, derived immediately from the potter's clays which underlie these glades), and more productive, the application of lime as a corrective for the sources of the soil, might enable the settler to raise a part at least of the vegetable necessaries of life. In dry seasons, the last mentioned soils crack open and become very hard, not so much from any clay they may contain, as on account of the sour, gelatinous condition of their vegetable matter. This also, would, to a great extent, be corrected by the application of lime. It is said that the raising of stock by pasturing in these regions, is a business somewhat uncertain, on account of the variability of the winters; which sometimes, when mild, allow the cattle plenty of pasturage through the year, but when severe, by killing the grass, will starve out the stock, which cannot, of course, be profitably supported on *bought* corn or hay.—At present, the making of hay on these meadows would scarcely be practicable; but it could undoubtedly be done in many of the *burnt* spots which I have seen; and thus the application of *lime* might enable the stock raiser to make hay enough for the support of his cattle during winter, in case of need.

831. As we approach within about a mile of the beach, the Pine timber rapidly improves in quality: the same is the case within about half a mile of Pascagoula river. The trees are stouter, but not very tall; and mixed with the Long-leaf pine there appears another species of pine, common all along the coast, and forming almost exclusively the larger timber of the Islands of

the Mississippi Sound. It is generally distinguished from the Long-leaf pine, in being called "Pitch Pine", on account of the extreme "fatness" of its wood. It is probably identical in species with the *common* "Bottom Pine" (*P. tæda*), of South Mississippi.

Within a quarter to half mile from the beach we find other timber mingling with the Pine, to-wit: Live Oak, and Spanish ("*Red*") Oak. A part of the land thus timbered, which extends inland from the beach in strips and bands, has for its undergrowth the Gallberry ("*Prinos glaber*): such constitute the "Gallberry flats" of the coast, which are said to be very poor, and not to produce without manure.

832. Nearer to the beach, we find the "sand hommocks" characterized by a growth of the "Pitch Pine" (*P. tæda?*) together with Live Oak (*Quercus virens*), Barrens Scrub Oak (*Q. Catesbaei*; generally called "Black Jack" in Mississippi, as well as the *Q. ferruginea*), and the narrow-leaved Black Jack (*Q. cinerea*—"Upland Willow Oak") and oftentimes some Magnolia. The soil of these "sand hommocks" is generally very sandy, and will produce, but for a few years, without manure; but in most cases the subsoil is sufficiently compact to allow of permanent improvement.

833. *Shell Hommocks.*—The soil most esteemed all along the coast of Mississippi, is that of the "Shell hommock," lying, in most cases, immediately contiguous to the beach, or at least, in such localities on the inlets and bayous as are easily accessible by water. In these we find irregular heaps and sometimes large masses of sea-shells—"shell banks"—often extending like ramparts, four to seven feet high, along the shore. The shells are only of two species, viz: the edible oyster now common on the coast, and the Gnathodon, popularly known as the "clam-shell". The only other species occasionally, but rarely, found accompanying the two above named, are the *Balanus* (Barnacle), and the *Mytilus hamatus*, a small shell now usually found adhering to the shell of the living oyster, like the barnacle. In clearing away these shell banks for the purpose of burning lime, bits of pottery, Indian arrow-heads, and charcoal, are frequently found among the shells; and the surface of the ground, when cleared of the shells, is found to be on a level with that of the "sand-hommocks." There can be no doubt, therefore, that these shell banks are the incidental work of human hands, and have been formed in consequence of the consumption of the edible shells by the Indians. In fact, the only difference between the soil of the sand hommock, and that of the "shell hommock", is such as would be expected in consequence of the pressure, and decay of calcareous shells (¶851, ff.). The soil is of a dark tint, to the depth of six to ten inches, but not, as a general thing, less sandy than that of the "sand hommocks"; its subsoil also is apparently the same; and it bears the same growth as the latter, with the addition of a number of lime-loving trees and shrubs. The following plants are found on a spot from which a specimen of soil was taken, on Mrs. McRae's land, at West Pascagoula: Live Oak, very prevalent; Red Cedar, Bay Galls (*Laurus carolinensis*, in trees of unusual size); *Magnolia;* Spanish ("*Red*") Oak (*Q. falcata*); Water Oak; Holly; some Dogwood; Sweet Gum; "Pitch Pine"; Wild Plum; Iron-wood; French Mulberry; Prickly Ash (*Xanthoxylon Carolinianum*); Hercules' Club (*Aralia spinosa*, commonly termed "Prickly Ash" in the interior of Mississippi); a great many vines of the Muscadine (*Vitis rotundifolia* and *cordifolia*). Among the herbaceous plants common on these "shell hommocks", one of the Sunflower tribe, with opposite leaves (*Actinomeris?*—not seen in bloom), deserves attention; it is called by

the French Creoles, "*l'herbe a trois quarts*", and is considered as an indication of an excellent soil.

The area occupied by the "shell hommocks" on the coast of Mississippi, is on the whole quite limited. Usually, the "sand hommocks" come up to the beach, forming a sandy bank from ten to twenty feet high, which falls off rather abrubtly towards the water's edge. It is only in a few places (as for instance, at the Ocean Springs, and about six miles west of Shieldsboro wharf, near Col. Claiborne's residence), that yellow brick clay or loam forms the bank: generally, it is composed of gray sands of various degrees of purity, down to low tide-water.

834. THE MARSHES.—It has been mentioned, that the "hommocks" extend inland in narrow strips or bands. These are usually from $\frac{1}{8}$ to $\frac{1}{2}$ mile in width, and are separated from one another by small marshes formed by short water-courses which empty immediately into the sea. There are, in fact, few water-courses, large or small, which do not form a marsh at their mouth, on the shore of Mississippi Sound. The Pascagoula, Tshula, Cahawfa, Biloxi, Wolf, Jourdan and Pearl, form very extensive marshes, the reclamation of which, for agricultural purposes, would add considerably to the sum total of arable lands along the waste. The small marshes just referred to, (which form the natural boundaries, as it were, between adjoining lots, usually occupied, each one, by a residence) afford a good opportunity of studying the several kinds of marsh soil. They differ, however, from the marshes of the larger streams, in that their soil, of whatever kind, is always very sandy; while in the larger marshes, such as those of Wolf and Pearl rivers, we generally find near to the main stream, quite a heavy soil. The cause of this difference is easily explained. The short streamlets have their origin in the Sand hommocks and Gallberry Flats, a short distance inland, and in the whole of their course, find nothing but sand to carry with them: while the larger streams, as we shall see hereafter, have to a great extent cut their channels in strata of stiff gray clays, which underlie the superficial sands; and as a natural consequence, their delta-deposits must be of a heavier nature.

835. Two kinds of marshes are most generally distinguished on the coast, viz: 1. Those occupied chiefly by the "Cutting rush" (Jonc coupant of the Creoles), a sedge-grass with a triangular stem, with formidably sharp, saw-toothed leaves, which the visitor soon learns to hold in awe. 2. The Round rush marsh, occupied mainly by a leafless, soft, pithy rush, with a round ("terete") stem (*Scirpus* sp.), and with it, we usually find the Marsh Milkweed (*Asclepias paupercula*), and a large species of Arrowhood (*Sagittaria lancifolia*). In both kinds of marsh, we frequently see stunted bushes of the Bay Galls (*Laurus carolinensis*); and the Candleberry (*Myrica carolinensis*), is quite at home in them. Stunted Pine, Cypress, Maple, Black Gum, etc., are sometimes scattered over the smaller marshes, especially those of the "Cutting Rush."

In the marshes of the latter character, it is oftentimes easy to push down a pole to the distance of eight to ten feet below the surface. The soil is, in fact, a semifluid, sometimes almost gelatinous, mass of black, fetid muck, which acquires a certain degree of firmness through the maze of thickly matted roots, which cover its surface to the depth of twelve to eighteen inches so that in taking a specimen at that depth, we obtain little else than the "grass roots". with a little muck adhering to them.

836. The Round-rush Marsh seems to differ from the other mainly in containing a large amount of sand, which renders the soil quite firm and safe to walk on. Whenever any considerable amount of sand is introduced into the Cutting-rush Marsh, the sedge-grass disappears, and the Round-rush takes possession of the ground. Of this I have seen numerous examples, but perhaps the most striking in the case of a small marsh at Mr. Alfred Lewis' residence, West Pascagoula. In order to test the agricultural value of the marsh soil, Mr. Lewis had a portion of a "Jonc coupant"-marsh thrown up, so as to mingle the muck with the underlying sandy soil. The experiment, as will be seen hereafter, was unsuccessful for the time being; but although the soil was left free to itself, no more of the Cutting-rush has since made its appearance; while the Round-rush is now rapidly taking possession of the spot. It appears, therefore, that by the intermixture of sand or sandy soil with the fluid muck, we can convert one kind of marsh into the other.

In the large River marshes, the two kinds of soil alternate in patches; and there occurs, besides, a third kind, for the reclamation of which there can be little hope. It consists of sand, nearly white, impregnated with sea-salt, and bears a growth of Samphire (*Salicornia*) and similar plants. Such soils are notoriously hopeless, in an agricultural point of view.

837. Both kinds of soil, when freshly stirred up with the spade, emit a powerful and very offensive odor; chiefly of sulphuret of ammonium, with an admixture of other odors resulting from the decay of vegetable matter, which nowise improve the quality of the scent. A silver coin, immersed in the marsh, is blackened by the sulphur in the course of a few minutes.

The great prevalence of these marshes, and the profusion in which this noxious mixture is evolved wherever the soil is stirred, render it a matter of suprise to the visitor, that the health of the coast region is generally excellent. We can scarcely believe, that residences situated in the very edge of the great Pearl River Marsh, surrounded by it on three sides, and overrun, at the proper season, with legions of mosquitoes of all colors and sizes, should, nevertheless, be as healthy, or even healthier, than the much praised "Piny hills" of upper Mississippi; yet such is indisputably the case. It has been suggested that the daily flow of salt water over these marshy plains is the cause of the phenomenon just referred to; and this explanation will suit well enough in the portions contiguous to the shore. But at the mouths of rivers, the tidewater which overflows the marsh, during a large part of the year, is scarcely brackish, and the upper portions, which are equally healthy, receive only the back water of the river itself. While, therefore, it is quite likely that the rise and fall of the tides is in causal connection with the healthiness of the marshes, the effect can hardly be ascribed to the antiseptic properties of the salt water; rather, perhaps, to the daily ablutions of the surface which are performed by the ebb and flow of the water.

838. *Composition, and Reclamation of Marsh Soils.*—But two analyses of Marsh Soils have as yet been completed; besides which, a partial analysis of Marsh Muck has been made. The specimens analyzed were selected with reference to obtaining fair samples of the two extremes of soil occurring in the marshes, viz: 1st. The sandy soil of the smaller marshes, and of those portions of the large river marshes which lie at a distance from the main channel; and 2d. the heavier soil which is generally found near to the main channel of the larger water courses.

839. No. 215. Soil thrown up about 3 feet deep, in a small "Cutting-rush" marsh, adjoining the premises of Alfred Lewis, Esq., West Pascagoula.

This is one of the small marshes formed by branchlets heading in the "meadows" or the "Gallberry flats" and "sand hommocks."

Vegetation consists of the "Jonc coupant", with scattered bushes of the trees mentioned on p. 374.

Where the marsh is in its natural condition, a pole may be pushed down to the distance of 8 to 10 feet. The portion in which the soil was thrown up adjoins the beach, is of a dark gray tint when dry, almost black when wet, and to the eye appears to be little else than a mixture of marsh muck with sand.

In attempting to cultivate this soil, Mr. Lewis found that both corn and rice thrive finely up to a certain age, producing a large crop of leaves. When both were about 15 inches high, the tops of the leaves began to turn yellow, and the corn soon died out altogether; the rice "spindled up" into a weakly stem, some of which even bloomed, but did not fructify.

Mr. Lewis further states, that the application of shell quicklime produced no sensible difference in the result, during the season following its application.

The soil, after saturation with moisture at 71.6 deg. Fahr., lost 15.437 per cent. of moisture, at 400 deg. The water obtained was somewhat acid, and possessed a pungent, empyreumatic odor; but contained only traces of ammonia. The soil, dried at the above temperature, consisted of:

Insoluble Sand and Silica	70.183
Potash	0.559
Soda	0.957
Lime	0.109
Magnesia	0.743
Brown Oxide of Manganese	0.067
Peroxide of Iron	1.171
Alumina	5.894
Phosphoric Acid	0.111
Sulphuric Acid	0.176
Organic Matter and Water	19.826
	99.796

840. No. 220. Marsh Muck.—A partial analysis of the *muck* of the same marsh, taken a short distance further inland, gave the following result:

Insoluble Matter (feathery silica)	25.225
Soluble Bases, Chlorine, etc	8.421
Sulphuric Acid	0.347
Organic Matter and Water	66.070
	100.000

The solution of the fixed ingredients of this material showed but a very slight reaction of chlorine; proving that the sea-salt does not reach far inland, and cannot, therefore, influence injuriously the growth of crops.

841. No. 241. Soil from the marsh of Pearl River, taken about 30 yards from the river bank, near Mr. Brown's mill, 2 miles below Pearlington. Thrown up from a ditch 3 feet deep.

This soil is very different in character from the other (¶839). Near the bank of the river, it is simply a bluish-gray, stiff clay, apparently with but little vegetable matter; but further inland it becomes darker, and where the sample was taken is black when moist, and becomes of a slate color when dry. It contains very little sand, cuts with a shining surface, and is variegated with irregular, dark-colored veins and specks, which on exposure to the air, become yellow.

According to Mr. Brown's statement, this soil, when laid dry, (which is very easy, as the firm clay soil forms staunch levees) is easily worked, and produces fine vegetables, such as peas, beans, cabbage, etc., but is peculiarly adapted to water-and musk-melons; none of these plants show any disposition to wither, like those planted on Mr. Lewis' soil.—The soil of the small marsh at Pearlington is similar to this. I was informed that immediately opposite the latter place, an attempt was made, on a small scale, to grow rice. The crop was very abundant, and of fine quality. The firm soil is reached about 12 inches below the surface; down to that depth, there is nothing but a tangled maze of grass roots. The marsh grasses, however, die very soon after the soil is drained, and their roots decay rapidly.—The chief growth of this marsh along the banks of the river and its bayous, is a tall rush with a round stem (*Scirpus*—differing in species, apparently, from the "Jonc rond" of the smaller marshes), 6 to 10 feet high; with an undergrowth of Arrowhead, Pickerel Weed (*Pontederia*), and Lizard's Tail (*Saururus*). The "Cutting-rush" also occurs, but apparently in the more elevated spots; and with it the Marsh Milk-weed (*Asclepias paupercula*). The only shrub to be seen on the green plain—(extending westward in a dead level, as far as the eye can reach)—is the Myrtle (*Myrica Carolinensis*) which grows to a hight of 8 to 14 feet; at intervals, a solitary bush of the Bay (*Magnolia glauca*) is seen.

The soil, when left to dry slowly, in a lump, becomes of a stony hardness. Being air-dried, it lost 7.940 per cent. of water at 400 deg. dried at which temperature it consisted of:

Insoluble Matter	74.150
Potash	1.003
Soda	0.379
Lime	0.182
Magnesia	1.004
Brown Oxide of Manganese	0.065
Peroxide of Iron	3.350
Alumina	10.643
Sulphuric Acid	0.858
Phosphoric Acid	0.188
Organic Matter and Water	8.390
	100.212

842. There is not much, in the composition of the last soil, to distinguish it from other heavy, fertile bottom soils. The large amount of Sulphuric Acid, and the rather small amount of Lime for a *soil* of such resources, constitute the main differences. Potash is present in about the same proportion as in prairie soils; there is no unusual proportion of either Soda or Magnesia, showing that the salt water exerts little influence over this soil. The supply of Phosphoric Acid is not large, but it is adequate. The supply of vegetable matter is not excessive, as is the case in the Pascagoula soil.

There are some essential anomalies, however, as to the *manner* in which some of these ingredients are contained. A qualitative test shows the Sulphuric Acid and Magnesia to be present in the state of Epsom Salt; the fresh solution also contains some iron; and the vegetable matter (as usual in soils in which vegetable matter decays in continual contact with water) is in an acid condition (¶406).

843. It is attributable, no doubt, to the large amount of clay contained in this soil, that these circumstances do not act as injuriously on the growth of crops, as might be apprehended. Still, in taking this soil into cultivation, it will be advisable to remedy these defects by the application of lime, either burnt or in the form of calcareous marl. This will correct the acidity of the soil; it will decompose the noxious Epsom salt, forming gypsum and common magnesia; and it will supply the deficiency of the soil, in that important igredient—lime—

itself. But above all, the soil must be thoroughly drained (an operation which at Mr. Brown's mill offered no difficulty, by the aid of a levee) and protected from overflow, and then fallowed for a season, at least, after thorough tillage.

Soils very similar to this, occur in the marsh of the Bayou Delisle, and Wolf River; also, probably, on the Bayou Bernard, and on Jourdan's River, both of which traverse the same strata of heavy gray clays from which, no doubt, these heavy marsh soils are derived.

I have not as yet ascertained, how far from the main stream this kind of soil extends. On the Mulatto Bayou, near Col. Claiborne's and Maj. A. Jackson's Sea Island Cotton plantations (¶861), the soil of the marsh, in which the "cutting" and the "round-rush" alternate, the soil is extremely sandy, so as to resemble, in specimens taken near the landing, the soil of the "pine meadows". There, also, salty spots, overgrown with samphire, are common. Situated as this marsh is, on the verge of a very sandy hommock, this circumstance cannot be surprising; it resembles, in fact, the Pascagoula marsh.

844. As for the latter, the analysis shows it to contain average amounts of most of the ingredients of a good soil, but rather an excess of soda, and of vegetable matter, in an acid condition, and likewise, quite a small amount of lime. Here too, therefore, the application of lime is indicated. It is true that in Mr. Lewis' experiment, the shell lime appeared to have no obvious effect; but this is probably attributable to the lack of proper drainage, inasmuch as the little island of thrown-up soil was surrounded by the undrained marsh, the waters of which, percolating through the loose soil, would be likely to render the lime ineffectual in a short time; and the want of proper aeration of the soil and roots at the depth of a few inches, consequent upon imperfect drainage would be likely to produce the effects noted. In all cases, *drainage* and fallowing are the first conditions of the reclamation of a marsh soil and where drainage is impracticable, in consequence of the low position, or too great permeability of the soil, it is doubtful whether it can be applied to any better use, than the improvement of the higher lands.—After the *physical* faults have been remedied, the *chemical* defects are easily righted.

845. There can be no doubt, that the addition of clay to these sandy marsh soils would be a great improvement, and ought to be effected whenever practicable—as for instance, in the marsh near the new residence of Maj. Jackson, where clay crops out on the beach. Hauling of clay as an improvement to land, is in general too expensive to be resorted to, but on the sea-coast land is so valuable, that many modes of improvement can be made to "pay", which would be impracticable elsewhere. There is not in the marsh soils analyzed, any large amount of phosphoric acid; so that the application of super-phosphate of lime, ground bones, or Columbian guano, would probably prove beneficial.

846. As to the best source from which to obtain the lime necessary in the reclamation of the marshes, it may be observed, that the shell banks of the coast may supply the demand for sometime to come. But when these are exhausted, it is to be hoped that the rich marl beds of Pearl and Pascagoula Rivers, and not the limestone quarries of Maine, will be resorted to. It were strange indeed, if a tract of country situated at the mouth of two rivers navigable during a large part of the year, and traversing the richest marl beds of the State, should fail to avail itself of these natural advantages.

Calcareous marls, as has been stated in the Geological Report, are found as low down as N. Marion, on Pearl River. These, however, might not bear transportation to any great distance, being rather poor in lime as compared with the marls cropping out on Pearl River below Jackson; *e. g.*, at Byram Station, or Cook's ferry. These marls, when burnt, would be far preferable to Northern lime, for the improvement of lands; for the analyses show that besides the lime, they contain notable amounts of other useful ingredients. The same is true of the marls of the Chickasawhay River, in N. Wayne county; and I have little doubt, that whenever these marls shall become properly known and appreciated, they will call into life a regular system of shipment during the proper season. What would be too expensive for any one to undertake, single-handed, at the present time, will assume a very different aspect when once the channel has been opened and the path marked out. We may then hope that the lands of the Pascagoula and lower Pearl will no longer be neglected; and that the extensive plains now covered with marsh rushes, will be made to bear lucrative crops of Sea Island Cotton, or at least, Rice.

847. It has already been stated (in the Geological Report, (¶), that deposits of fossil shells have been found to exist on the Bayou Bernard, and on Wolf River; and have been struck in wells at West Pascagoula and on the Habolochitto, in Hancock county.—There can be little doubt therefore, that such deposits underlie a notable portion of the sea-coast counties; and if a more special Survey should show them to exist within convenient reach, they may prove highly valuable to the agriculturist of the coast. The calcareous clay in which these shells are found imbedded, would of itself be a great improvement to the sandy marsh soils and hommocks; and in places where, as at Pass Christian, the gray clays are found at a moderate depth (8 to 10 feet) they might be made to serve for the improvement of the gardens, which at the present time will not produce a number of vegetables, for which there would be an excellent market on the spot. It is always advisable, however, before applying these clays to the soils, to allow them to "cure" or disintegrate in the air for sometime. They sometimes contain iron pyrites, copperas, etc., which are noxious to plants, but are destroyed by exposure to the atmosphere, especially if some burnt lime be added to the pile. In composting manure, they might be made very serviceable, inasmuch as the manure does not require transportation to any great distance.

848. In traveling from West Pascagoula to Ocean Springs, we pass almost entirely through wet Pine Meadows of the character heretofore described. Occasionally, where a stouter growth of pine occurs, coal-burning is carried on, on a considerable scale. Approaching Ocean Springs, the soil changes: instead of the usual yellow sand, the subsoil consists of a pale yellow loam which also forms the bank at the beach. The growth likewise, differs from that of the "sand hommocks"; oaks are very scarce, and the "pitch pine" prevails almost exclusively, near to the beach.

Bellefontaine Island, which forms the promontory between Biloxi and Pascagoula Bays, possesses considerable tracts of very fertile hommocks, and several plantations are situated on it. I have not, however, visited the region as yet. Fine "shell hommocks" are also found at the upper portion ("Back Bay") of Biloxi Bay; with these, also, I am not as yet personally acquainted, having passed from Ocean Springs to MississippiCity (Tegarden's) by water.

849. Between Biloxi Bay and Bay St. Louis, the pine meadow lands do not, as a general thing, approach so closely to the beach as is the case further E. Between the two, there intervenes a tract of level pine woods, the soil of which is very sandy, and the undergrowth intermediate in character between that of the "Meadow" and the "Pine Hills". The soil of the sea-shore hommocks also is extremely sandy; close to the beach, the "pitch pine" invariably prevails,

together with the Live Oak, while a little further inland, on the elevations, we find the Long-leaf Pine, and in the wet, flat depressions or "hollows intervening between them, there is a growth of Bay, Black Gum, Water, Willow, and Live Oaks, some Hickory and Magnolia. In these depressions, the soil, and especially the subsoil, is somewhat heavier than on the ridges, and the land, when drained, does very well for 5 to 6 years, but then becomes exhausted.

850. *Improvement of the Sand Hommocks.*—Lands as sandy as these cannot under any circumstances be expected to be productive for any considerable length of time, without manure of the most comprehensive kind; for the soil is naturally poor in everything but sand, though what there is in them of nutritive ingredients appears to be in a very available condition. Hence such manures as guano or ammoniated guano are thrown away on them; they do not require stimulants, but nutritive matters; and what is very important, they require to be corrected, first of all, with reference to their relations to moisture. Thorough draining of the level lands is the first necessity; after this is done, it would be best to allow them a season's fallowing, after thorough tillage, inasmuch as they are usually bluish at first (from the presence of protoxide of iron—¶383[1]). Wherever there is a clayey subsoil *of some thickness*, the tillage ought to be as deep as practicable; but care must be taken in this case, that there be some clay subsoil *left* between the tilled layer and the yellow sands which generally underlie; for if the plow were to penetrate to these, the land would be rendered incapable of improvement, as all the manure which could be applied would sink beyond the reach of plants in a short time (¶510).

The high market value of the sea-shore lands might render it practicable in not a few cases, to improve the soil by hauling on it clays occurring in the neighborhood. Each one must, however, judge for himself as to the practicability, in his own particular case, of this mode of improvement, which is generally too expensive to be practiced on the large scale.

851. *Origin of the Shell Hommock Soil.*—The mode of improvement most practicable at the present time is probably that of the joint application of lime and vegetable matter to the soil. This is precisely what has been done by nature, assisted by the Indians, in the case of the "hommocks".

All of these were at one time, undoubtedly, "sand hommocks". The action of the lime of the shells at first induced a more vigorous vegetation; the latter, when dead, was rapidly decomposed by the action of the lime, and the healthy humus thus formed, prevented the return of the nutritive matters of the plants to depths beyond the reach of the roots. Every year's growth thus deposited on the surface an additional supply of nutritive ingredients, which the roots, penetrating to great depths in the loose soil, had brought up from below; and thus finally we have had a soil formed, which is essentially a mixture of sand and humus, with but very little clay. It contains the accumulated wealth of many years vegetation, to which is added the lime, phosphoric acid, and animal matter of the shells.

852. If, therefore, we would effect a similar transition of the present "sand hommocks", we must imitate what nature has done, as nearly as we can

Shell lime alone, applied to the sandy soil, might increase its productiveness for a short time, but would kill it very soon (as guano is known to do), *if the crops were removed from the soil.*—We must add vegetable matter *at the same time* with lime; and *that* vegetable matter ought to be in a considerably advanced state of decay.

In clay soils, which are very retentive of moisture (¶378), undecayed vegetable matter, when brought into the soil in company with lime, will very soon decompose. But in sandy soils, which are subject to continual, abrupt changes from wet to dry and *vice versa*, the decay is exceedingly slow; and besides, the presence of much undecayed straw, leaves, etc., is liable to increase the "openness" of the light soil to an injurious extent. Vegetable matter ought always, therefore, to be well "rotted" in the compost or manure pile, before being applied to soils of this kind. (In reference to this subject, see ¶790, ff.).

853. *Marsh Muck as a Fertilizer.*—There is a source of vegetable matter already decayed, very generally available on the Coast—viz: the *Muck* of the marshes, especially those occupied by the "Jonc coupant" (¶835, 840). It is doubtful whether this muck, if applied to the hommocks *by itself*, in its naturally acid condition, would be much of an improvement, although (as the analysis of Mr. Lewis' Marsh soil shows) it is rich in the nutritive ingredients of plants. But when applied conjointly with a due proportion of lime (shell lime or any other), it would undoubtedly form a highly valuable addition to the soil (¶442), and improve it permanently by correcting its defects in relation to the retention of moisture and manure.

It would probably be found most convenient in practice to mix the muck with a certain (not excessive) proportion of lime when freshly thrown out; leaving it afterwards to lose the greater part of its water, to diminish the cost of hauling, before applying it to the land. More lime may then be added by sowing it broad-cast, after the muck is turned under. If too much lime were added while the muck is in a moist condition, by itself, a portion of the valuable ammonia it contains might be driven off and lost.

854. *Plaster* (¶436), would not probably answer very well in the place of lime; but in most cases, an *admixture* of this substance, when lime is *chiefly* used, would be highly advantageous. Ground bones, super-phosphate of lime, and "*Columbian* Guano" (¶432), would be very useful in conjunction with the muck; and in most cases, by themselves alone also, though not to the same extent.—All kinds of ashes will be especially beneficial when mixed with the Muck.

Pine straw is oftentimes a valuable fertilizer, where muck is not. It ought to be well rotted before application. (In regard to its use, composition, etc., see ¶790, ff.).

855. In the sandy soils of the "hommocks", as well as in those of the inland Meadows (¶821, 824), there are sometimes "clay ridges". Athough termed *ridges*, they are not *necessarily* elevated above the general level of the sandy lands; perhaps in the majority of instances, this is, however, the case; so much so that any unusual elevation of the ground, away from the shore, is rather indicative of a clay subsoil. These "ridges" do not seem to conform very sensibly to the direction of the present drainage of the country. Thus, at Handsboro', we find a heavy, orange-yellow clay forming the subsoil on a part of Mr. T. J. Humphries' land, at an average depth of 12 inches; the surface soil being quite light and sandy, so as to allow of an undergrowth of gallberry and dwarf palmetto, while the timber is formed by Long-leaf Pine, Sweet Gum and Black Jack—the last two, as a general thing, denizens of a heavy soil.*

We have, in this instance, a striking example of the difference which may

*At least—so far as the Black Jack is concerned—when its trunk is high and its branches spreading; while a short trunk and small, bushy tops are characteristic of a sandy soil.

occur in the indications of the timber as compared with the undergrowth; the timber being indicative of clay soil, whereas the *arable* surface soil is really sandy. The clay stratum is some 20 feet in thickness; as we go down, it gradually becomes paler and mingled with bluish and white specks; it is underlaid by white or blue sand.

856. This clay is found on both sides of the Bayou Bernard, for a short distance, and its limits are pretty sharply defined. On an elevation 30 yards from Mr. Humphries' house (where there is a well dug entirely in this clay, of the depth above named, and without curbing) no clay is struck at 20 feet—all sand.—The soil is said not to produce well without manure; but it seems that subsoiling has never yet been tried. At all events, such land is capable of fine improvement.

Another example of a clay ridge approaching the coast, has already been mentioned as existing at Ocean Springs (¶848). Others occur on or near the "Back Bay", according to Dr. Tegarden. As a general thing, the clay ridges become more frequent as we advance westward; and at the head of the inner Bay St. Louis, a few miles inland, we strike a Pine Hill region, where the greater portion of the lands have a good loam subsoil. Here the pines attain to a good size, and a great deal of charcoal is made. Fine lumber is rafted down Wolf River and Bayou Delisle, to Mr. Huddleston's mill, and others; and I understand that the country between Wolf and Jourdan Rivers is generally of the hilly character just mentioned, with but few meadow spots of considerable extent.—At Mr. Huddleston's mill, too, we find a heavy clay subsoil, similar to that at Humphries', above mentioned; here also, the surface soil, to the depth of 8 to 10 inches, is quite light and sandy. These clay lands extend about a mile up the Bayou Delisle, from its mouth—into the Marsh of Wolf River. This underclay makes fine brick—quite a desideratum in the coast region.

857. The singular outcrop on Wolf River, at Mr. I. Saucier's, S. 20, T. 7, R. 12 W., has been described in the Geological Report (¶249). It is effectually, as there stated, an ancient, now subterranean, Cypress swamp. As such its muck or mud might be supposed to possess considerable fertility; it is, however, a pretty stiff gray clay, which, from its aspect would not seem to be worth transportation. Analysis, however, will decide this point.

Mr. H. Taylor, at Pass Christian, informed me that about twenty-two miles, by water, above the mouth of Wolf, there is an outcrop of shells on the banks, on both sides, I regret very much my inability to visit the locality at the time, both on account of the geological interest attaching to such a deposit, and its probable value for agricultural purposes. The deposit is probably of a character similar to the small outcrop at Mr. Bell's, S. 16, T. 7, R. 11 W., on the Bayou Bernard, which has also been described (¶248); and shells have also been found in a well at Habolochitto Bridge, by Col. Kimball. Altogether, it is highly probable that clayey shell deposits of considerable extent exist in the middle portion of Harrison and Hancock counties, which may prove of great value to the agriculturists of the coast.—The special survey of these counties will have to decide the point.

858. On the Bayou Bernard (at Bell's), and in many other localities in the hilly country, there are outcrops of white pipeclay and hardpan, belonging to the Orange Sand formation (¶70). They are here, as everywhere, almost absolutely void of nutritive ingredients, and unfit for the improvement of soils—except perhaps in a few cases, as purely mechanical manures. These clays are readily distinguishable by their chalky touch; they are frequently (as at Bell's), accompanied by variously colored sands, and red and yellow ochre. These, with the Selenite or gypsum found at Dwyer's ferry (¶246), and the iron pyrites in some of the gray clays, are the only minerals found, or likely to be found, in the seacoast counties.

859. Pass Christian and Shieldsboro' (Bay St. Louis), are both situated on Sand Hommocks, elevated from five to twelve feet above tide-water. In both,

the beach is occupied by the "Pitch Pine" and Live Oak; and level pine woods (of Long-leaf Pine), with wet spots characterized by the Pitcher-plant (*Sarracenia variolaris*), and yellow star-grass (*Aletris aurea*) form the back ground at no great distance. Such, also, is the aspect of the country passed over in traveling from Shieldsboro' to the mouth of Pearl River, and to Pearlington.

Shell banks and hommocks (¶833; 851), occur, to a large extent, on the western shore of the inner Bay St. Louis, inland from Shieldsboro'. The shells (chiefly the "clam", or *Gnathodon*) have been used in the improvement of the (extremely sandy) streets at Pass Christian; and the "shell roads" thus made are exceedingly pleasant to the traveler who has been obliged thus far, to jog along at the rate of a mile and a half an hour, in the deep sand of the "hommocks." I have not as yet personally visited these shell deposits.

Thereafter, we meet with no more shell banks or hommocks, up to the mouth of Pearl River; there, on the Sea Island Cotton plantations of Col. Claiborne and Maj. A. Jackson, we find several extensive deposits—the last, in this direction, in the State of Mississippi.

860. An exception to the general character of the sand "hommocks" of this region, occurs at Col. J. F. H. Claiborne's residence, at the extreme west end of Shieldsboro', five miles from the Point. The hommock land on which Col. Claiborne's residence is situated, resembles a good deal that of the Pascagoula shell hommocks, although *no shells are found there.* The light, "mulatto" colored soil scarcely changes for about ten inches from the surface; then its color gradually becomes paler; the subsoil is very sandy, so that it is advisable not to plow too deep (¶510). At two and a half to three feet, there underlies a yellow hardpan, which at times passes into a pretty heavy clay, which has been used to advantage in making brick. It lies too deep to be reached by the plow. The same material crops out on the beach, forming a steep bank some five feet high. This is another of the "clay ridges" reaching down to the shore.

This hommock land produces corn finely—forty bushels to the acre—and is a warm, generous soil, easily tilled. Its growth is mainly Sweet Gum and Magnolia, with Oaks, viz: the Live Oak, Spanish ("*Red*"), Water and Laurel-leaved Oak; Pitch Pine, Hickory, "Cassina", Stag-horn Sumach, Persimmon, Spanish Mulberry, Wild Plum, and Grape vines. This growth, it will be observed, is almost identical with that of the Pascagoula "Shell hommocks" (¶833), as well as the river hommock at Dwyer's ferry (¶819). Patches of hommock land somewhat similar occur near the heads of Mulatto Bayou, *e. g.*, at Maj. White's plantation; it is, however, underlaid by stiff gray clay at about three feet.

Between Shieldsboro' and the mouth of Pearl River, the coast is mostly low, and a great deal of it taken up with marshes, usually of the "Round Rush" character.

861. THE SEA ISLAND COTTON PLANTATIONS.—The rich "hommocks" which form the soil of these plantations, are situated at the south-eastern border of the great Pearl River marsh on Mulatto Bayou. They comprise, on the whole, an area of about —— acres, and are bounded by the level pine woods on one side, and by the marsh or the Bayou on the other, forming a belt one-third of a mile on an average, and elevated six to ten feet above the marsh. The soil is very light and easily worked, of a dark "mulatto" color; its aspect does not vary sensibly for eighteen to twenty inches, at which depth there underlies a pale yellow sand. It bears a magnificent growth of Magnolia, the latter being almost the predominant tree; next to it Sweet Gum, Bay, Live Oak, Spanish ("*Red*"), White and Laurel-leaved Oaks; Ironwood, Sassafras, Hickory, and the Pitch or Bottom Pine, sparingly; French

Mulberry (*Callicarpa americana*), Hercules' Club ("Prickly Ash"—*Aralia spinosa*), Muscadine and Summer-Grape. The Magnolias, Oaks, Hickories, Gums, and especially the Pines, are very large trees and thickly hung with long Moss.

The character of the soil, as well as that of the vegetation, is very similar to that of the shell hommocks seen at West Pascagoula, but as a general thing, no shells are found on their surface at present, save in two localities, viz: one about three hundred yards long by ten wide, on the very banks of the Mulatto Bayou, at the south end of the tract (on Maj. Andrew Jackson's plantation); and another rather smaller one, further north, on Col. Claiborne's land.

862. *Shell Deposits.*—The former, which is about 10 feet high where it adjoins the Bayou, consists altogether of the "clam" shell or Gnathodon, and has been largely drawn upon for the purpose of improving roads and streets at New Orleans; and although there is but very little earthy matter mixed with the shells, the cotton thrives finely on its very summit. The other shell bank, on Col. Claiborne's plantation consists almost exclusively of oysters; it has been greatly spread and leveled by cultivation, and much soil is mingled with the shells. This shell deposit is at some distance from the present channel of Mulatto Bayou, but it is on the verge of a broad, deep ravine, in which there is but little water at present; but as it connects with the present bayou, there can be little doubt that it was once a navigable channel. The position of this shell-bank at a distance from the present channel does not therefore form a real exception to the rule, that these banks are found in spots accessible by water.

863. Several branches in deep ravines flow through this hommock; they are fed by springs yielding abundance of good drinkable water throughout the year. Their temperature is not very low, but they are not in the least brackish. The growth on their banks differs very little from that of the "hommock".

Most of the "hommock" land is now in cultivation, and when fresh, it yields about—— of Sea Island Cotton per acre. The mode of culture does not differ materially from that usual with the common cotton; the chief difference is in the preparation for market as the Sea Island staple requires to be ginned by means of the *roller gin*—a much more troublesome process than that with the saw gin. Moreover, it is not pressed into bales, but put up in long round bags, by tramping with the feet. These bags are made to weigh from 250 to 350 lbs.

864. In passing from the Sea Island Cotton plantations towards Pearlington, around the head of Mulatto Bayou, we find at first a country very much resembling that between Shieldsboro' and the Plantations (¶859); after crossing the Bayou, the soil becomes more clayey, but no better for all that; countless crawfish chimneys in all low regions, show the existence of an impervious clay stratum at no great depth—as in fact, proves to be the case at Maj. White's; and at Pearlington (¶251), where the soil is moderately clayey and productive, and bears a young growth of Oaks, which here spring up wherever the Pine is cut down.

In traveling the "River road" from Pearlington northwards, we see, for the first 3 or 4 miles, a level country timbered with tall, somewhat lank, Long-leaf Pine, with only here and there a Post or Water Oak, and full of crawfish holes. As we advance northward, however, and the country ascends, the soil improves, especially near the river, where we find, near Napoleon or Pearltown, a hommock elevated 15 to 20 feet above the river level, possessing a yellow loam subsoil—a good brick-clay—2 to 3 feet thick, and a growth of stout Bottom (Pitch) Pine, Post, Water, and White Oak, and of Willow Oak of tall, graceful growth. This hommock, however, is only from 300 yards to ½ mile wide, gradually increasing in width as we advance northward; and further inland we find the level "Pine Woods".—At Gainesville, the same condition of things obtains; the bluff is higher; wells obtain freestone water at 20 to 25 feet, in sand.

865. Northward of Gainesville, the level Pine Woods are sometimes interspersed with tracts of undulating land possessing quite a heavy clay soil, on which the Oaks sometimes preponderate over the Long-leaf Pine; it is said, nevertheless, that the soil of the level Pine Woods is preferable to the former on account of the great heaviness of the Oak soil, which is underlaid at about three feet, by heavy gray potter's clay. In native fertility the Oak soil is doubtless superior, and judicious cultivation would, doubtless, render it the most profitable (¶808, ff.). But in all this region, cattle-raising, rafting timber, and tar-burning, are the prevalent occupation of the inhabitants, and the soils have scarcely been fairly tested. Col. Kimball, of Habolochitto, informs me, however, that in both soils, the muck of the hollows and bottoms exercises a fine effect, as also does pine straw—all of which, in the north-eastern portion of the county, have been used on a large scale by some planters. The bottom of Pearl River, in the whole of Hancock county, is almost entirely on the Louisiana side (¶703).

866. The heads of Jourdan's and Wolf River are in a level Pine country, like that just described; but on the east fork of the Habolochitto, there are some higher ridges.

The bottom of the Habolochitto is quite extensive, and, judging by its growth, possesses a fertile soil; but is too often overflowed.

Northward of Habolochitto Bridge, we travel for about four miles in a level Pine country, void of springs, which divides the waters of Pearl from those of Habolochitto. Occasionally we still see, in this tract, wet spots with the peculiar flora of the Wet Meadows of the Coast (¶821, 824, ff.). But beyond we ascend into the Orange Sand ridges which here skirt Pearl River (¶780), and take a final farewell of the flora and soils of the Seacoast.

867. Waters of the Coast—The geological phenomena of the Coast, as far as observed, have been described in the Geological Report (¶247 to 251). It has there been stated, that strata of compost blue or gray clay underlie, at no great depth, all the Coast region; and it is well known that clays of a similar character form the bottom of the sea at no great distance from the land, where the beach sands cease. Wells dug in the sand hommocks of the coast, strike these clays at a depth from ten to twenty-five feet; but the water obtained *in* them, is almost always mineral, and unfit for daily use. Doubtless the mineral springs of Lynchburg or Ocean Springs, have their origin in the same strata. Sometimes logs or stumps of Cypress or Pine are struck in these wells, buried in the "black mud", which is frequently very fetid. In digging wells near the coast, it would be well always to ascertain, by a preliminary bore, at what depth the "black mud" underlies. A moderate supply of good drinkable water is frequently obtained a few feet above the clay stratum; at Pass Christian, for instance, at a depth of from eight to ten feet; but every attempt to deepen these wells, so as to increase the volume of water, is liable to result in the entire loss of the well, so soon as the "black mud" is reached.

868. It appears, from observations made both on the Coast and on the islands of the Sound, that the water of the latter is rendered almost fresh by filtration through the beach sands, which contain more clayey and vegetable matter than one would give them credit for. It is therefore better, in general (if cisterns be not used), to rest satisfied with shallow wells, and have several of them, than to risk spoiling the water by undue deepening.

869. In the few deep wells which have been dug along the Coast, not an inconsiderable rise has been observed in the water obtained at greater depths, beneath the uppermost clay stratum. Thus, in a well forty feet deep, at the residence of Mrs. McRae, West Pascagoula (¶250), the stream of water last struck rose fifteen feet.

So near the beach, one might suppose that the sea-water had some part in effecting this rise; but the Coast-Survey soundings show the existence of the impervious clay stratum at the sea-bottom, all along this coast; besides, the mineral water of Mrs. McRae's well is very different in composition from sea-water. It is not impossible, therefore, that artesian wells, most likely yielding mineral water, might be obtained on the sea-coast at the proper (not very great) depth.

The character of the strata renders boring easy, and it might be well worth the while of some of our enterprising dispensers of sea-shore air to refugees from the cities, to try the experiment. Artesian fountains would certainly be a great addition to the beauty and attractions of the rural palaces of Pascagoula, Mississippi City, Pass Christian, and Bay St. Louis.

870. The character of the mineral waters of the Coast is generally that of *saline chalybeates*, with more or less sulphuretted hydrogen, and some carbonic acid. The iron exists in them, partly in the state of sulphate (copperas), partly as the carbonate. Chloride of Sodium (common salt), Chloride of Magnesium, and Chloride of Calcium, are present in all that I have examined; to these is sometimes added (*e.g.*, in Mrs. McRae's well-water, and that of a mineral spring on the land of Mr. Alfred Lewis, West Pascagoula), Sulphate of Soda, or Glauberls salt. Few are entirely free from sulphuretted hydrogen; some (*e. g.*, one of the Ocean Springs waters), are strong sulphur waters. In many cases, however, the taste of decaying vegetable matter (the smell of the "black mud"), predominates over all the rest. Such is the case with the waters dripping from the gray and black clay bluffs containg cypress trunks, on Wolf River (¶249), and, according to report from others, in the wells dug near the Bayou Bernard, in Mr. Bell's neighborhood, six to ten miles above Handsboro' (¶248.)

871. The Islands.—Ship Island is the only one of the islands of Mississippi Sound, which I have personally visited; it is said, however, to be a pretty fair specimen of all the rest, with the exception of the Chandeleur Group, which are said to be different in character, and quite productive.

At the East End of Ship Island, we find a bar of white sand, about a mile and a half long by ¼ wide, little elevated above tide-water; storm tides always sweep over it, and hence it is strewn with sea-shells. It bears no vegetation save a few tufts of grass, and small patches of a species of Stone-crop. Further west, the ground becomes more elevated, and the "Pitch pine" appears, with an undergrowth of Dwarf Palmetto (*Sabal minimus*), stunted Live Oak, and three or four kinds of undershrubs, not found in bloom. The Prickly Pear, also, is occasionally seen. Such is the growth on the ridges, which rise 10 to 25 feet above tide level; between these extend small marshes, mostly covered with the Round-rush; their water is very brackish. The soil is scarcely anything but a white sand, without any coherence, save where it is matted with roots.

At the West End, near the fort and light-house, vegetation is somewhat better; the grass (chiefly *Panicum* and *Paspalum*) sufficient to sustain a number of cows, the milk of which is of excellent quality. With the aid of manure, the light-house keeper has raised good vegetables in his garden; which is a great deal more than these white sand ridges promise at first sight. Water is readily obtained in the level spots by digging a few feet, or sinking a barrel; it is so nearly fresh, even within 30 yards of the beach, that those accustomed to its use, do not seem to notice the slight brackishness which is apparent to the visitor.—The pines average 35 to 45 feet in height, and are about 6 inches in thickness.

872. Such appears to be, with little variation, the character of

all the islands of this group. Cat Island is probably the best in point of fertility, as there is a plantation on it—respecting which I could not, however, learn any particulars. The " —— Spit", a white sand-hill on Cat Island, sixty feet in hight, is a land mark, and the only one, on this coast.

The shape and extent of the sandbars connected with these islands, is, of course, somewhat variable, since storm-tides will sometimes sweep away some and enlarge others; yet the channels for navigation are on the whole subject to but little change.

It is asserted by pilots that the narrow neck of land which connects the East End of Ship Island with the West End, has within their recollection been broken through by the sea, so as to allow small craft to pass through the break; but has subsequently been closed up again.

873. In consequence of the irregular configuration of the sea-bottom (as exhibited in the soundings of the Coast Survey charts) and the diversions caused by the islands, the tides of Mississippi Sound are very perplexing to the novice. The increase of depth from the shore seaward, is so gradual, that wharves of great length are necessary to accomodate the shipping.

Thus the wharf at Dr. Tegarden's Hotel, Mississippi City, is about two-thirds of a mile in length, and that of Barnes' Hotel nearly three-quarters; which allows of sufficient depth of water for the New Orleans Steamers, even at low tide. Hundreds of smaller wharves have been built, all along the coast, in front of private residences.

The extensive oyster banks of Mississippi Sound are well and widely known and appreciated; the bivalve is of superior quality. The great number and variety of excellent fish found in the same waters, will scarcely fail to satisfy the most fastidious taste.

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874. I have been somewhat minute in the description of the general character of the Coast region, because it is less known to the majority of the people of Mississippi, than any other portion of the State; in consequence, no doubt, of the difficulty of inter-communication at present existing. Although abstractly aware of the fact that Mississippi possesses a share in the shores and waters of the Gulf, it has not, until recently, entered to any great extent into the calculations of the people at large. Yet the most casual observer, so soon as personal inspection shall have made him conscious of the reality, cannot fail to be impressed with the immense importance of opening a highway through which Mississippi may communicate, over her own soil, with a portion of her territory which possesses both a harbor commensurate with the magnitude of her commercial interests, and a climate not only healthful and pleasant, but capable, moreover, of producing many

of the choicest fruits, of the tropics as well as of the temperate zone.*

Along with the cotton bales of North and Central Mississippi, the lumber and turpentine of the vast Pine forests of the South would find their way through this channel, to the great highway of nations. Nor would the ample grazing grounds which separate these forests from the Coast long remain without a landmark to guide the traveller. May the day not be far distant, when one uninterrupted band of iron shall link together the wheat and cotton fields of Tennessee, and the Live Oak and Orange groves of the Coast of Mississippi.

*Through the courtesy of Mr. B. H. Green, the Chief Engineer, I have been placed in possession, both of the new location of the Gulf and Ship Island R. R., which will be found on the map, and of the results of the levelings on the route, which for lack of space are reserved for a subsequent Report.

	Clarke Co.	Hinds County.		Warren Co.	Rankin
	Garland's Creek.	Jackson.	Byram.	Vicksburg.	Dr. Qu
Insoluble Matter........	45.881	37.400	12.308	20.967	[illegible]
Potash................	1.717	0.445	0.611	0.753	[illegible]
Soda....	0.465	0.208	0.179	0.283	[illegible]
Lime..................	14.785	28.821	43.932	37.543	[illegible]
Magnesia..............	2.476	1.407	1.688	2.082	[illegible]
Brown Oxide Manganese	0.403				[illegible]
Peroxide of Iron........	13.020	5.133	2.696	4.722	[illegible]
Alumina....	7.751				
Phosphoric Acid........	0.327	0.256	0.224	0.135	
Sulphuric Acid.........	0.566		1.266 (Pyrites)		[illegible]
Carbonic Acid..........	12.492	23.084	34.720	30.838	[illegible]
Organic Matter and Water		3.246	2.396	2.657	[illegible]
	99.556	100.000	100.000	100.000	[illegible]

	Marshall County.		Claiborne County.		
	Claystone. Soil.	Subsoil.	Soil.	Subsoil.	Loar
Insoluble Matter........	83.247	83.993	87.573	79.477	[illegible]
Potash................	0 549	0.700	0.458	0.741	[illegible]
Soda..................	0.082	0.049	0.124	0.248	[illegible]
Lime....	0.245	0.139	0.244	0.238	[illegible]
Magnesia..............	0.479	0.579	0.545	0.830	[illegible]
Brown Oxide Manganese	4.798	0.332	0.205	0.346	[illegible]
Peroxide Iron..........	6.282	3.862	3.231	5.635	[illegible]
Alumina...............	6.282	7.729	4.842	8.849	[illegible]
Phosphoric Acid........	0.068	0.236	0.105	0.092	[illegible]
Sulphuric Acid.........	0.062	0.054	0.028	trace	[illegible]
Carbonic Acid..........					[illegible]
Organic Matter and Water	4.195	2.716	3.073	3.496	[illegible]
	100.039	100.399	100.429	100.038	[illegible]

APPENDIX A.

MARLS, LIMESTONES, ETC.

	MARLS.														LIMESTONES.					CLAYS.		
	CLARKE CO.	HINDS COUNTY.		WARREN CO.	RANKIN CO.	CARROLL CO.	MARION COUNTY.		FRANKLIN CO.	LOWNDES CO.	TIPPAH COUNTY.		CHICKASAW CO.		PONTOTOC CO.	RANKIN CO.	TISHOMINGO COUNTY.			ITAWAMBA CO.		SIMPSON CO.
	Garland's Creek.	Jackson.	Byram.	Vicksburg.	Dr. Quin's.	Shongalo.	Barnes'.	Burnett's Bluff.	Cassady.	Waverley.	Ripley.	Wilhite's.	Houston.	Rotten Limestone, Okalona.	Daggett.	Yosts' Furn.	Black Limestone, Cypress Pond.	Hydraulic Limestone. Eastport.	Billings' Mill.	White Clay, Clingscale.	Astr. Earth, Stovall	Pine Straw.
Insoluble Matter	45.881	37.400	12.308	26.067	13.074	55.705	77.438	83.691	49.475	88.702	62.411	73.410	35.750	10.903	8.374	2.029	1.680	35.281	54.201	90.877	86.879	65.312
Potash	1.717	0.415	0.611	0.753	0.265	1.604	0.709	0.827	1.242	0.204	0.730	0.702	0.681	0.248	0.359			0.348	0.473			5.530
Soda	0.465	0.208	0.179	0.283	0.031	0.045	0.101	0.268	0.152	0.190	0.272		0.197	0.320	0.089							0.416
Lime	14.785	28.821	43.932	37.543	40.222	0.166	4.800	0.793	13.190	1.351	7.952	6.315	20.558	45.791	48.815	52.474	53.494	32.603	23.247	0.140	0.732	13.860
Magnesia	2.476	1.407	1.688	2.082	0.614	1.630	1.248	1.053	1.825	0.723	1.560	0.886	1.366	0.877	0.751	0.667	0.817	0.630	0.788	trace	0.237	5.208
Brown Oxide Manganese	0.403				0.067		0.316	0.223	0.266		0.160	0.050	0.305		0.173							1.681
Peroxide of Iron	13.020	5.133	2.696	1.722	2.722	34.317	2.989	4.394	5.538	5.598	11.849	7.055	4.190	1.421	2.412	2.125	0.580	1.581	0.903	0.126	4.518	0.441
Alumina	7.751						6.449	8.347	12.587		5.865	5.888	9.475	1.957				1.914	1.064	2.214		4.539
Phosphoric Acid	0.327	0.256	0.224	0.135	trace	trace	0.111	0.148	0.132	0.328	0.266	0.046				0.075			trace			1.154
Sulphuric Acid	0.566		1.266 (Pyrites)		0.058		trace	0.022	0.033	0.013			1.743 (Pyrites)		0.077						1.385	0.894
Carbonic Acid	12.492	23.081	34.720	30.838	34.754	0.129	3.372		9.555	0.472	9.905	5.640	16.760	35.725	38.485	41.529	42.035	27.643	15.572			1.479 (KCl)
Organic Matter and Water		3.216	2.396	2.657	2.050	7.012	2.664		5.876	2.303			8.774	2.840	0.832	1.100	(c) 1.340		3.752	6.930	6.083	
	[illegible]	100.000	100.000	100.000	99.857	99.948	100.197	99.761	99.871	99.884	100.000	100.000	99.799	100.082	100.367	99.924	99.947	100.000	100.000	100.287	[illegible]	100.000

SOILS AND SUBSOILS.

	MARSHALL COUNTY.		CLAIBORNE COUNTY.			HINDS CO.	MONROE CO.	JASPER CO.	HANCOCK COUNTY.		JACKSON COUNTY.		JACKSON CO.	SMITH COUNTY.		PIKE COUNTY.		JASPER CO.	PONTOTOC COUNTY.		RANKIN COUNTY.	
	Claystone. Soil.	Subsoil.	Soil.	Subsoil.	Loam.	Dr. Catchings, Subsoil.	Prairie Underclay.	Prairie Soil.	Pontotoc Ridge Soil.	Pearl River Marsh Soil.	Pascagoula Marsh. Soil.	Muck.	Pine Meadow Soil.	Pine Hill, Soil.	Subsoil.	Summit. Soil.	Subsoil.	Hogbed Prairie Soil.	Flatwoods. Soil—Heavy.	Soil—Light.	Gypseous Prairie Soil.	Underclay.
Insoluble Matter	83.347	83.993	87.573	79.477	71.314	80.788	71.539	63.435	90.572	74.150	70.183	25.225	95.592	93.257	83.030	89.801	77.931	76.758	77.854	93.575	82.558	67.027
Potash	0.549	0.700	0.458	0.741	0.511	0.634	0.542	0.796	1.096	1.003	0.559		0.061	0.259	0.485	0.218	0.266	0.525	0.753	0.254	0.339	0.518
Soda	0.082	0.049	0.124	0.248	0.115	0.185	0.230	0.127	0.423	0.375	0.957		0.050	0.065	0.061	0.076	0.072	0.190	0.166	0.066	0.023	0.411
Lime	0.245	0.139	0.244	0.238	1.921	0.266	1.075	1.815	0.178	0.182	0.109		0.023	0.129	0.073	0.034	0.152	0.424	0.178	0.082	0.432	5.695
Magnesia	0.479	0.579	0.545	0.830	1.278	1.029	0.771	1.112		1.004	0.743		0.069	0.180	0.519	0.306	0.352	0.674	0.831	0.175	0.513	1.233
Brown Oxide Manganese	4.798	0.332	0.205	0.346	0.252	0.159	0.016	0.474		0.065	0.067	8.358	0.045	0.146	0.153	0.072	0.095	0.559	0.167	0.111	0.092	0.509
Peroxide Iron	6.282	3.862	3.231	5.635	4.272	4.927	5.419	6.996	2.060	3.350	1.171		0.459	1.251	4.145	2.402	5.456	4.121	5.899	1.445	3.084	4.311
Alumina	6.282	7.729	4.842	8.849	2.823	8.940	13.253	15.895	3.555	10.643	5.894		0.848	2.356	8.871	3.783	11.870	10.059	10.302	2.605	7.424	10.751
Phosphoric Acid	0.068	0.236	0.105	0.092	0.143	0.151	0.051	0.232		0.188	0.111		0.021	0.030	0.022	0.038	0.043	0.063	0.052	tracers	0.076	
Sulphuric Acid	0.062	0.054	0.028	trace	0.060	0.076	0.036	0.085		0.858	0.176	0.347	tracers	0.024	0.021	0.036	0.035	0.059	0.032	0.008	0.058	5.751
Carbonic Acid					0.729			9.028														1.018
Organic Matter and Water	4.195	2.716	3.673	3.496	1.231	3.239	6.992		2.455	8.390	19.726	66.070	2.277	2.330	3.117	3.446	3.261	5.733	3.689	1.333	5.322	2.740
	100.039	100.399	100.429	100.038	99.779	100.393	99.954	100.000	100.212	100.212	99.796	100.000	99.443	99.997	100.497	100.202	99.977	99.163	99.841	99.653	99.911	100.000

APPENDIX B.

CATALOGUE OF TOMBIGBEE GREEN SAND FOSSILS, BY DR. WM. SPILLMAN, OF COLUMBUS, MISSISSIPPI.

Anomia tellinoides.
" *argentaria.*
Ammonites carinatus. n. s. Tuo.
" *lobatus.* " "
" *nolosus.* " "
" *angulatus.* " "
Baculites asper.
" *compressus.*
" *arculus.*
" *labyrinthicus.*
**Buccinum.*——2 sp.
Cardita——.
Coprolites.
Dentalium rugosum.
**Exogyra costata.*
**Fusus.*——3 sp.
**Gryphea incurva.*
**Hamites torquatus.*
* " *circulus.*
Inoceramus alveatus. n. s. Tuo.
" *inflatus.* " "
" *triangularis.* " "
" *proximus.* " "
" *biformis.* " "
" *scalaria.* " "
* " *barabei.*
Lucina.——3 sp.
Nucula. ?
**Nucleolites.*
Nautilus orbiculatus. n. s. Tuo.
" *angulatus.* " "
" *Spillmani.* " "
**Natica petrosa.*
Ostrea ambigua. " "
* " *plumosa.*
* " *cretacea.*
* " *falcata.*
Pyrula trochœformis.
" 2 undetermined species.
Pinna——very large.
Pecten quinque costatus.
* " *membranosus.*
Placuna.——unknown.
Pholadomya occidentalis.
**Serpula.*——2 sp.
**Trigonia thoracica.*
Turritella vertebroides.
Terebratula Harlani.
Teredo tibialis. n. s. Tuo.
" *calamus.* " "
Voluta Spillmani. " "
" 2 undetermined species.

FOSSIL TEETH.

Saurocephalus lanciformis.
Oxyrhina Mantelli.
Otodus appendiculatus.
Enchodus cretaceous.
Corax appendiculatus.
Sphyruria.——
Lamna.——
Ptychodus Mortoni.

*Those so marked are common to the Tombigbee Green Sand and the Rotten Limestone.

APPENDIX C.

EXPLORATION OF THE HYDRAULIC LIMESTONE DISTRICT OF TISHOMINGO COUNTY, BY PROF. W. D. MOORE.

UNIVERSITY OF MISSISSIPPI, July 20, 1860.

DR. E. W. HILGARD—*My Dear Sir* :—According to promise, I left Oxford on the 11th inst., for Tishomingo County, in order to verify or disprove your conjecture, "that the Hydraulic Limestone would be found between Eastport and the Tennessee line", in other localities than those recorded in your field notes. I reached Red Sulphur Springs—the "point d'appui" on the 12th, and though very much wearied, spent the remainder of the day, in making myself familiar with the aspect of the Limestone as it appears there, the form of the hills made by it, its characteristic vegetation, and its relations to the Orange Sand. I found the rock, on the road between "Red Sulphur" and the "Big Chalybeate" about a mile from the former, and *at* the latter in a solid ledge twenty or thirty feet thick, which runs along the little branch formed by the spring, for nearly half a mile. About three hundred yards from the Red Sulphur, due east, a little stream is crossed by the road; along this stream, to the Tennessee river (nearly two miles), the rock appears in a continuous ledge, till at Winn's Ferry, it rises in a cliff to the height of seventy feet; at this point, not more than a quarter of a mile from the Tennessee River, specimens were taken from the base, middle and top of the cliff. This examination settled in my mind the general structure of the hills, along the course to be examined, and as all subsequent investigations only served to confirm this conclusion I may as well state it at once, viz: the road from Red Sulphur to Eastport runs along a ridge, the base of which is the Hydraulic Limestone, overlying which is the angular chert, itself covered by the ferruginous conglomerate; on this ridge so constructed the loose sand and pebbles of the Orange Sand have been piled, borne against it at some points with such violence as to have denuded the ridge of everything except the Hydraulic Limestone, leaving *your* "bald hills" covered with their peculiar vegetation, and at others with such velocity and force as to have passed over the face of the cliff, forming immense deposits which hide the limestone entirely; the streams, great or small, cutting through this ridge—as Yellow Creek, Indian Creek, the little branch running down to Winn's landing, the one flowing through Mrs. Brigg's place, and that through Mr. Moore's—emptying into the Tennessee—all expose in their beds and banks the Hydraulic Limestone. There is no exception to this.

On Friday morning, in company with Mr. Skipwith of N. Orleans, who has a summer residence near "Red Sulphur," and to whose intelligent kindness I am greatly indebted, I started to Eastport, his object being, to point out to me a fine example of a "bald hill" about two miles south-east of the Red Sulphur Springs, with the characteristic Red Haw, Stonewert and Prickly Pear; it is simply the bluff of Yellow Creek, and on both sides of the stream, to its mouth, there is a continued ledge of the rock as already observed by you. Crossing Yellow Creek and passing Billing's Mill about two miles, I found a road running down to the river (Tennessee) and followed it, descending and passing over the Orange Sand and loose pebbles—the ferruginous conglomerate—the shattered angular chert—to Billing's Hollow, in which I found a pretty little stream, running over the limestone for nearly two miles, to the river. I traveled along the river bottom, clambering over the debris of the cliff and through all sorts of obstructions for nearly two miles further and found the limestone again, in great force, in the bed of a little stream, flowing through Mrs. Briggs' plantation. At this point, further progress along the river seeming impossible, I ascended the ridge once more and went on to Eastport, finding the limestone only once in a "bald hill," on Mr. Moore's place.

Somewhat discouraged, I determined to go up the river, if compelled to walk, believing that I had correctly made out the structure of the ridge, and that I should certainly find limestone all along the river from Eastport to "Red Sulphur"; fortunately in Eastport I found a guide and a very intelligent and obliging one, in the person of Mr. Vance, who undertook to show me a path along the face of the cliff and who fulfilled his engagement. Without wearisome details I give you the result of subsequent explorations, in the following specifications of localities, on a line along the Tennessee River from Eastport to Winn's Landing. The limestone forms a continuous cliff from Eastport to the limit of Mr. R. W. Brice's land

½ mile through Mr. J. Hill's land;
¼ " " Mr. J. Welsh's "
¼ " " Mr. Dan. Dexter's "
½ " " Mr. Wm. Clement's land;
1 " " Dr. Cochrane's land;
1 " " Mrs. Brigg's land;
½ " " Mr. Moore's land;
½ " " Mr. Busby's land;
¼ " " Mr. J. Mar's land;

for the next three miles the limestone is covered by fallen chert, conglomerate and pebbles of the Orange Sand, but can no doubt be easily reached and worked —for the succeeding two miles, to Winn's Landing it appears repeatedly.

You have, therefore, a complete verification of your conjecture that the limestone would be found between Eastport and "Red Sulphur." I need not enlarge upon the importance to the immediate district, and to the whole State of such an immense deposit of Hydraulic Limestone, sufficient to supply the whole valley of the Mississippi with cement, for generations to come, which can be easily worked, and from its vicinity to the Tennessee River, easily transported to every part of the South and South-west.

Truly yours,

W. D. MOORE.

E R R A T A.

The reader is requested to correct the following additional errata.

Page 76, middle of page, between *northeastward* and *further* [illegible]
" 188, beginning of ¶316, place the semicolon after *Sodium*, the comma after *Glauber's Salt.*
" 227, end of ¶432, after *guano* insert a parenthesis.
" 245, end of ¶501, for *anghow* read *anyhow.*
" 265, second reference in ¶556 sould be to ¶629.
" 277, end of ¶573, reference should be to ¶619 instead of ¶96.
" 283, tenth line from above, for *leveling* read *leveeing.*
" 287, twelfth line from below, for *dust* read *crust.*
" 289, second line from below, for *length* read *height.*
" 294, second line of ¶627, for *yellow lands* read *yellow loam lands.*
" 294, third line from below, for *muck* read *much,*
" 295, middle of page, for *subsoil fields* read *subsoiled fields.*
" 312, middle of page, for *Dr. Stalehane's* read *Dr. Stateham's.*
" 313, tenth line of ¶675, for *bluff* read *buff.*
" 317, first line of ¶687, for "UPLAND SOIL" read "UPLAND SUBSOIL."
" 324, fourth line from above, for *specimens* read *species.*
" 328, second line of ¶716, for *unfrequently* read *frequently.*
" 332, middle of page, a new paragraph begins at No. 298.
" 333, eleventh line of ¶727, for *this* read *these.*
" 334, eighteenth line from below, for *effervescing* read *efflorescing.*
" 335, seventh line from below, for *visible* read *variable.*
" 340, ff., for *Hatehushe* read *Hatchushe.*
" 341, sixteenth line from below, for *occupying* read *accompanying.*
" 343, middle of page, for *Arehusa* read *Archusa.*
" 348, 356, for *P. rigida* read *P. mitis.*
" 349, first line of last paragraph, for *Brown Ledge* read *Broom Sedge.*
" 351, first line of the analysis, for "889" read "89."
" 353, thirteenth line from below, for "*Pig Woods*" read "*Piny Woods.*"
" 353, ¶775, for *Bowie* read *Bouie.*
" 353, ¶776, for *Bowie White Sand* read *Bouie and White Sand.*
" 356, ninth line from above, for *Tallahala* read *Tallahoma.*
" 364, fourth line from above, for *S. W. Cato* read *S. W. of Cato*
" 364, seventh line from end of ¶802, for *Neglan's* read *Neylan's.*
" 366, fourth line from above, for *McCaun's* read *McCann's.*
" 366, middle of page, for (*P. mitis*) read (*P. ——?*)
" 372, fifth line of ¶829, for *least* read *best.*
" 373, thirteenth line from below, for *pressure* read *presence.*
" 374, middle of page, for *waste* read *coast.*
" 380, second line from below, for *transition* read *transformation.*
" 381, first line above, the word *kill* should be quoted, thus, "kill."
" 381, sixteenth line from below, after *not* add *accessible.*
" 382, seventh line from above, for "30" read "300."
" 385, third line of ¶867, for *compost* read *compact.*

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