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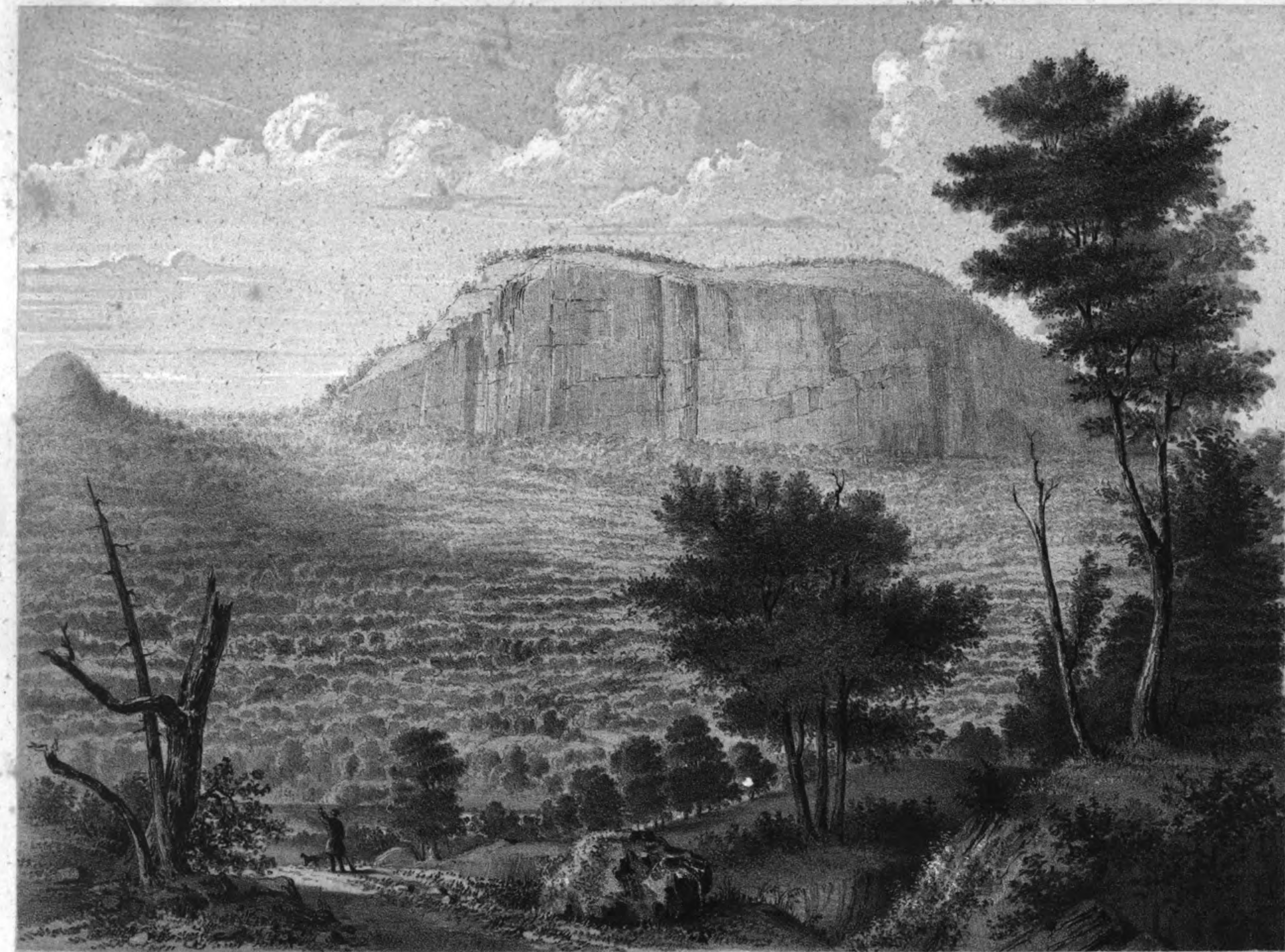

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TABLE ROCK IN SOUTH CAROLINA.

REPORT

ON THE

GEOLOGY OF SOUTH CAROLINA;

BY

ichael
M. TUOMEY,

MEMBER OF THE AMERICAN ASSOCIATION OF GEOLOGISTS AND NATURALISTS—CORRESPONDING MEMBER OF THE NATURAL HISTORY SOCIETY OF BOSTON, AND OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

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To his Excellency,

WILLIAM AIKEN,

Governor of the State of South Carolina.

Sir:—I herewith present a Report on the Geology of the State of South Carolina, and have the honor to be,

With profound respect,

your Excellency's obedient servant,

M. TUOMEY,

Geologist to the State.

Columbia, Nov. 1846.

PREFACE.

Geology, Mineralogy and Chemistry, have been long recognized in their relation to Mining, Metallurgy, and some other of the useful arts, but it is comparatively of recent date that these sciences have been applied, systematically and extensively, to the advancement of agriculture and the arts of civilization.

Men there were, it is true, who cultivated these sciences, and whose labors were published for the public good—the journals and transactions of associations for the promotion of science, have furnished those, to whom they were accessable, a vast amount of information applicable to the common affairs of life. But little more than twenty years have elapsed since the first attempt was made by any Government to cause a systematic Geological Survey to be made by competent persons, for the purpose of collecting into a body, for the express use of the people, a correct knowledge of the facts derived from science, in relation to the resources of the territory which they inhabit. North Carolina* has the merit of having commenced the work; and, in 1826, a Report upon the Geological and Mineralogical Survey of South Carolina, made by order of the Legislature, was presented by Mr. Lardner Vanuxem. Since that time, the example of these States has been followed by nearly all the others, so that we have now embodied, in a series of reports, a mass of information on the Geology and industorial resources of the United States, as gratifying to the friends of science as it is useful to the people at large.

The Survey, of which the result is contained in the following pages, is due to a movement altogether agricultural. A survey of the State had been long and ably advocated by the late R. W. Roper, Esq. Chairman of the Committee on Agriculture; and, in 1842, an Agricultural Survey of the State was ordered by the Legislature, and Edmund Ruffin, Esq. of Virginia, whose name and writings are identified with the agriculture of the country, was called to conduct the survey, by Gov. Hammond. After a year of arduous labor, in the development of the agricultural resources of the State, the result of which is found in his excellent report, Mr. Ruffin resigned, and I had the honor of receiving a commission from Gov. Hammond, to succeed him in conducting the survey.

It is difficult, if not impossible, to separate an Agricultural from a Geological Survey—for the science of Agriculture is a combination of all the natural sciences, and whoever examines Mr. Ruffin's Agricultural Report,

* I stated in my first annual Report, on the authority of Mr. Vanuxem's report, that South Carolina made the first movement. This, I have since learned, was a mistake.

must be struck with the amount of Geological information it contains, particularly as relates to the Tertiary formation of the State.

In the renewal of my commission, by his Excellency, Gov. Aiken, in 1844, I was directed to make a Geological and Agricultural Survey of the State. Such a survey, as it is at present to be understood, includes the following objects.

1. The determination and description of the various minerals and rocks of the State.

2. Their examination as to extent and relation to each other in their order of superposition, as well as their influence upon the physical features of the State.

3. The discovery of metallic veins, and beds of other useful substances, such as lime, rock, marl, &c. that they may contain.

4. The relations of the rocks to soils, and their chemical examination, to a certain extent.

5. The pointing out of such improvements in mining and metallurgy, as may be thought useful to those engaged in those operations.

While the Natural Sciences form so limited a portion of the systems of instruction in our schools, there will always be difficulty in presenting to the minds of the mass of the people information derived from these sciences. Hence, we constantly hear the objection made to Geological and Agricultural Reports, that they "are too scientific," which only, generally, means that words have been used that are not understood. Now if we speak at all of the constitution of plants, or of rocks, we must use such words as Hydrogen, Oxygen and Carbonic acid—Gneiss, Mica and Hornblende; nor could any degree of circumlocution obviate the difficulty. Every profession and even every trade has terms technical to itself, yet no one objects to them on this account. No one finds fault with the art of the miller because he uses such terms as ink, headstock and hopper, although they are quite as unintelligible as any scientific terms could be to persons who have paid little or no attention to the subject. I never heard that the long name *morus multicaulis* offered any impediment to the introduction of that plant, nor does it, at present, produce any difficulty or ambiguity.

Geology proper, however, has but few technical terms, and these are explained in the brief sketch of the science prefixed to this Report; I know of no other means of obviating the difficulty complained of; when new objects are presented they must have names; and to bring every thing down to our previous knowledge, would put an end to all progress.

It is always pleasant to acknowledge the labors of those who have preceded us, and who have aided in the removal of the difficulties, inseparable from the first steps, in geological investigations. In the Cabinet of the South Carolina College, an excellent collection of the minerals of the State will be found, which were collected by Mr. Vanuxem in 1826.

A list, and an account of the distribution of these minerals, I have appended, taken from Mills' Statistics, where the substance of his report was published.*

He also published a paper on the Tertiary and Cretaceous formations of the State,† and was the first to notice the Post Pliocene of Charleston.

In 1832, Mr. Conrad examined the Tertiary of the Cooper and Santee rivers, and determined the existence of the middle Tertiary, from some fossils discovered by the late Stephen Elliott, Esq.

Mr. Lyell has gone over the Eocene of the State, and the results of his observations have appeared in the Journal of the Geological Society of London, and in Silliman's Journal.

Before Mr. Ruffin's Report, there had been but little published in relation to the economic value and extent of the beds of the Tertiary. The existence of the middle Tertiary was barely known, from the inference alluded to, drawn by Mr. Conrad from a few fossils, said to be from "below the junction of the Wateree and Congaree rivers." He pointed out in his Report, localities of this formation, in Darlington and on Goose Creek; and in an appendix to my annual Report, he mentions others on Lynch's Creek, and on Waccamaw river; so that it

* Appendix.
† Journal Academy of Natural Sciences, Philadelphia.

is to his labors we are most indebted for an accurate knowledge of this part of the Geology of the State.*

Some of the Post Pliocene localities, near Charleston, were discovered by Prof. L. R. Gibbes; the first list, of any extent, of the fossils of that formation, was prepared by him, and published in Mr. Ruffin's Report.

I have also to acknowledge numerous other obligations to the cultivators of science in this State.

To Dr. R. W. Gibbes I am indebted for many favors, besides his unabated attention to the best interests of the Survey from its commencement to its close.

To Dr. Henry, I owe the opportunity of consulting the numerous rare scientific works in the Library of the South Carolina College. I am under similar obligations to Dr. Ellet, to whose liberality I also owe many useful hints, and much valuable information.

For access, at all times, to his fine collection of recent and fossil shells, and the most liberal use of his Library, containing many valuable and rare conchological works, I am under obligation to Dr. Edmund Ravenel, of Charleston, who also liberally communicated to me the result of his observations on the Geology of the State.

To Prof. Gibbes, of the Charleston College, my thanks are due, for assistance in comparing recent and fossil shells, but most of all, for preparing for this Report, a synopsis of the Fauna of the State.

I have also to acknowledge numerous favors received from Dr. Hume, of the Military Academy.

For the means of completing the geological section of the State, I am indebted to the politeness of Major Colcock, who placed in my hands a valuable collection of Reports and Field-notes of Rail Road Surveys of the State.

For a fine collection of Post Pliocene fossils, I am indebted to Dr. Burden, of John's Island.

From Dr. Barratt, of Abbeville, I received very important assistance in my investigations in Orangeburg, Barnwell and Beaufort Districts. I am also indebted to him for the means of comparing the fossils of the Burrstone with those of Claiborne, Ala. as well as for many other favors.

To the highly intelligent Secretary of the Black Oak Agricultural Society, I owe the communication of a fine suit of corals and other fossils from the Eocene of Cooper river.

It would be impossible, if it were necessary, for me to separate my own labors from those of F. S. Holmes, Esq. both on the Ashley and in the Post Pliocene of the State. His fine and valuable collection of fossils were placed at my disposal, and I have used it without reserve; it is chiefly through his labors that the Ashley has already become noted for its organic remains.

Of the kindness and hospitality with which I was everywhere received, which cannot soon be forgotten, and of which it is impossible to think without feelings of gratitude, I can only speak in general terms; for such favors, and for the interest, on all occasions, taken in my pursuits, it only remains for me to return my sincere, heart-felt thanks.

M. TUOMEY.

OF THE GEOLOGICAL MAP.

Of the map annexed to this Report, I desire to say one word in explanation. It is obvious, in the nature of the case, that absolute accuracy is not to be expected. For instance, I have taken special pains in noting the trap dykes of the State, yet I am conscious that, in numerous cases, they are not accurately located; for it often happened that they were observed where there were no points of reference to the map. In the upper

* Perhaps this is not an improper place for me to assume an error into which I led Mr. Ruffin. The external characters of the silicious bed of the Burrstone, together with the existence in it of some polythalamia, derived from the calcareous beds, where they are common, which I took for infusoria, led me to refer it to the infusorial beds; and it is so stated in Mr. Ruffin's Report.

part of the State, the roads have been so altered, and so many new ones constructed, that there often is but little agreement between them and those on the map. Very many other sources of difficulty could be mentioned, but they will occur to every one, and will serve to explain any discrepancies that may be observed.

The geological section is constructed, as far as Columbia and Aiken, from the Rail Road grades published in the report of the President, and the rest of the distance to Saluda Gap from Maj. Colcock's notes.

The horizontal and vertical scales are, necessarily, different, and may be ascertained by comparing the distance from Charleston to the Saluda Gap with the height of that mountain.

POSTSCRIPT.

While the report was passing through the press, A. S. Johnston, Esq. informed me that the Committee on publication had decided that the plates, containing figures of the fossils of the State, which were to have accompanied it, were not essential, and they are, therefore, omitted.

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REPORT ON THE GEOLOGY OF SOUTH CAROLINA.

INTRODUCTION.

CHAPTER I.

Objects of Geological Science.—Descriptive Geology.—Practical Geology.—Composition of rocks. Unstratified rocks.—Granitic and Basaltic rocks.

The objects contemplated by the science of Geology may be conveniently distributed under two heads—Descriptive and Practical Geology. *Descriptive Geology* includes the facts derived from the examination and study of the various appearances presented by the earth's crust, the materials of which it is formed, the manner in which these materials are arranged, whether disposed in crystaline masses, or in beds and strata, the order of succession observed in these beds and strata, the study of the organic remains which they may enclose, and their comparison with the living forms of the present period. It investigates and explains the causes at present in operation, as well as those disturbing forces which have acted in past times—which have resulted in the present form and appearance of the earth's crust.

Practical Geology, on the other hand, has for its objects the application to the ordinary affairs of life, of the knowledge that may have been thus acquired by a careful study of the phenomena exhibited in the earth's structure, and of the general laws which have governed these phenomena.

It applies this knowledge to the discovery of substances useful in the arts, such as minerals and ores, and thus it directs the practical pursuits of the miner.

To the engineer it exhibits the character of the country where his operations may be carried on; and often enables him to anticipate the difficulties to be encountered, arising from geological structure; while to both engineer and architect it may render important aid in the selection of proper materials for construction.

To the agriculturist it points out the origin and character of soils, and their relations to the rocks from which they are derived; and in this manner Practical Geology forms, in a great measure, the basis of agricultural science.

DESCRIPTIVE GEOLOGY.

It is probable that our actual knowledge of the earth's crust extends to a depth of fifteen miles, including the tops of the highest mountains. Sixteen substances, usually considered simple, constitute the greater portion of the materials included in this thickness. Of these, eight are non-metallic substances:

Oxygen,	Nitrogen,	Sulphur,	Fluorine,
Hydrogen,	Carbon,	Chlorine,	Phosphorus.

Six are metallic bases of the alkalies and earths:

Silicium	Potassium,	Magnesium,
Aluminium,	Sodium,	Calcium.

And two are metallic Oxides:

Iron,	Manganese.

Such is the chemical relation existing between these substances, that, with a few exceptions, they rarely occur in nature in their simple and uncombined state. Oxygen, for instance, by its chemical union with the bases of the alkalies and earths, and with Hydrogen and Carbon, produces the well known substances, Silica, Alumina, Potash, Soda, Magnesia, Lime, Water, and Carbonic Acid.— These again, by their combination with each other, give rise to a few minerals, which, by their aggregation, make up by far the greater portion of all rocks. Thus,

Silica alone forms - - - - - - - -	Quartz;
Silica, alumina, potash, or soda, form - - - -	Feldspar;
Silica, alumina, potash and iron, - - - - -	Mica;
Silica, magnesia and iron, - - - - - -	Talc;
Silica, magnesia, lime, alumina and iron, - - -	Hornblende;
Silica, alumina, lime and iron, - - - - -	Argillite;
Lime and carbonic acid, - - - - - -	Limestone.

Numerous other minerals are found embedded in rocks, and entering into their composition; but of the mass, they generally form but a small proportion, compared with these.

The first object of the student of Geology should, of course, be to make himself acquainted with these minerals; and although it is not easy to give correct ideas of minerals by mere ordinary description, yet these are so widely distributed, so abundant, and so easily recognized, that they offer but little difficulty.

Quartz, which in this State is called white flint, is readily known by its glassy appearance, uneven fracture, and great hardness. It presents a variety of colors, and is esteemed for gems, under the names of amethyst, agate, cornelian, &c. It constitutes nearly one half the mass of all known rocks.

Feldspar is distinguished from quartz by its inferior hardness and its distinct cleavage. It has a high lustre, is generally semi-opaque, and is of a white gray or flesh color. It constitutes nearly one-tenth of the earth's crust.

Mica is known by the thin elastic plates into which it is readily divided. Its bright shining *metallic* lustre is a fruitful source of disappointment to unskilful searchers after gold and silver. It is called, in this country, isinglass.

Talc is quite soft and greasy to the touch. From mica, which it sometimes resembles, it is distinguished by the want of elasticity, and by its unctuous touch. It is sometimes known by the name of French chalk: its colors are white and green.

Hornblende, in its most common form, presents a confused crystaline structure, and dark green color, approaching black. The rocks composed of this mineral are exceedingly tough, and yield with difficulty to the hammer—a fact known to the Aborigines of the country, who used them as the principal material in the construction of their tomahawks and other instruments requiring much strength.

Argillite, which is rather a rock than a simple mineral, is well known on account of its extensive use as common writing slate. It has a fine texture, an earthy fracture, and presents many shades of color, such as black, grey, red and purple. Alumina, its principal ingredient, next to silica, is the most widely diffused substance.

Limestone is best known in the numerous varieties of marble. It is sometimes crystalized, and is then called calcite, or calc-spar. It is softer than feldspar, and may be readily scratched. It is easily distinguished by the effervescence produced by the application of an acid. It is more abundant in the newer rocks, and constitutes about one-seventh of the rocks of our globe.

If attention be now directed to the mineral masses or rocks made up of these simple minerals, and which constitute the earth's crust, so far as man has penetrated, it will be seen that they are disposed in beds or layers, piled up, one upon another, in the manner in which matter would be deposited which was once held in suspension in water; or else they occur in masses of uniform structure and appearance, and without any traces of those beds or planes that would indicate a mechanical origin. And thus we have a very natural division of rocks, into two great classes—*Stratified* and *Unstratified* rocks.

Unstratified Rocks.

The examination of this class of rocks will not proceed far before it is seen that it is composed of two groups, varying widely in structure and external appearance. The one consisting of crystaline rocks, in which each of the component minerals presents the appearance of crystalization, independent of the mass. They underlie the stratified rocks, or are pushed up through them, and may, therefore, be regarded as the foundation, or frame-work, of the earth's crust. The rocks composing the other group occupy a less important place, generally only filling the cracks and fissures in other rocks, or spread out over their surface, where they frequently assume regular forms. These two groups or classes of rocks may be designated as the *granitic* and the *basaltic* rocks.

Granitic Rocks.

Common granite, which is an aggregate of quartz, feldspar and mica, is the type of this class of rocks. It is either coarse or fine, generally depending upon the quantity of the feldspar. Its colors, which are also much influenced by that mineral, are white, gray, or red. Its component minerals appear aggregated promiscuously, and sometimes as if the mica and feldspar were embedded in a quartz base. The ease with which granite splits in two directions, when quarried by a skilful workman, is due to the coincidence of the cleavage planes of the felspar with those of the blocks split out. Fractures or seams of considerable extent, are often seen in granite—not unfrequently dividing it into cubical blocks; but these are the effects of a different cause.

Granite has various names, derived from the different proportions and mode of aggregation of its constituent minerals: it is called *micaceous*, *feldspathic*, or *quartzose*, as mica, feldspar, or quartz may predominate.

Porphyritic granite has the feldspar disseminated through the whole in large crystals, which are often of a different color from the rest of the mass, and hence the striking appearance of some varieties of this rock.

Graphic granite is composed of a base of feldspar, traversed by variously shaped plates of quartz. When this rock is fractured in certain directions it presents the appearance of certain alphabetic characters.

Albite granite. When felspar contains soda instead of potash it is called albite. When this mineral takes the place of common feldspar in granite, the rock is whiter but less durable than the common variety.

Other minerals, such as hornblende, chlorite, talc, &c. often replace the ordinary constituents of granite. Where hornblende takes the place of the mica the rock is called *Syenite*, and when mica is also present with the hornblende it is called *Syenitic* granite.

Protogine. This term is applied to those varieties of granite in which chlorite, talc, or steatite takes the place of mica.

Granite is very widely distributed, being found in all parts of the known world. It rises in enormous masses, forming mountain peaks, and it is also found penetrating other rocks, in the form of veins. It every where underlies the older stratified rocks, and hence, in common with these, it has received the name *Primary*, on the supposition that it was the oldest or first formed rock. It is now, however, well understood to belong to various geological periods: for besides forming the great foundation of the earth, it is found piercing and superimposed upon strata of very modern date. This, however, has nothing to do with the origin of granite—it simply proves that the materials of which it is composed were in a fluid state; that in this form the mass was erupted or forced upwards through the other rocks, even as late as the commencement of the Tertiary period, where it was consolidated, producing a granite in all respects as characteristic as that found beneath the oldest stratified rocks. Granitic veins are also seen to intersect granite. The apparent inconsistency of applying the term primitive or primary to a rock formed at so many and at such recent periods, induced Mr. Lyell to substitute the term *Hypogene* (formed beneath,) for that name. The term Primary, however, is so well understood, and in such common use, that but little advantage will arise from the change, particularly if we bear in mind the facts just stated.

Basaltic Rocks and Porphyries.

These rocks are far more limited in extent than the preceding; instead of forming the base or frame-work of the earth's crust, they occur rather in the form of dykes and veins, and appear to have been forced upwards through rents and fissures in the superincumbent rocks. They are, however, widely distributed, and sometimes occupy considerable space. Basaltic rocks have been designated by the names of *whin*, *trap*, *greenstone*, *clinkstone*, and *amygdaloid*. In general, they are more homogeneous in appearance, if we except the embedded minerals which they contain, and rarely present a crystaline structure like granite. Their color is a greyish black, approaching green. A remarkable difference between these rocks and granite consists in the greater abundance of lime, which is owing to the prevalence of hornblende in all the basaltic rocks.

They occur in veins or dykes in tabular masses, as if spread out over the surface by overflowing.

Basalt and *trap* often occur in beds composed of a series of vertical columns, exhibiting a structure apparently the result of crystaline forces; the sides presented by these columns vary in number from three to nine. This structure is not properly crystaline, but the effect of cooling after fusion, and the consequent contraction, the fractures probably taking the direction of the cleavage planes of some of the constituent minerals.

These columns often present a jointed structure, the result of cleavage parallel with the base, which is doubtless due to the same cause.

Fingal's Cave and the Giant's Causeway are well known and magnificent examples of columnar basalt. Numerous localities of trap occur in the upper districts of South Carolina.

Greenstone is composed of feldspar and hornblende. It is granular, and sometimes the crystals of its component minerals may be distinguished. The hornblende generally predominates, and imparts its characteristic green color to the mass.

Amygdaloid. This name is applied to those varieties of trap or basalt having vesicular cavities filled with kernel shaped minerals. It is probable that the materials composing the minerals found access to these cavities by the percolation of the water holding them in solution. The absence of those silicious minerals which abound in the granitic rocks is a remarkable feature in the rocks of this class.

Eurite is, for the most part, composed of compact feldspar: its color is white or grey. It occurs in South Carolina in the form of veins or dykes.

Porphyry. This name was at first applied to a certain class of stones susceptible of a polish, and characterized by a red color. But it is now restricted to rocks having a compact base, generally of feldspar, hornstone or claystone, with crystals or grains of some other mineral scattered through the mass. These crystals or grains are very frequently common feldspar of various colors.

Igneous rocks. The unstratified rocks thus briefly described are often designated by the name of igneous rocks.

Speculations upon the form in which the materials composing our planet first came from the hands of the Creator, would be evidently beyond the limits of this introduction. Yet there is something as beautiful as it is simple in the thought that these materials once existed in a gaseous state; that condensation took place, and a consequent evolution of heat sufficient to fuse the solid substances resulting from condensation; that this molten mass, cooling down by slow radiation, produced the unstratified rocks. There is in this simple process so much in unison with the simplicity and unity of those causes in nature which are constantly producing the most stupendous effects, that the mind rests upon it with pleasure.

Whether the solid materials of our globe existed originally in the gaseous state or not, we have abundant evidence that the state which pre-existed the consolidation of the unstratified rocks was that of fusion. For they have altered the rocks through which they pass in a manner quite analogous to the alteration that would take place on contact with intensely heated matter. They have been imitated or reproduced artificially by fusion. Trap rocks can scarcely be distinguished from the molten products of modern volcanoes. Where there is any marked difference it is owing to the fact that trap rocks have cooled slowly under great pressure, whilst the lavas of modern volcanoes have been ejected in the open air. The increase of temperature which is observed as we descend below the surface, and which amounts to 1° Far. for every 45 feet of depth, as well as the existence of thermal springs, seems to point to a source of heat beneath the earth's surface, even at the present day.

It is impossible to examine the relation of trap rocks to the sedimentary deposits without coming to the conclusion that they had an igneous origin. Chalk is converted into crystalline marble, and bituminous coal into anthracite, when they come in contact with trap dykes. In Chesterfield District a trap dyke passes through the new red sandstone, baking it at the points of contact, so that it can scarcely be distinguished from over-burned bricks.

CHAPTER II.

Stratified Rocks.—Stratification.—Joints.—Slaty Cleavage.—Primary Stratified Rocks.—Formations.—Systems.—Series and Periods.—Gneiss.—Hornblende Slate.—Lime rock.—Mica Slate.—Quartz rock.—Talcose Slate.—Chlorite Slate.—Clay Slate.—Relation of Igneous and Metamorphic Rocks.—Volcanoes and Earthquakes.—Dip.—Strike.—Outcrop.—Metalliferous Veins.—Faults.

It has been already stated that the stratified rocks consist of tabular masses or layers, called beds or strata, of mineral substances piled up one upon the other. The analogy existing between these strata and sedimentary accumulations known to result from the deposit of matters held in suspension in water, has given rise to the names aqueous or sedimentary, by which they are sometimes designated.

The term *bed* is often applied to a subordinate or irregular layer, interposed between the strata. And a *seam* is a thin layer disposed between strata or beds.

Stratification, Joints, Slaty Cleavage.—The parallel planes which divide aqueous deposits into laminæ or layers of various thickness, and which are the result of deposition from water, are called planes of stratification, or bedding planes.

They afford useful indications to the Geologist of the circumstances under which rocks were deposited. The mud and silicious matter found on the banks of rivers, deposited by freshets, which divide readily into thin leaves, offer a good illustration of this structure. Besides these, there are other divisional planes, quite different from these. They are called joints, and are common to both stratified and unstratified rocks. They are generally fissures, extending frequently to a considerable distance, both vertically and horizontally, dividing rocks into forms more or less regular. The parallelism which they often observe is very remarkable. When they cross each other, which is frequently the case, they divide the rocks into rhomboidal masses, adding much to their value as building materials.

These joints are thought to be the result of mechanical force, produced by contraction and other forces, during the consolidation of the rocks. On Horse Creek, at Vaucluse, fine examples of this structure may be seen, and at various places on Steven's Creek.

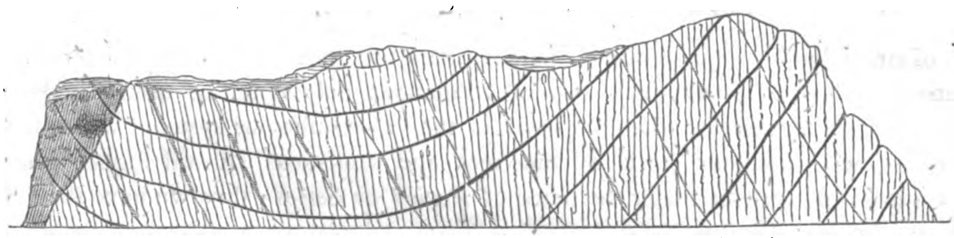
Slaty cleavage differs both from stratification and joints. It is most conspicuous in clay slates, which owe their value in the arts to this structure. The planes in which common roofing slate splits are due to slaty cleavage, and have no connection with those partings called planes of stratification, but, on the contrary, often make a considerable angle with them.

It is not always easy to distinguish these structures from each other, and yet it is quite important to be able to do so. Rocks having jointed structure have no tendency to split in lines parallel with the joints, and in this manner jointed structure may be distinguished from cleavage.

In hand specimens it is difficult, if not impossible, to distinguish cleavage planes from those of stratification; but when the rock is examined in place, there will generally be found a layer or bed presenting a different mineral composition or color, which will be seen to cross the cleavage planes, thus indicating the plane upon which it was deposited, or the true plane of stratification.

The cause of cleavage is obscure, but it is supposed to result from the tendency of the simple component substances of the rock to arrange themselves in crystaline forms, at a time when the semi-fluid state of the mass permitted a certain degree of motion among its particles. Re-arrangement of the molecules of matter seems, however, to take place, even when the mass is in no degree fluid. The crystaline structure which metals assume under particular circumstances, is illustrated in the axles of rail-road cars long in use; and I have found fossil shells on the coast of Horry District, where the passage of the ordinary structure of the shell into calc-spar may be traced. The sketch, Fig. 1, will exhibit these structures better than many words.

Fig. 1.



The dark lines represent the planes of stratification, the lines crossing these, joints, and the short, vertical lines exhibit cleavage planes.

Primary Statified Rocks.

The lowest of the stratified rocks—those which contain no organic remains—are included under this name. They are *gneiss, hornblende-slate, mica-slate, talcose-slate, and clay-slate.*

In mineral composition these rocks are very dissimilar, but they agree in some very important points. They comprehend vast beds or accumulations of sedimentary matter—such as might be derived from the preceding rocks by abrasion and other causes, and differ from recent sedimentary rocks, in their crystaline structure, in containing no distinct fragments of other rocks, and in the entire absence of any remains of organic bodies.

Their crystaline structure is supposed to result from a degree of subterranean heat, which, although intense, did not destroy the lines of stratification or bedding, which they received at the time of their deposition. Such a degree of heat can readily be supposed to result from contact with the underlying, intensely heated granite. The alterations, both in texture and appearance, produced by this cause, have suggested, for these, the name of *metamorphic rocks.*

The absence of organic remains observed in the metamorphic rocks, could only arise from one of three causes: 1. That they were deposited before the appearance of either animals or vegetables on the earth. 2. That their deposition took place under circumstances unfavorable to the preservation of organic remains. 3. Or, if they ever did contain such remains, every trace of them has been obliterated by the high temperature to which they have been subjected during their consolidation.

Still we must not be too hasty in concluding that, because no organic remains are found, no organized beings existed at the time of the deposition of the rocks. Prof. Forbes has shown, in a report made to the British Association, on the distribution of the Mullusca and Radiata, that at a depth estimated at 300 fathoms, and which he calls the zero of life, all animals cease to exist.

The passage of the metamorphic rocks into the oldest fossiliferous strata, is so gradual, that it is often difficult, if not impossible, to distinguish one from the other; so that it is probable that some, at least, of the metamorphic rocks did once contain organic remains, every trace of which has disappeared. The chemical constitution of metamorphic limestones leads also to this conclusion. It is, however, highly probable, from the gradation apparent in the order of creation, as unfolded by the monuments preserved in the fossiliferous rocks, that the beginning of life, on our planet, was not far removed from the period of deposition of the newer metamorphic rocks.

Formations, Systems, Series or Periods.

Groups of strata, having some common characteristics, are often united under the term *Formation*, as "Eocene and Miocene formations." Several formations may again be united under the more comprehensive term *System*, as when we speak of the "Carboniferous system," which includes the coal formation, and numerous strata of lime-rock and sandstone. A still higher generalization includes a number of systems under the name of *Period* or *Series*—thus we have the "Secondary and Tertiary *Series* or *Periods*."

The formations composing the metamorphic rocks have no invariable order of superposition, although they generally overlie each other, in the following manner:

Clay Slate,
Talcose Slate,
Mica Slate,
Hornblende Slate,
Gneiss.

Besides these, beds of limestone, quartz rock, chlorite slate and soapstone, form no inconsiderable portion of the metamorphic rocks.

Gneiss is a compound rock, differing from granite only in having a stratified structure. It is composed of quartz, feldspar, and mica. These minerals are disposed in layers, which gives the rock a slaty or schistose structure, and a striped appearance sometimes. These layers are exceedingly regular, and the rock may be split into flagging-stones: they are, however, often so much bent as to give the mass a singularly contorted appearance. Gneiss frequently loses its slaty structure, and then it can scarcely be distinguished from granite; and hence the name *gneissoid granite.* Table Rock, in Pickens District, is a magnificent example of the occurrence of gneiss in beds of vast thickness.

Gneiss forms an important rock in the principal mountain ranges of the world, and as a metalliferous rock, few of the metamorphic rocks are of equal consequence. Many of the principal mines in Norway, Sweden, Saxony and Bohemia occur in gneiss.

Hornblende slate.—Alternating with gneiss, we find strata having a dark or greenish color, which, on examination, is found to result from the substitution of hornblende for the mica of the gneiss. It is often difficult to distinguish this rock, by external appearance, from those varieties of gneiss with black mica. The easy cleavage of the mica, however, will always be sufficient to distinguish the two.

From the trap rocks, which it may resemble, it can always be distinguished by its slaty structure; the hornblende and feldspar, of which it is generally composed, being disposed in alternate layers.

Lime rock.—Beds of lime rock are also of common occurrence in gneiss. Although frequently crystaline in structure, they are generally stratified, having layers of mica disposed in planes, along which the rock splits readily. Lime rock occurs in these beds of every degree of purity—from gneiss, containing a little calcareous matter, to pure lime rock. A granular variety, containing magnesia, is known by the name of dolomite.

Mica slate, which is composed essentially of quartz and mica, passes insensibly into the other slaty rocks with which it is associated. Into gneiss by the addition of feldspar; into talcose slate by the substitution of talc for mica; and when the quartz disappears, the mica is seen in small scales; it then passes into clay slate—so that, where these rocks occur together, it becomes extremely difficult, if not impossible, to define their limits. Although the rocks just mentioned often alternate, the mica slate generally occurs in the order in which I have placed it, resting on the gneiss.

Quartz rock is, in texture, generally granular, the grains presenting every degree of coherency, from that of loose sand to the solid rock. It requires the examination of this rock in masses of considerable extent, in order to distinguish it from common quartz, as it occurs in veins. In South Carolina it is always stratified, and more or less mixed with mica or talc. The passage from the arenaceous to the compact variety is gradual, and it is in this passage that it assumes the form of *itacolumite*, a variety that has assumed some interest from its connection with the diamond-bearing rocks of South America.

Another curious form of this rock occurs in South Carolina: it has the appearance of a conglomerate, on the weathered surface, but this structure is not presented by a fresh fracture. It seems to be the result of the manner in which iron is distributed through the mass, and which is only rendered evident by its oxidation at the surface.

Talcose slate is chiefly composed of talc and quartz, and sometimes of talc and feldspar. In texture it often resembles clay slate, but can be distinguished from that rock by the peculiar soapy touch of talc. When mica is present in this rock it receives the name of *talco-micaceous slate*.

Chlorite slate.—Chlorite often takes the place of mica and talc, and forms this rock. Like hornblende slate, it is green, but it is much less hard. It occurs in this State but rarely.

Clay slate, as its name implies, contains a large portion of argillaceous matter. In texture it is quite fissile. Its colors are various, and although sometimes dull, it often has a shining lustre. In the Districts bordering the tertiary series of South Carolina, this rock is well known for the abundance of excellent whetstones which it furnishes. The clay slate of the metamorphic series passes into the argillaceous rocks of older fossiliferous strata, in such a manner that nothing but the presence of fossils in the latter will enable us to distinguish them.

Relation of the Igneous and Metamorphic Rocks.

Although granite is found, of various ages, protruded through, and even overlying some of the newer rocks, nevertheless it always constitutes the foundation of the oldest stratified rocks, which are often found resting against it in highly inclined positions.

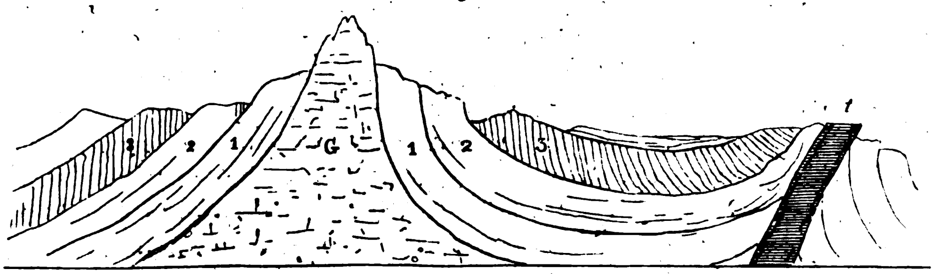
The inclination observed in stratified formations is a subject of great interest and practical importance.

That all rocks deposited from water were originally horizontal, or nearly so, can admit of no reasonable doubt; for it would be absolutely impossible for sedimentary matter to be deposited on a plane inclined beyond a certain angle: so that when we find strata standing nearly or quite vertical, we are forced to the conclusion that they were pushed up by some mechanical force, acting from below. We often find disturbances in the lower rocks, which did not extend to those above; and this we find through all the series, showing that from the very beginning such disturbances existed. These subterranean movements varied in intensity, from a force barely sufficient to produce a gentle flexure in the strata, to one sufficiently powerful to elevate and rend asunder the crust of the earth throughout its entire thickness.

The rents and dislocations seen in mountain regions show that violent and sudden changes have been effected; and we have evidence equally conclusive that vast changes have taken place slowly and without leaving on the surface traces of disturbance. It is remarkable that these disturbing forces should have acted in lines of nearly uniform direction, as the courses of the great mountain chains fully attest. Although the action of these forces was more energetic at some periods than at others, yet we have abundant proof that they are still at work, in the numerous alterations of level of very modern date which every country presents.

The annexed cut (Fig. 2) will illustrate the nature of the changes produced by these disturbing forces, as well as the connection of the igneous and metamorphic rocks.

Fig. 2.



G—Granite: 1—Gneiss. 2—Mica slate. 3—Clay slate.

The physical impossibility of the deposition of sedimentary matter at an angle so great as that presented by the inclined beds of stratified rocks, has already been alluded to; but besides this, the points of contact with the igneous rocks show very clearly that the latter have been forced up in a molten state, through the superincumbent rocks, bearing them upwards in its ascent, as represented in the section, Fig. 2.

It sometimes happens that the protruded mass passes through without any apparent marks of violence. This is the case very often with trap dykes, which seem to be igneous matter barely injected into cracks and fissures in the rocks. It sometimes happens, however, that trap dykes, in their passage through other rocks, turn the edges of the strata up, as represented at *t*, Fig. 2, leaving evident marks of great violence.

The origin of a force capable of such stupendous effects, has long been the subject of interesting investigation with Geologists. Volcanic action, from its well known effects, and from its connection with the changes produced by earthquakes, naturally suggests itself when we look for the cause of those upward movements which have taken place, on a vast scale, in the earth's crust.

Volcanic action, taken in the wide sense in which Humboldt defined it, as "an influence exercised by the interior of a planet, on its exterior covering, during its different stages of refrigeration," does indeed include all the causes assigned for these phenomena; but in its more limited meaning it is difficult to conceive of its action along extensive mountain chains; and hence many Geologists have been led to attribute the inequality of the earth's surface to the slow cooling down of the surface of the melted matter, beneath the solid crust of the earth, and the consequent contraction.

This theory seems applicable, whether we consider this molten mass as forming the nucleus of the globe, or distributed in immense reservoirs, like seas and lakes, beneath the surface, and constantly replenished by electro-chemical action. Every one who has had any experience in stone structures must have noticed the difficulty of preserving the cement or mortar in the joints of large stones, such as coping stones and door-steps. This difficulty arises from the annual expansion and contraction of the stones, owing to changes of temperature: the expansion crushing the cement, and the contraction leaving the joints open.

A series of experiments was instituted by Col. Totten, to determine the amount of expansion produced by a known increase of temperature, which resulted in showing that granite expands, for 1° F. .00004825 of its lineal dimensions. Mr. Lyell has calculated from this, that if a portion of the earth's crusts, one hundred miles in thickness and equally expansible, were to have its temperature raised to 600° or 800° F. it would be sufficient to produce an elevation of two or three thousand feet. We have, then, in the enormous force that may be exerted by expansion and contraction, (for they exert equal force,) a cause sufficient to account for all the phenomena of elevation and subsidence.

The operation of this contraction will be rendered plain by supposing a sheet of igneous matter, covered by a crust, produced by the cooling of the surface by radiation. As the cooling and consequent contraction went on, portions of the crust would be drawn down to accommodate itself to the diminishing central mass. This would produce a subsidence of those parts, and as the crust became thicker and less yielding, while the cooling still proceeded, foldings, fractures, and upheavals would be the result. The water on the surface would be collected into the depressions, to form oceans, while elevated strata would appear above the surface, as islands and continents.

The deposition of sedimentary matter at the bottom of the ocean would retard radiation from the heated mass, and an elevation of temperature would be the result, which would produce a corresponding elevation of these newer beds. And in this way may be explained the repeated oscillations of level, by which dry land has been converted into the bed of the ocean, and again elevated, to form the habitation of land animals. Numerous instances of such alterations of level have occurred at comparatively recent periods. It is not many years since the coast of South America was elevated many feet above the surface of the ocean, over a distance of 2,000 miles. And at this moment the coast of Scandinavia is gradually rising, while a corresponding subsidence is going on upon the coast of Greenland. Such instances as these show the fallacy of the opinion that the elevation of land is a consequence of the diminution of the waters of the ocean; for while a diminution would be necessary on the coast of Scandinavia, an increase or rise would be required to explain the subsidence on the coast of Greenland.

Volcanoes and Earthquakes.

These are among the most interesting of the phenomena attendant upon igneous agencies.—They enable us, to some extent, by comparison, to appreciate the enormous force that may be called into action by subterranean heat. A volcano is a rent or fissure in the earth, through which steam, gases, stones, and molten matter are ejected into the air. The lava, scoriæ, and ashes that fall around the opening, which is called a *crater*, form a cone of considerable elevation. Stones are thrown to a great height in the air; and a rock, weighing two hundred tons, was projected to a distance of nine miles, during an eruption of Cotopaxi, one of the volcanoes of the Andes.

Changes of level around volcanic centres are not uncommon, and are probably due to the expansion and contraction of the liquid mass below. That these seas of molten rock are connected over vast areas, is rendered highly probable by the simultaneous eruptions and alternations of action of distant volcanoes. Their occurrence along the line of ocean coasts is remarkable, and seems to indicate some connection with the dislocations and fracture of strata that occur in the parallel mountain chains. Those which have remained dormant since the commencement of the Historic period are termed extinct volcanoes.

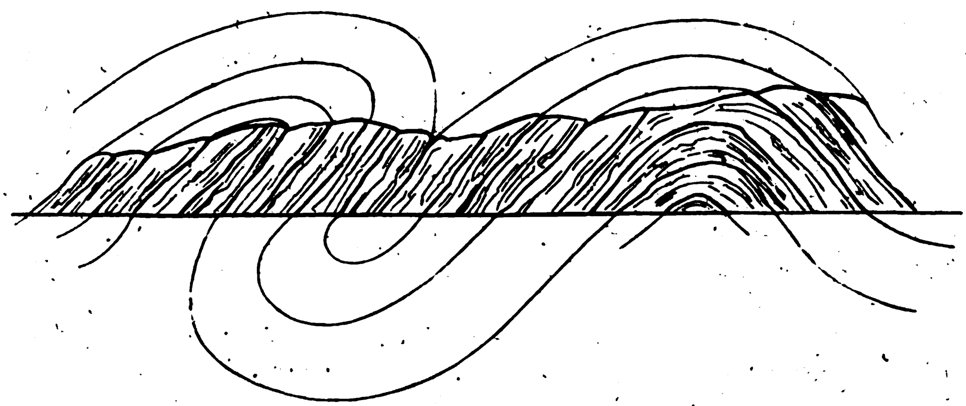
Certain tremulous or wave-like motions of the earth, which often accompany sudden volcanic eruptions, are called *earthquakes*. They seem to be due to paroxismal motions, produced by some disturbance of the molten mass below, which are propagated like waves on the surface of water, communicating their motion to the solid crust of the earth, frequently to a very great distance; and, during their periods of greatest violence, producing the most awful results. In 1811, the earthquakes which destroyed the cities of La Guayra and Caraccas, in South America, produced, in South Carolina, sufficient violence to cause the mud and silt in the beds of the creeks along the coast to recede or slide from the banks towards the channel, leaving the line of parting of the mud and solid matter of the banks as distinct as if the latter had been elevated one foot above its former level. In the valley of the Mississippi the convulsions felt were sufficient to produce important physical changes in the face of the country—such as the formation of lakes and islands, where they did not exist—some of them of great extent. For miles the banks of the river sunk eight feet below its former level. Frightful chasms opened and sent up water and sand to a great height. The directions of these chasms was about N. E. and S. W. a fact noticed by the inhabitants, who felled trees at right angles with this course, and placing themselves upon the trees, they often saved themselves when the ground opened beneath them.

These rents and fissures, it will be observed, had a direction nearly at right angles with a line joining South Carolina, New Madrid, on the Mississippi, and Caraccas, the points where this earthquake was most felt. It seems, then, that rents and fissures are produced at right angles with the line along which earthquake waves are propagated. The coincidence in direction between these rents and that of the trap dykes of the Atlantic slope is remarkable.

Some Geologists have been led, from a consideration of the phenomena of earthquakes, to attribute the flexures and even the elevation of mountain ranges to earthquake waves.

Having thus glanced at the probable origin of elevating force and other igneous agencies, we may now return to the examination of some of their effects. Instead of the abrupt elevation and fracture of the strata, as represented in Fig. 2, we frequently observe a folding and contortion, caused by lateral pressure, which sometimes produces little more than gentle undulations. Fig. 3 will make this plain.

Fig. 3.



The upper part of these flexures, represented by faint lines in the cut, is often removed by denudation, and the corresponding lower portions are below the surface, so that we only see that part of the section represented by full lines. Such sections as these are fully exhibited between Edgefield Court House and the village of Abbeville; and generally the rocks below the mountains are thus turned up and contorted.

This turning up, and consequent exposure of the edges of rocks, is a result of the utmost importance. It is indeed one of those beautiful contrivances which meet us every where in nature; remarkable alike for its simplicity and adaptation to the end to be accomplished. Had the rocks in the upper part of the State retained their original horizontal position, the clay slate, being the newest rock, would overlie the rest; and instead of the variety of surface and soil which it now presents, the whole country would exhibit a monotonous level, and be covered with the poor, grey soil of the clay slates. The beds of lime rock, the ores of iron, and the metals, would be placed far beyond our reach—nor would their existence even be known to us. But by this simple contrivance, we are not only presented with this beautiful variety, but the rocks are made to reveal their treasures for our use.

The angle formed by the planes of stratification of a stratum and the horizon, is termed the ***dip***, and the direction or course of the edge of the stratum is called the ***strike***.

Fig. 4.

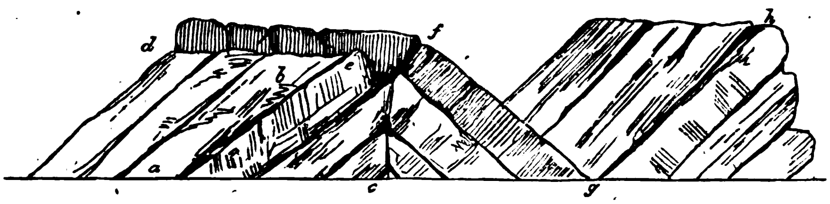


Fig. 4 represents strata of rocks tilted up into an inclined position. The angle formed by the inclined surface *a b* and the horizon is called the *dip* of the stratum; and the course of the edge of the stratum, *d e*, is the strike. The *dip* and strike are therefore at right angles with each other;—that is, if the *dip* be towards the East, the *strike* will be North or South. The angle *b a c*, which is about 43°, represents the dip of the surface *a b*, and we say the rock dips 43° West. Trifling as this fact may seem, practically it is of the utmost value. When barely the edge of a bed of ore can be seen on the surface, it is obviously of great importance to be able to determine in which direction it dips, and even the amount of that dip. Otherwise, in sinking our shaft for exploration, we may locate it in an unfortunate position, or miss the bed altogether.

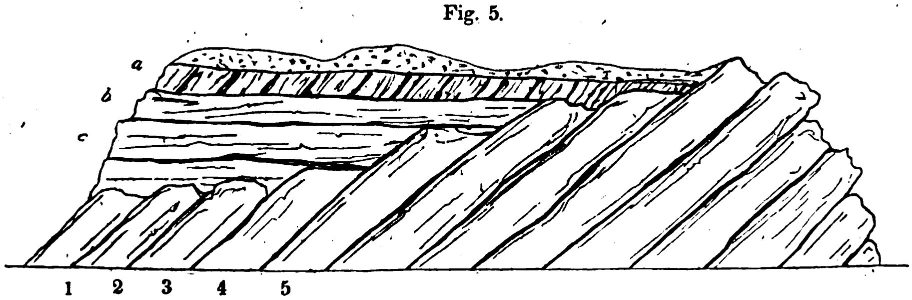
In York District I saw a bed of iron ore which had once been worked. A new shaft became necessary: it was sunk, but no ore found. It was therefore concluded that the bed was exhausted: further search was accordingly given up, and the ore remained to be re-discovered some years after. A knowledge of the simple facts just explained, would have prevented the vexation and loss incurred here. The new shaft, in consequence of a change in level of the surface, was sunk on the wrong side of the strike.

In tracing the edge of a stratum or bed over a considerable space, the undulations of the surface of a country must be taken into account; otherwise we may be led into great errors. The line *towards* which strata lean, or that along which the force acted, which tilted them up, is called the ***anticlinal axis***. In Fig. 4, *d e* represents the direction of this axis—which is the line towards which the strata *a b* and *f g* are inclined. The term *synclinal* is applied to the line *from* which contiguous strata incline: it is the line joining the bases of the strata *f g* and *g h*.

Out crop is another term frequently used in speaking of rocks. It is applied to the edges of rocks, as they rise up or are exposed at the surface, when they are said to *crop out*.

When superincumbent beds rest without any conformity to the stratification of the lower beds, they are said to rest upon them *unconformably*. The beds *a b c*, Fig. 5, represent unconformable beds resting on the upturned edges of the strata 1 2 3 4 5.

Fig. 5.



Metallic Veins.

Veins being cracks or fissures in rocks, filled with mineral matter, their analogy with dykes is quite obvious. When the mineral matter is a metal the veins are called metallic veins. The whole substance of the vein is, however, rarely composed of a metal: in that case, the mineral with which the metal is combined is called the *gangue*, and the whole metalliferous vein the *lode*. The rock which contains the vein is called, in mining phraseology, the *country*. Veins occur of all sizes, from the thickness of a mere thread to that of many fathoms; nor does there appear to be any connection between the thickness and relative productiveness of veins, although it often happens that when a very thick vein contracts its dimensions, it is found comparatively richer.

The passage of a vein from one rock to another is often marked by a corresponding change in productiveness. It is a common impression among the miners in South Carolina, that gold veins become richer when they pass from a soft to a harder rock. But this difference is still greater at or near the point of contact of the igneous and metamorphic rocks.

Metalliferous veins are regarded as contemporaneous with the strata in which they are found—when they are completely enclosed in them, forming irregular masses of limited extent, and generally differing but little in appearance from the rest of the rock. When the veins intersect the strata they are, of course, posterior to them, and are generally very distinctly separated from the rock in which they occur, by smooth walls. Such are called true veins, and are designated by English miners as *rake veins*, when they cut the strata either perpendicularly or inclined, and descend to a great depth in the earth. The course or bearing of *rake veins* is generally straight. *Pipe veins* are large, irregular masses, that seem to push themselves, like wedges, between the strata, and have sometimes the appearance of beds—their inclination depending frequently on the dip of the rocks. *Flat veins* are generally horizontal, and seem to be openings between the strata, filled with metalliferous matter. Such veins are subject to frequent dislocations and disturbances.

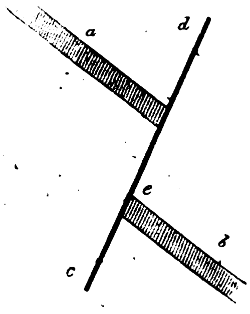
Interlaced masses are portions of the rock or *country*, intersected in all directions by veins, forming a sort of net-work.

East and West lodes are metalliferous veins, whose direction or bearing does not vary more than 30° from these points.

When a series of such veins is intersected by other veins, nearly at right angles, the latter are called *cross courses*. The dislocations that take place at such intersections are often sources of great difficulty to miners. The continuity of the veins is broken. The derangement thus produced is called a *fault* or *shift*, and the distance to which the vein is thrown from its bearing is called the *offcast*. In coal mines, such dislocations are a source of great difficulty to the miners. Very often, when they are pursuing a seam of coal with great success, it is suddenly cut off, and recovered with much labor and delay. When a fault occurs it becomes, therefore, a matter of great interest to determine on which side the *offcast* takes place; or, in other words, on which side we are to look for the lost vein.

In the mines of Saxony and Cornwall it is considered as established, as a general law, that the *offcast* takes place on the side on which the obtuse angle occurs. For example, if the vein *a b*, Fig. 6, be dislocated by the intersection of the cross course, *c d*, we must search for the lost vein, *e*, on the side of the obtuse angle *e*, made by the vein and cross course; and this, it is plain, will hold good, no matter which end of the vein we are pursuing.

Fig. 6.



Mining, in our gold regions, has not been pursued with sufficient regularity to enable us to ascertain whether or not this law holds good in them, and the subject is introduced for the purpose of directing the attention of our miners to a fact so highly important.

The origin of the metallic matter in veins has excited a good deal of speculation, but it still remains in obscurity. Four theories have been proposed to account for it. The 1st is that proposed by Werner, who supposed that veins were filled from above, by aqueous solution. The 2d is the theory of Hutton, that proceeds upon the supposition that veins were injected from below, in a state of igneous fusion. The 3d accounts for the repletion of veins by the process of sublimation from intensely heated mineral matter, by which cracks and fissures in the superincumbent rocks were filled. And the 4th theory supposes veins to be the result of slow segregation of matter from the adjacent rocks, either into cavities formed during or subsequent to their deposition, or into fissures which may be caused by fracture or dislocation of the consolidated rocks. This segregation may result from electro-chemical action, as illustrated by the experiments of Fox, Becquerel, and, more recently, by those of Hunt.

Much might be said in favor of each of these hypotheses, and it is highly probable that metalliferous veins are not the result of either exclusively, but may be due sometimes to one, and again to the others. It is quite certain that where pebbles and other surface materials are found in veins, they must have been filled from above; and when we find the mineral matter in a vein embedding fragments of the walls torn off in the passage of the mineral matter through the rocks, it is equally certain that such veins are produced by injection from below. Numerous cases occur where metallic matter is enclosed on all sides in the rocks, and the origin of which must be referred to segregation.

The richness of veins, where the rocks are much disturbed, as well as where granite comes in contact with the overlying stratified rocks, is well known; and it is quite probable that this richness is due to the rents and fissures that intersect the rocks at these points, which furnish favorable receptacles for ores and metals.

It would be desirable, if it were possible, to present rules for determining the presence of useful ores and minerals; but the only reliable indications are those derived from a knowledge of the geological structure of the country, added to a careful study of the recorded results of experience and observation. Many useful minerals are peculiar to certain geological formations. No one acquainted with its geology, would think, for example, to look for coal in the rocks of South Carolina; nor would he expect to find any other metal than iron in the lower part of the State—at least in workable quantities. Coal is of vegetable origin, and of course cannot occur in rocks that preceded the existence of plants on the earth, and iron is the only ore that is found in all the formations in sufficient quantity to be worked.

Gold, in the United States, is principally confined to the slates of the metamorphic rocks—generally the talcose and talco-micaceous slates; but in South Carolina it also occurs in granite, gneiss, and hornblende rock. The gangue is universally cellular, ferruginous quartz, and iron pyrites, excepting where it is disseminated in the slates in minute particles. I do not speak of deposit mines, derived from veins, where the gold is found in detached particles, intermingled with rounded pebbles and angular rocks of every description.

Silver is found in all the metamorphic rocks, as well as in those of the carboniferous formation.—It is very frequently associated with lead. In North Carolina it is found with lead, zinc and gold, in talcose slate.

Copper has a wide range, and is found from the granite to the new red sandstone inclusive.

Lead is also extensively distributed. The Davidson mine, in North Carolina, is in the talcose slates; but the lead mines of the West are situated in the limestone of the Silurian system. The carboniferous or mountain limestone is also a great repository of this valuable mineral. The principal form in which it occurs is that of galena.

Mercury is, for the most part, confined to the secondary rocks, although it sometimes occurs in older formations.

Tin belongs to primary rocks: it is generally disseminated through the rocks and rarely occurs in regular veins.

Zinc is found in the form of *blende* in granitic and metamorphic rocks; and in the palæozoic rocks, in that of *colamine.*

Antimony occurs in primary and palæozoic rocks.

Cobalt, *Bismuth*, and *Nickel* are found in granite, metamorphic and upper palæozoic rocks.

Manganese.—The principal deposits of this mineral are confined to the metamorphic rocks.

Recapitulation.

The conclusions of Geologists respecting the unstratified and stratified primary rocks, may be briefly expressed.

1. That the lowest rocks in the earth's crust, of which we have any knowledge, are crystalline, unstratified, and composed of a few simple minerals. They were called primary, because it was once thought that they were the oldest or first formed rocks. More recent investigations have shown that although they form the base or foundation of all the other rocks, they have been formed at various and comparatively recent periods.

2. These rocks admit of a very natural division into granitic and basaltic rocks. The former are highly crystalline, and although they are often protruded into the superincumbent rocks, they compose the platform on which all the others rest. The basaltic rocks, on the contrary, are generally found filling the fissures and rents of other rocks, or spread out on the surface, as if by overflowing. They frequently assume a columnar structure, often of striking regularity.

3. That the primary rocks are of igneous origin is proved by the fact that they have been imitated or re-produced by fusing rocks and allowing them to cool slowly, and that they have produced effects upon other rocks that can only be explained by the supposition of contact with intensely heated matter.

4. The increase of temperature, which is about 1° in 45 feet, as we descend below the surface of the earth, thermal springs, and volcanic action, all point to a central, or at least a source of heat beneath the earth's crust of immense extent.

5. Resting upon these are other rocks, for the most part composed of the same materials as granite, but differing from it in presenting evidence of mechanical origin, and in having a structure apparently the result of deposition from water. They are more or less crystalline, which is supposed to be the result of subterranean heat, and the alterations produced by this cause have obtained for them the name of metamorphic rocks. Besides their stratified structure, the result of deposition from suspension in water of the materials of which they are composed, they are often intersected by planes, (supposed to be produced by contraction.) This is called jointed structure. Some of them are divisible into laminæ whose planes do not coincide with the planes of stratification. This structure has received the name of slaty cleavage.

6. That the metamorphic rocks have been elevated from their originally horizontal beds by a force acting from below; and hence the inclined position in which they are always found. The phenomena produced by this elevation have given rise to the terms *dip*, *strike*, *outcrop*, *anticlinal* and *synclinal axis*, *&c.*

7. That no organic remains have hitherto been found in these strata, and hence they are sometimes called non-fossilliferous stratified rocks. This can only be explained by supposing that they were deposited before the beginning of life on the earth; that they were deposited under circumstances unfavorable to the preservation of animal and vegetable remains; or that these remains were obliterated by the intense heat to which the rocks have been subjected during their consolidation.

CHAPTER III.

Palæontology.— Classification. — Vertebrata—Mammalia.— Characters of the class.— Orders.— Birds.—Reptilia.—Characters of the class.—Fossil Reptiles.—Orders.—Enaliosauri.—Ichthyosaurus. —Plesiosaurus.— Crocodilia. —Dinosauria.—Lacertilia. —Pterosauria. —Chelonia.— Ophidia.— Batrachia. —Class Pisces.— Sub-kingdom Articulata.—Sub-kingdom Mollusca.— Radiata.—Infusoria.—Fossil Plants.

Before proceding to the consideration of those rocks which contain organic remains, it will be proper to take a general view of the science which has for its object the determination and description of those forms which have passed out of existence in the revolutions of time, and whose remains are entombed in the solid crust of the globe.

For a long time these remains were considered mere "sports of nature"—the work of what was called a "plastic force"—and violent was the opposition that those met with who held the opposite opinion, that they belonged to forms which once had life. It seems, at this day, almost incredible that fossil shells, presenting all the characteristics of the exuviæ of living mollusks, should ever have been considered as mere imitative forms assumed by rocks. When observation, at length, gained its proper ascendency over speculation, and organic remains were viewed in their true light, Geology made a rapid stride towards its proper place as a science.

Geology was first cultivated by Mineralogists, and constituted a subordinate branch of their science; and hence rocks were identified by their mineral composition and structure. Its cultivators had indeed observed that certain rocks contained no fossil remains, whilst others abounded in such forms. This led, at once, to the division of rocks into primary and secondary; but beyond this, although Hooke seems to have been aware, in 1688, that some fossils were "peculiar to certain places," no further use was made of fossils, as the basis of a classification of rocks, until Mr. William Smith, in 1790, proposed the identification of the strata of the secondary formations of England, by their peculiar fossils. He had studied the rocks around Bristol, and was struck with the fact that each formation had fossils peculiar to itself. Even beyond Bristol he found the same fossils, characterizing identical formations, and conceived the thought of determining rocks by their organic remains. To satisfy himself of the truth of this happy generalization, he made numerous journies on foot, and embodied the result of his observations in a geological map of England—a work of extraordinary merit. Here Geologists saw at once a far more certain mode of determining the contemporaneous character of rocks than could be hoped for from the most minute study of their physical structure; and the fragment of a shell became to them what a medal or coin is to the eye of the antiquary.

About this period the attention of the immortal Cuvier was directed to certain fossil bones found in an excavation near Paris. Applying to these, with incomparable skill, the immutable laws of existence, he was enabled, in many cases, from mutilated fragments, to restore the entire skeleton to which they belonged.

These researches gave an impulse to science that is still felt. Botanists, Conchologists, and Zoologists, anxious to connect their favorite sciences with the past, pursued their investigations with a success truly astonishing; and startling were the results of their labors. The remains of animals were found in countries where even the order to which they belong is no longer found among their living fauna. Many wanting links in the chain of actual being were supplied, and not a few forms were discovered that have no living types to which they can be referred as analogues. It is thus that Geology has assumed its elevated position among the sciences, and that the history of rocky strata becomes identified with elevated views of the history of the dawn and progress of life upon the earth.

A correct knowledge of the past can only be acquired by a careful study of existing nature; but it is obvious that the characters presented by fossil remains must be quite limited, compared with those of living organisms, as it is the hard and more indestructible portions alone that are found embedded in the rocks: so that, for the most part, the laws of anatomical analogy alone can furnish us with any certain guide in our investigations. So successfully have these laws been applied, that a new science has grown up, in modern times, which has received the name of Palæontology, (the science of ancient being.)

The following classification of the Animal Kingdom, by Professor Owen, offers some slight modification of that of Cuvier.

Kingdom—Animalia—*Animals.*

Sub-kingdom—Vertebrata—*having a spinal column.*

Class—Mammalia—*animals that give suck.*

" —Aves —*birds.*

Class—Reptilia —*reptiles.*
" —Pisces —*fishes.*

Sub-kingdom—Articulata—*with external jointed skeletons.*

Class—Crustacea —*with an external hard crust—crabs, &c.*
" —Arachnida—*spiders.*
" —Insecta —*insects.*
" —Anellata —*worms.*
" —Cirripedia —*with curled feet.*

Sub-kingdom—Mollusca—*soft animals.*

Class—Cephalopoda —*feet around the head.*
" —Gasteropoda —*feet under the belly.*
" —Pteropoda —*winged feet.*
" —Lamellibranchiata—*with lamellated gills.*
" —Brachiopoda —*feet like arms.*
" —Tunicata —*covered with a mantle.*

Sub-kingdom—Radiata—*radiated animals.*

Nematoneura—*with thread-like nerves.* Acrita—*with obscure nerves.*

Class—Radiaria—*rayed animals.*

Echinoderma—*with spinous skin.* Acalepha—*with stinging skins.*

Class—Polypi—*polypes.*

Ciliobrachiata—*with ciliated arms.* Anthozoa—*flower animals.* Nudibrachiata—*with naked arms.*

Class—Entozoa—*internal animals.*

Coelelmintha—*hollow worms.* Sterelmintha—*solid worms.*

Class—Infusoria—*infusorial animals.*

Rotifera—*wheel animalcules.* Polygastria—*with many digestive sacs.*

The preceding classification gives a pretty correct view of the present state of our knowledge in relation to the affinity existing between the classes and groups of the animal kingdom. The gradation between the classes of vertebrata is quite evident, beginning with the class mammalia, the most highly organized, and ending with the fishes, the lowest in the scale. The reptiles properly take precedence of the fishes; they have a higher organization. Many of them have feet, and all, to a certain extent, have the power of assuming a vertical position. Among the fishes the cartilaginous group stands lowest; and the "gar" of our coast, seems to connect the osseous fishes with the reptiles; for, besides other peculiarities, it has concavo-convex vertebræ, and can move the head independently of the body.*

But between the lowest animal, with a spinal column, and the highest without one, there is a vast gap in the scale. The sub-kingdoms, Articulata and Mollusca, cannot be arranged in a continuous series, so as to exhibit the relative degrees of perfection of their organization; for the highest class of Mollusca, the Cephalapoda, are far above the lowest class of Articulata, the Cirripedia. And, on the other hand, the highest of the Articulata are equally removed from the lowest of the Mollusca. The two sub-kingdoms must, therefore, be arranged in parallel series.—

*Agassiz.

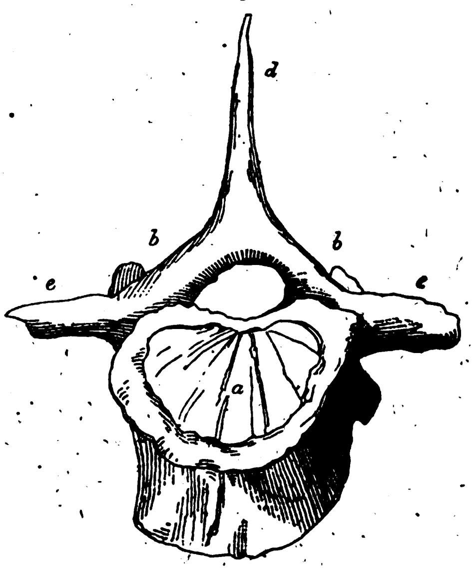
This must also be the case in the arrangement of the sub-kingdom Radiata, as far as relates to the groups under the classes which cannot follow each other, but must be arranged side by side.

It seems, then, that we must not look for a scale of beings that will fairly represent the gradation of species, from the lowest organism up to man; and although it is true, to a certain extent, as regards the great groups, which do exhibit relative degrees of complication or perfection in their structure, yet among the subdivisions of these groups many wide breaks occur.

Vertebrata.—The osseous character of the skeletons of these animals is highly favorable to their preservation, when enclosed in sedimentary deposits, and hence the vast number of the remains of vertebrata found in the rocks of every country.

The great characteristic of this sub-kingdom is the spinal column, which is continued, with wonderful constancy, from the lowest to the highest animal included in it. With the exception of some of the lowest fishes, in which it consists of a cartilaginous tube, the spinal column is divided into a number of articulating osseous pieces, called vertebræ. And as these present modifications characteristic of the several classes of vertebrata, they are entitled to special consideration.

Fig. 7.



This figure represents the essential parts, or elements, as they are called, of a vertebra. *a* is the *centrum* or body, the ends of which constitute the articulating surfaces of the vertebra; *b b* are two bony plates that proceed from the centrum, and form the sides of an arch, whose office is the protection of the spinal cord, and is hence called *neurapophysis*. These plates are united at the top by the *spinous process*, *d*, which completes the arch. Corresponding with the preceding are two other plates that extend from the under side of the centrum, and are connected, in like manner, by a spinous process—forming a canal for the protection of the large blood vessels that pass along the under side of the centrum. It is therefore called *hæmapophysis*. This corresponds with the *chevron bône* of some writers, and is found in fishes and cetacea as well as in the caudal vertebræ of reptiles.—Proceeding from the sides of the centrum are two plates, *e e*, called *transverse processes*, with which the ribs are connected. Besides these there are other processes forming articular surfaces, by which contiguous vertebræ are united, but they are not constant. In fishes other bones are developed for special purposes, and are called *interspinous* bones.

The relation between the spinous and transverse processes and the flexures and motions of the spinal column is curious and interesting. When these processes are much developed there can be but little motion in the direction in which the development takes place—for instance, in the osseous fishes the processes extend in the vertical direction, and are but slightly extended laterally. The flexures of the spine are consequently made with ease laterally, but it has scarcely any motion in a vertical direction. In the Cetacea, on the contrary, the transverse processes are large and the spinous processes small, and hence the spinal column moves, without obstruction, vertically, but with difficulty in a lateral direction.

These motions are intimately connected with the wants and habits of these animals; but it would lead us beyond our purpose to consider them here—our object being simply to point out some of the principal characters derived from the solid parts of animals, that may give useful hints to the Geologist in his investigations.

The ribs may be regarded as vertebral elements, and the limbs and other bones of the skeletons of animals have been referred to modifications of similar elements, or as accessories to the spinal column. From the analogy found to exist between the mode of developement of vertebræ, and that of the cranial bones, comparative anatomists have been induced to consider the latter as highly modified forms of vertebræ; and this analogy is strikingly constant, as appears from the fact that wherever the elements of the vertebræ remain unanchylosed, a like condition is observed in the elements of the cranial vertebræ—facts that enable the Palæontologist to distinguish, at a glance, the remains of cold from those of warm blooded animals.

The following are the orders of the class Mammalia.

Class Mammalia.

Quadrumana	—*Monkies.*
Cheiroptera	—*Bat, &c.*
Carnivora	—*Bear, Cat, Wolf.*
Marsupiata	—*Opossum.*
Rodentia	—*Squirrel, Rat.*
Edentata	—*Sloth, Armadillo.*
Pachydermata	—*Elephant, Hog.*
Solidungula	—*Horse.*
Ruminantia	—*Ox, Sheep.*
Cetacea	—*Whale, Porpoise.*

Characters of the Class.—In Mammalia the cranium articulates with the spinal column by means of a *double condyle.* The lower maxillæ, which consist each of a single bone, articulate distinctly with the cranium, without the intervention of other bones. The articulation varies with the habits of the amimal; in Carnivora the condyle fits into a hinge-like groove, which admits only of a vertical motion in the jaw. In the Herbivora provision is made for lateral motion; and in Rodentia a backward and forward motion of the jaw is indicated. The lower maxillary angle has a process, which, in Carnivora and Rodentia, is extended backwards. In Marsupiata, the angle is expanded laterally, terminating inwards in an acute process, as in the opossum.

The application of microscopic research to the teeth of animals has given rise to a new science, called by Prof. Owen, Odontography, by which the affinities of animals may be determined by the microscopic characters of their teeth.

In general teeth are composed of three elements, *dentine, cement,* and *enamel.* In herbivorous animals these are disposed in vertical plates, variously folded and convoluted, as may be seen in the tooth of a horse or ox. Being of unequal hardness, the grinding surface of the teeth is always uneven and rough—conditions necessary to the proper fulfilment of their functions, as instruments of trituration. In the Mammoth the plates are disposed in series parallel with the shorter or transverse diameter of the tooth, and connected at the extremities. The molars of the Mastodon, on the contrary, have prominences on the crown, covered by a thick coat of enamel, which appears more or less removed by detrition in adult individuals. The tusks of these animals often occur in the fossil state, and may always be detected by the peculiar "twilled" appearance of the ivory, which, when once observed, cannot be mistaken for any other substance. In Carnivora the teeth are covered with enamel, but no plates extend through the body of the teeth.

No animals but those of the class Mammalia have teeth with more than one fang or root. The roots of the teeth of sharks are divided into two lobes, yet can scarcely be mistaken for the teeth of animals of this class. The articular surfaces of the vertebræ are always flat or slightly concave. The cervical vertebræ of the horse present an apparent exception; but a single comparison with the true ball and socket joint of reptilia will prevent mistakes on this point. The processes are united to the centrum by anchylosis, or, as Professor Owen expresses it, are exogenous, and distinguish mammalian vertebræ from those of reptilia in those fossils where the ball and socket joint of the latter is absent, as in Ichthyosaurus. The number of vertebræ in the spinal column is various, but constant in certain portions of it. There are, with one or two exceptions, seven cervical vertebræ; the average number of dorsal vertebræ is twelve. The caudal vertebræ are quite variable, and sometimes numerous.

The bones of the limbs in Mammalia are in general firm and elastic; the interior filled with tissue, having a cancellated structure, or presenting a medullary cavity. In the bones of cetacea which have no medullary cavity, the cancellated structure is coarse and conspicuous. Certain bones of the ear of cetacea, which are nearly as hard as flint, are found in our tertiary formation. They are oblong and irregular, with depression on one side: they have been called *otolithes*.

The following list comprehends nearly all the genera that are found fossil of this class.

1. Order, *Quadrumana.*
   - Macacus—*Monkey.*
2. Order, *Cheirotherium.*
   - Rhinolophus—*Bat.*
3. Order, *Carnivora.*
   - Talpa—*Mole.*
   - Sorex—*Shrew-mouse.*
   - Amphitherium.
   - Ursus—*Bear.*
   - Meles—*Badger.*
   - Putorius—*Pole cat.*
   - Canis—*Wolf.*
   - Hyæna.
   - Felis—*Cat.*
   - Phoca—*Seal.*
4. Order, *Marsupiata.*
   - Didelphis—*Opossum.*
   - Phascolotherium.
5. Order, *Rodentia.*
   - Castor—*Beaver.*
   - Casteroides.
   - Mus—*Rat.*
   - Lepus—*Hare.*
6. Order, *Edentata.*
   - Megalonyx.
   - Megatherium.
   - Mylodon.
   - Scelidotherium.
   - Macrauchenia.
   - Toxodon.
7. Order, *Pachydermata.*
   - Elephas.
   - Mastodon.
   - Rhinoceros.
   - Hippopotamus.
   - Lophiodon.
   - Tapir.

Pachydermata—(Continued.)
Elasmotherium.
Palæotherium.
Anoplotherium.
Xiphodon.
Dichobunes.
Chæropotamus.
Anthracotherium.
Adapis.
Hyracotherium.
Sus—*Hog*.

8. Order, *Solidungula*.
Equus—*Horse*.

9. Order, *Ruminantia*.
Urus—*Auroch*.
Bôs—*Ox*.
Capra—*Goat*.
Cervus—*Roe*.
Dama—*Deer*.
Megaceros.
Sivatherium.

10. Order, *Cetacea*.
Manatus.
Balæna.
Monodon.
Delphinus.
Zenglodon.

Birds.—But few remains of birds are found in any country. The foot-prints in the sandstone of Connecticut, however, afford positive evidence of the existence of this class of vertebrata, as far back as the secondary period. Many of these foot-prints are of extraordinary size, being fifteen inches in length; and the length of the strides of the bird, as indicated by the impressions on the sandstone, was from four to six feet. The vast proportions of a bird capable of such strides as these, for some time induced doubts as to the true nature of these "ornithicnites." The persevering labors of Prof. Hitchcock and Dr. Deane, in this novel field of enquiry, removed all scepticism, at least on this side of the Atlantic. And abroad the discovery of the osseous remains of a gigantic bird, fully proportionate to the largest foot-prints on the Connecticut sandstane, removed all doubt. In New Zealand the bones of birds were found imbedded in mud, one of which, the largest bone of the leg, measured twenty-eight inches in length. These relics were described by Professor Owen, under the name of *Dinornis*.

The cranium of birds presents a remarkable peculiarity in the early coalescence of its separate bones, so as to appear as if composed of one. The lower jaw articulates with it by means of the *os quadratum*, as in reptiles.

In general the bones are hollow, thin and smooth; those of the trunk are hard and elastic, and of the extremities brittle.

Taken in connection with the foot prints left on the solid rocks, the peculiarities of the form of the feet become a matter of some interest.

When there are four toes, three of them are directed forward and one backward, which may be called the thumb: in the latter there are two joints, in the first on the inside there are three, in the next four, and the outer toe has five joints. When the bird has but three toes, two are directed forward. The hind toe, in this case, has three joints, and the others four and five respectively.

We have here, then, a simple means of inferring, with confidence, the existence of birds from their tracks, in the absence of other evidence; as no other animals have feet presenting the same organization.

Reptiles.—The following are the types to which living reptiles are referred.

Class Reptilia.

Sauria —*Alligator, Lizard.*
Chelonia —*Turtle, Terapin.*
Ophidia —*Rattlesnake.*
Batrachia —*Frog, Salamander.*
Ichthyodea—*Proteus, Siren.*

Characters of the Class.—In Reptilia the cranium is articulated by means of a single condyle; which in some of the orders presents a disposition to divide, and in Batrachia the lateral occipitals terminate in two articular tubercles. The cranial elements are not firmly united, as in other vertebrata, but generally remain separate.

The lower maxillæ are composed of two pieces, which in Sauria are united by suture, but in Chelonia are firmly anchylosed and form one solid piece. Each of these is composed of six bones, a character that enables the Palæontologist to distinguish the lower jaws of Reptilia from all others. The lower maxillæ articulate with the cranium by means of the intermediate *os quadratum.*

The teeth are conical and composed of a pulp cavity, surrounded by dentine. They are indented on the surface by irregular striæ, and in addition to these, two prominent acute ridges mark the anterior and posterior sides of the crown. The root or fang is always single. In the alligator the hollow of the root is occupied by the young tooth, which, when it comes in contact with the sides, produces a notch in the old tooth. The alligator differs from the crocodile proper, in having the upper jaw larger than the lower. When the mouth is closed the lower teeth fit into pits in the upper jaw; whereas, in the crocodile, the upper and lower series of teeth meet like those of a trap. In some fossil teeth a succession of teeth may be observed fitting closely, like a series of hollow cones, one over the other.

In Batrachia the microscopic character of the teeth is very curious and characteristic.

The vertebræ of reptiles are characterised by that peculiar mode of articulation called "ball and socket" joints, consisting of a convex and concave surface adapted to each other.

In Sauria the concave surface is placed anteriorly and the convex posteriorly; but in Batrachia this order is reversed—the concave part being turned backwards, and the convex surface before: while in Ichthiodea both ends are concave, like those of fishes. The crocodiles have about sixty vertebræ, of which seven are cervical, twelve dorsal, five lumber, two sacral, and the rest are caudal. The alligator, however, has sixty-eight, the additional ones being found in the tail. The neurapophyses are united by suture to the centrum, but the suture is often obliterated by age.

The ribs in crocodiles are bifurcated at the proximal end, and articulate with contiguous vertebræ. The bones of the extremities, having no medullary cavity, are solid in recent species.

The *Chelonians* present a most strange modification of the prevailing characters of vertebrata.—Instead of the usual internal skeleton we find long shields, enclosing the body on all sides. The upper one, which is called the carapace, is composed of the coalesced ribs, vertebræ, and processes.

The cervical and caudal vertebræ show the true reptilian characters; and even the ribs may be seen united to two adjacent vertebræ, and one or two of the first are bifurcated. Towards the extremities the broad costal plates terminate in narrow points like true ribs, and the union of these with the surrounding marginal plates or scutes affords some useful characters.

In the land and fresh water species, with the exception of Trionyx, these points are anchylosed with the scutes, but in marine species they only abut against them. The bones of the extremities are solid, and the humerus much curved. The clavicles, which are in number two on each side, are united with the scapula, so as to produce a bone somewhat resembling a tripod.

The peculiarity in the articular surface of the vertebræ of serpents that distinguishes them from other reptiles, is an oblong concavity, placed with its longer diameter transversely with the axis of the spinal column.

Few subjects have excited equal interest among Palæontologists, with the discovery of the extraordinary forms of this class found in the secondary rocks of Europe. Their gigantic dimensions and their anomalous structure, which offered but few points of comparison with living forms, were well calculated to excite wonder, if not incredulity, as to their real character. These have been studied with great success by British naturalists, and they have recently been marshalled into their appropriate places in the scale of being, by Professor Owen, in a most valuable report on British fossil Reptilia.

They are distributed under the following orders in that report.

Orders of Fossil Reptilia.

1. Order—Enaliosauria,	5. Order—Pterosauria,
2. Order—Crocodilia,	6. Order—Chelonia,
3. Order—Dinosauria,	7. Order—Ophidia,
4. Order—Lacertilia,	8. Order—Batrachia.

Characters of the Orders.—The Enaliosaurians, at the same time that they present in their structure true typical reptilian characters, such as the unanchylosed state of the cranial, lower maxillary and vertebral elements, they also, by other characters, approach the cetacea. For, besides having nostrils near the top of the head, for breathing, their fore and hind paddles resemble, externally, those of certain cetacea; and it is from this modification of the reptilian type that they derive the name of Enaliosarus, or marine Saurians. Other reptiles have extremities adapted to a life on land, or they are fitted for both land and water—these were exclusively aquatic.

The remarkable genera *Ichthyosaurus* and *Plesiosaurus*, constitute, according to Professor Owen's arrangement, the first order; and certainly their huge dimensions and anomalous structure entitle them to a separate and distinguished place at the head of the reptiles.

Icthyosaurus.—The head of this reptile in form resembled that of the porpoise, with comparatively less space for brain, but was of gigantic dimensions; a head figured by Dr. Buckland measures over four feet in length. The eyes must have been of enormous size, for the orbital cavity in one instance was found to be fourteen inches in diameter. The lower maxillæ are composed of several bones, like those of Reptilia. The teeth, which are conical and striated, are not inserted in distinct sockets, but in a continuous groove, which presents, however, rudimentary divisional plates at the bottom and sides of the groove, extending between the teeth. The mode of growth of the teeth is very similar to that in the alligator; the young tooth pressing against the basal margin produces a notch in the old tooth.

The vertebræ, instead of the concavo-convex articular surfaces of reptilian vertebræ, present conical cavities, like those in the osseous fishes. The diameters of the vertebræ, in the direction of the spinal column, or their anterio-posterior diameter, is quite small, and they are consequently flat, compared with those of osseous fishes.

The neurapophyses are not connected with the centrum by the modes peculiar to either reptiles or cetacea, but are inserted in sockets on each side of the depression along which the medullary cord passes.

The paddles are connected with the trunk by means more complicated than that found in cetacea, and in this structure they approach Reptilia. The ribs, which were bifurcated at top or proximal extremity, were placed along the whole of the vertebral column between the head and the pelvis, so that the animal had no neck.

Plesiosaurus.—This was a contemporary of the preceding animal, and in many respects far more extraordinary. Cuvier has designated its structure as "altogether the most monstrous that has yet been found amid the ruins of a former world." "To the head of a lizard it united the teeth of crocodile; a neck of enormous length, resembling the body of a serpent; a trunk and tail having the proportions of an ordinary quadruped; the ribs of a chameleon and the paddles of a whale."

The cranium resembles that of the crocodile or alligator; but is much smaller in proportion to the body. The occipital elements remain in a separate condition, and in this respect, as well as in the composite character of the lower jaw, it resembles the true Saurians.

The teeth are placed in distinct sockets: they are slender, pointed, and a little arched and striated. The vertebræ are somewhat shorter in anterio-posterior, than in the vertical or lateral diameter. The articular surfaces are slightly concave, with a gentle convexity in the centre. The centrum is marked near its lowest surface by the costal pits, which are elliptical depressions, intended to receive the ends of the costæ, and are placed a little below the neurapophyses.

The most striking character of the genus is the extraordinary length of the neck, which is composed of from twenty to forty vertebræ—nearly double the number found in any recent animal.

Of this genus Prof. Owen has described, as occurring in England, sixteen species, and of the preceding ten. That so many species of animals so destructive and ferocious in their habits, should have been congregated together in so small a space, is a fact almost as extraordinary as their strange organization. This order is connected with the next by a huge reptile called *Pliosaurus*. The flattened character of the vertebræ of this fossil distinguishes it from the preceding—the length being one inch and a half, while the other diameter is five inches. The teeth are also peculiar—being somewhat trihedral at the summit.

Crocodilia.—The characters of recent Crocodilia have been described under the class. The fossil species, however, present modifications and characters unknown in recent forms. In living reptiles with concavo-convex articulating surfaces to the vertebræ, the concave end is turned anteriorly and the convex end behind, but in the fossil congeners this order is often reversed, and some are even found with both articular surfaces concave or flat. Prof. Owen divides the order into two groups—the first containing those fossils with concavo-convex vertebræ, and the second including those with biconcave vertebræ. To the first belongs *Crocodilus Spenceri*, which differs from recent crocodiles in the larger size of the temporal holes, the rapid tapering of the head forwards, and in the straight line joining the alveoli. In the second group we find *Suchosaurus cultridens*, which is characterised by teeth that are compressed laterally, and having trenchant edges, resembling the teeth of Megalosaurus, excepting that they are not, like them, serrated on the edges. They differ still further from the latter, by being striated on the sides of the crown. And the teeth of the Gavial are compressed in an opposite direction.

Goniopholis crassidens.—The teeth of this species have thick, round blunt crowns, finely striated, and marked by two strong ridges which extend to the termination of the enamel.

The other genera belonging to the group, with *biconcave vertebræ*, are—

Teleosaurus,	Streptospondylus,
Steneosaurus,	Cetiosaurus.
Poikilopleuron.	

Dinosauria.—The fossils of this order are characterised by a large and unusual sacrum, composed of five anchylosed vertebræ, by the great height and breadth of the neurapophyses, and by having the ribs articulated at the anterior portion of the spine by a head and tuburcle, and to the rest of the spinal column by a head attached to the transverse process only. They were all of gigantic size—far exceeding, in this respect, all living reptiles. The Megalosaurus must have been, according to Prof. Owen's determination, full thirty feet in length. The Iguanodon was fifteen feet long, while his living relative, the Iguana of the West Indies, seldom attains a length of five feet, even with the addition of a long prehensile tail, which could not have belonged to the Iguanodon.

Lacertilia.—The animals whose fossil remains are included under this order approach in structure the living lizards, which have compressed angular teeth, with the edges denticulate: in some recent species there is an additional row on the posterior edge of the palate.

The fossil species deviate very widely from any living types. Prof. Owen has designated the mode in which the teeth are attached to the jaw, by the term *acrodont*, when they are anchylosed to the summit of an alveolar ridge; *pleurodont*, when they are attached to the bottom of an alveolar groove; and *thecodont*, when inserted loosely in sockets, or anchylosed to the walls of the alveoli.

The following genera are placed here.

Mososaurus,	Rhyncosaurus,
Leiodon,	Thecodontosaurus,
Rhaphiosaurus,	Palæosaurus,
Lacerta,	Cladeiodon.

Pterosauria.—The anomalous character of the remains placed in this order is made quite evident by the widely differing conclusions of distinguished naturalists respecting them—the Pterodactyle having been referred to birds and Mammalia respectively. Cuvier was the first to settle the true affinities of this strange animal, having apparently the head and neck of a bird joined to the wings of a bat. He shewed that however great the resemblance to these animals may appear, the differences were still greater. No bird has more than one metatarsal bone—in the Pterodactyle they are as numerous as the phalanges. No bird has less than nine cervical vertebræ—the Pterodactyle has only six or seven: and no Mammal has so small a cranium in proportion to the beak. Besides, the teeth are truly saurian. It was a critical examination of such characters that enabled Cuvier to refer this animal to the saurians.

Prof. Owen has added, with a doubt, two other genera to this order.

Pterodactyle,	Polyptychodon,	Rysosteus.

Chelonia.—The fossil genera described under this order are—

Testudo,	Tretosternon,
Emys,	Trionix,
Platemys,	Chelone.

Ophidia.—Some remains of a serpent found in England, belonging to individuals at least twenty feet in length, have been placed in this order, under the name of *Palæophis toliapicus.*

Batrachia.—There are a few remarkable fossils belonging to this order, known to Palæontologists. Among these is the noted "Fossil man of Œningen"—a huge salamander which was described, about the middle of the last century, as belonging to the human species. And although doubts had been entertained of its true characters, it remained for Cuvier to settle its real affinities.

Another extraordinary form, the Labyrinthodon, for whose name and true relations we are indebted to the new science "Odontography," has been added to this order. A portion of the cranium, together with the lower jaws, teeth, vertebræ and other bones were found, and from these materials Prof. Owen has restored five species of this huge Batrachian.

The teeth are conical, finely striated, and slightly curved. In microscopic characters they resemble the fangs of the teeth of Ichthyosaurus, and Prof. Wyman has pointed out this folded and otherwise remarkable structure in the Lepidosteus or "gar" of our rivers.*

Orders of the Class Pisces.

The systematic arrangement of fishes, up to the time of the illustrious author of *Poissons Fossiles*, depended upon the osseous or cartilaginous structure of the spinal column, and upon the number, structure and disposition of the fins. The imperfection of this mode of classification was felt and admitted by Cuvier himself; and while the remains of almost every other class of animals were available for the extension of knowledge of the former state of existence on the globe, fossil fishes scarcely added any thing in this respect. This was the more striking from the fact that so large a portion of the present dry land was once under water, as well as from the high locomotive power of fishes, that enabled them to distribute themselves over numerous and widely distant localities. This deficiency in the knowledge of the geological relations of fossil fishes arose, in a great measure, from the imperfect state of knowledge of living fishes, and from the difficulty of referring fossil species to their recent analogues.

When any portion of the spinal column of a fish was preserved in a fossil state, it was not difficult to refer it to the osseous or cartilaginous division of the class. The vertebræ of the former are hollowed out at their articular surfaces, so as to represent hollow cones with their points in juxtaposition. The exterior portion of the centrum is marked by deep grooves that in some genera penetrate the articular cavity.

In the ossified cartilaginous vertebræ of sharks and rays, similar articular conical cavities occur, but they are quite shallow—the anterio-posterior diameter being, in all cases, quite small. The outer surface, which is generally smooth and regular, is, in the genus *Lamna*, impressed by four oblong pits, and in *charcarias* there are numerous narrow excavations surrounding the vertebræ in

*Am. Jour. of Sci. vol. xlv. p. 359.

a line with the vertebral axis. So far the classification was available for identifying the affinities of fossil with recent fishes, but when it was to be applied to lower divisions of the system its defects became hopelessly obvious. It rarely happens that fossil fishes are found so perfect as to retain all the fins, and when fins are absent it is not always possible to say that they never existed. It was in this state that Prof. Agassiz found fossil Ichthyology. Observing the constancy with which the scales of fossil fishes are preserved, even in the oldest rocks, when every vestige of all other characteristic parts have disappeared, the happy idea occurred to him of founding a classification upon the structure of the scales. Now it is known that the tegumentary parts of all animals are subject to the greatest changes and deviation from typical characters, and hence at a superficial view, a classification based upon the scales of fishes has an exceedingly artificial aspect. It is found, however, that there exists an intimate connection between the organization of the animal and the structure of the scales, and hence the orders founded upon that structure are perfectly natural groups. And nothing could afford stronger proof of the practicability of the system than the rapid strides that have been made in this department of Palæontology, since it was adopted. From a few genera and species that were before known, the number described probably amounts, at this time, to nearly two thousand: and what is still more important, these investigations have shown that no organic remains are capable of affording the Palæontologist more certain or more important results. For, as they extend through all the great geological periods, he has an opportunity of studying the changes that have taken place in an important class of vertebrate animals continued through a vast succession of ages. A class, too, that has been studied with more care in every stage, from the embryo up, than almost any other.

The orders under which fishes are comprehended, according to this arrangement, are four.

1. *Placoids*, fishes having scales composed of plates of enamel alone, of various sizes; sometimes large and with pointed protuberances, and sometimes small and scattered over the body of the fish. This order includes the shark, ray, and indeed all the cartilaginous fishes of Cuvier, except the sturgeon.

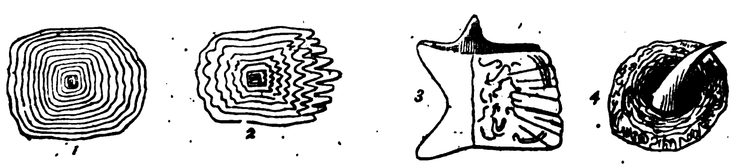
2. *Ganoids*, which have angular and bony scales, covered at their exposed surface with enamel, often elegantly sculptured; the "gar" is a fine example of this order.

3. *Ctenoids*, have scales of bone alone, without enamel, and cut, at the exposed ends, like the teeth of a comb; the scales of the perch exhibit these characters.

4. *Cycloids* have also bony or horny scales, without enamel, more or less circular; smooth on the edges, and frequently ornamented on their upper surface. The herring is a familiar example of this order.

The form of these several scales is represented in

Fig. 8.



1—Placoid. 2—Ganoid. 3—Ctenoid. 4—Cycloid.

That at least apparent exceptions should arise in the application of this system, was to be expected. The mackerel, for instance, has both ctenoid and cycloid scales, and therefore, at first sight, presents one of the strongest cases that can be produced as an objection to this classification; but a closer examination shows that so far from being really an exception, it affords the strongest possible proof of its truth and accordance with nature—the mackerel, as shown by its organization, being the connecting link between the two orders, and hence is characterised by the scales of both.

The oldest known fishes, or those found in the lowest rocks, belong to the first order, or Placoids; their remains consist, for the most part, of certain spinous appendages found in the fins, very similar to the well known process near the tail of the common ray of the coast, which is called by the fishermen the "sting." These fossils have received the name of *Ichthyodorulites*.

In the old red sandstone well characterised entire fishes occur for the first time, but so unlike all others of their class that they have been referred to both the Articulata and Chelonia respectively.

"Never shall I forget," says Agassiz, "the impression which the sight of these creatures, provided with appendages resembling wings, produced upon me when I had assured myself that they belonged to the class of fishes. It was an entirely new type, which was about to figure, for the first time since it had ceased to exist in the series of beings—again to form a link, which nothing that had been revealed up to the time, with regard to extinct creations, would have led us even to suspect the existence of; showing forcibly that observation alone can lead us to the recognition of the laws of development of organized beings, and how much we should guard against all those systems of transformations of species which the imagination invents with as much facility as reason refutes."

The Ganoids which make their appearance here include the remarkable group of sauroid fishes having an organization approaching that of reptiles. Two genera alone of this group are living—one an inhabitant of the Nile and the other the gar or Lepidosteus, of the rivers of America. The Sauroid fishes are distinguished by certain peculiarities of the teeth, which are common to Saurians; they are conical, pointed and striated. The Lepidosteus has the air bladder cellular, which shows a still nearer approach to the air breathing animals.

To convey even a distant idea of the strange inhabitants of the deep at this period, without figures and minute details, would exceed the limits of what is intended as a mere outline, to be filled up by the reader at his leisure. The fishes of these two orders, the Placoids and Ganoids, continued the sole inhabitants of the seas up to a comparatively recent period in the earth's history.

The other two orders, the *Ctenoids* and *Cycloids*, first appear in the cretaceous system where the Sauroid family of the Placoids ceased to exist, with the exceptions already mentioned.

Sub-kingdom Articulata.

The class Crustacea of this sub-kingdom has received some attention from Palæontologists, and more especially the family of Trilobites—but the ordinary fossil crustacea, which are not uncommon in the tertiary formation, have not yet received, in our country, the attention which they deserve. We generally find only detached portions of crustacean exuvia, such as the carapace and claws, and it is not always easy to refer them with certainty to their living types, supposing them to have such. The classification of recent crustacea stands in the same relation to fossil species that Cuvier's classification of recent fishes stands to those that are found in a fossil state.

The hard covering of these animals does not admit of extension with the growth and enlargement of the body. To obviate this the crust or shell is cast off, and it is probable that the usual imperfect state in which these fossils are found is due to the fact that they consist, for the most part, of these empty crusts.

Desmarest felt the difficulty of establishing the analogy between fossil and recent species, where those parts were wanting upon which their distribution in the system depended. He showed that the protuberances and inequalities of the exterior of the shell were connected with the structure and organization within, and by a careful study of these, that a classification might be established that would afford the Palæontologist results as satisfactory as those derived from the classification of fossil fishes by their scales. Whoever will follow up the method indicated by this naturalist will confer a vast benefit on this department of Palæontology.

The class Crustacea has been separated into two groups—those with the eyes situated on moveable peduncles, and those in which they are immovable. To the former belong crabs, shrimps, &c. and to the latter the trilobites, which are all extinct. For a long time these fossils were regarded as insects, and were even placed in that class by Linnæus himself.

The anterior portion of the body, to which the head belongs, is composed of a crescent shaped plate; in the middle is situated the abdomen, which is composed of plates laid over each other, like the tail of a shrimp or lobster, and articulated in such a manner, in some species, as to allow the animal to roll up like the common wood-louse. This portion of the body is divided by two grooves, more or less distinctly, into three lobes, and hence the name. Some species have a tail composed of a semi-circular plate.

The most extraordinary circumstance connected with these animals is the preservation of their eyes, which are found to be highly organized; and in *Asaphus caudatus* each eye is said to contain 400 lenses. This appears truly wonderful when we reflect that these animals were among the earliest inhabitants of the primeval ocean, and gives but little countenance to the doctrine of development.

No feet have yet been observed in these animals, so that it is probable that those organs only existed in a soft and highly perishable state. Some of them are surrounded by a border very similar to that of the *Chiton*, which may have served the purpose of attaching them to the rocks in the manner of that animal. But where the head is distinct and the organs of sight well developed, we must suppose that the animal possessed locomotive powers.

They existed in great numbers in the early silurian seas, and ceased to exist during the carboniferous period.

Dr. Emmons has figured a crustacean, found at Cape Horn by Dr. Eights, which has very much the habit of a Trilobite. When left in the pools along the shore after the recession of the tide it is found rolled up in the manner in which the fossil Trilobite of the genus Calymene so often occurs.

The following are the principal genera of the Trilobites.

Calymene,	Bumastis,
Asaphus,	Odontocephalus,
Homalonotus,	Cryphæus,

Platynotus,	Isotelus,
Trinucleus,	Paradoxides,
Ogygia,	Brontes.

Of the class *Insecta*, as they occur in the strata of England, Rev. Mr. Brodie has presented a beautiful memoir. In our country very few fossil insects have been found.

SUB-KINGDOM MOLLUSCA.

The soft and destructible nature of the animals of this sub-kingdom has left us in ignorance of much that it would be desirable to know, in relation to the organization and economy of many of the inhabitants of the fossil shells of extinct species, so abundant in all fossilliferous rocks. But we are left, in most cases, to infer their affinities from the analogy existing between the calcareous coverings of fossil and recent forms. In many cases this analogy is apparently very remote, and it required much patient research to discover it at all. In general, however, the shells are so well preserved that they may be studied with success; and from their great numbers in all countries they afford excellent guides to the Geologist in identifying rocks.

Class Cephalopoda.—The Cephalopods derive their name from the apparatus which surrounds their heads, and which they use for the purpose of seizing their prey and holding it. This apparatus, which is highly curious, will be better understood by five minutes' examination of the "squid," so common along the coast, and which may be found in any shrimp-woman's basket in the Charleston market, than by the most minute description. They are all characterised by highly developed heads, large eyes, and mouths armed with hard beaks.

Those without exterior calcarious coverings have a bony internal appendage, and are also provided with an ink-bag, from which they eject a dark colored fluid that colors the water and favors their escape when pursued by enemies. These are further distinguished by having a gill on each side of the body.

Prof. Owen has divided the class Cephalopoda into two orders, founded on the number of gills. To the first order, *Dibranchiata*, belong all the naked cephalopods, together with the living genus Argonauta, which is covered with a shell. The beaks of the animals of this order, together with the internal bone, are found fossil. The latter is represented by the fossil Belemnites, so common in the cretaceous formation. That this fossil is analogous to the internal bone of the recent naked Cephalopods is proved by the fact that it has been found in the same relation to the fossil ink-bag that it is known to have in the recent animal.

The Belemnite is a pointed cylinder, composed of semi-crystalline limestone, having a radiated structure. At one extremity there is a conical hole in which there is sometimes found a chambered shell, called *phragmocone*; and although this is rarely found, the impressions of the septa may frequently be observed. It is probable that the genus *Bellerophon* belongs to this order. It is a small, involute shell, having, like Argonauta, but a single chamber.

The order *Tetrabranchiata* includes those external chambered shells, which are perforated by a tube called *siphunculus.* The recent Nautilus represents this order. It has been divided into two groups, which have their types in the Nautilus and Ammonite, and are hence called *Nautilidæ* and *Ammonitidæ.* In the *Nautilidæ* the septa are not undulated on the margin, and the siphunculus is either in the centre or towards the inner edge. In the *Ammonitidæ* the septa are waved and foliated on the margin, and the siphunculus is placed towards the outer edge or back of the shell.

In the first of these groups we find three common genera.

Nautilus, which has contiguous spiral whorls, convoluted in the same plane, and the siphunculus central.

Orthoceras, a straight, elongated chambered shell, with septa concave towards the opening, and siphunculus central.

Cyrtoceras, which only differs from Orthoceras in being slightly curved.

Here also must be placed the beautiful little shells called Polythalamia, (composed of numerous cells,) in which the divisions between the shells are punctured and appear as if covered with dots; these, although often microscopic, are sometimes sufficiently large to be visible to the naked eye. They are known to form a large portion of the chalk beds of England, and the marl of the Ashley abounds in the most beautiful forms, which are also of great size. In the cabinet of F. S. Holmes, Esq. in Charleston, a fine suite of well preserved specimens may be seen, which were taken from the Artesian well in that city.

The Ammonitidæ include several interesting genera.

Ammonites—shell discoidal, whorls contiguous, septa lobed, margins foliated, lip thick, siphuncle at outer or dorsal edge.

Goniatites differs from the last genus principally in having the septa without notches or foliation.

Crioceras differs from Ammonites in having the whorls not contiguous.

Ancyloceras has the whorls like Crioceras, but the last one is prolonged and again recurved.

Toxoceras has a slightly curved shell.

Hamites—whorls not contiguous, elliptic, last whorl recurved.

Ptychoceras—shell bent like a siphon.

Baculites—shell straight, tapering, upper part without septa.

Scaphites—whorls rolled up and partly concealed by the last whorl, which is also rolled up like a hood, and has no septa.

Turrulites—coiled spirally around an axis, conical, umbilicated, septa sinuous, siphunculus continuous, near the outer edge or next to the suture. The fossils of this class are among the oldest of animated beings.

Of Nautilidæ only two genera have come down to us; of the other groups, not one, although they existed in vast numbers during all the geologial periods, up to the termination of the Cretaceous system, and a few have extended into the Tertiary rocks.

Class Gasteropoda.—The *Gasteropods* derive their name from the muscular foot beneath the body, by means of which they move about. They are marine, fresh water and land animals. When provided with calcareous coverings they are composed of one piece—hence called univalves. The land and fresh water species are mostly herbivorous, but the marine species are carnivorous. The depredations committed on oyster-banks by Buccinum cinereus is well known. This animal, like many others, is furnished with a boring apparatus. Circular perforations may be seen in fossils, the work of these predatory animals. The shells of this class, in fresh water and land species, have the aperture entire, and without canal or notch. On the contrary, the marine species have the aperture notched or extended into a canal. Some exceptions there are to this characteristic, but they are not numerous. And the facts stated furnish the Geologist with the means of discriminating between marine and freshwater deposits. The marine Gasteropods generally inhabit shallow water, and hence their abundance in a deposit would indicate a littoral formation.

They diminish greatly in number as we proceed downwards in the geological series, and below the cretaceous formation they become comparatively rare. Some genera, however, date as far back as the Silurian rocks.

Pleurotomaria and Euomphalus are remarkable genera that occur in the oldest fossilliferous rocks. The shells of this class abound in the Tertiary formation of the United States.

Class Pteropoda.—A single fossil shell of this class is found in the post-pliocene of South Carolina. It belongs to the genus Hyalæa.

Class Lamellibranchiata.—The oyster and clam are examples. They have bivalve shells, and the opening and shutting of the shells is effected by the joint action of a ligament, placed at the hinge, and muscles attached to the shells. The class is divided into two orders: those with one muscle, called Monomyaria, and those with two, called Dimyaria. To the first belong the oyster, gryphæa, anomia, plagiostoma, plicatula, hippurites, &c. The latter is a very remarkable fossil, whose affinities are but little known. It is a conical or cylindrical shell, having on the inside two longitudinal ridges. At the base there are sometimes cells, formed by transverse septa. The upper valve is placed like a cover on the aperture of the conical valve.

In the cretaceous formation of Alabama these shells are found of considerable size, amounting sometimes to one foot in diameter. Fragments of the shell may be known by its cancellated and cellular structure.

Class Brachiopoda.—The molluscs of this class are furnished with ciliated arms, spirally coiled, and supported by a spiral calcareous appendage, which is often found preserved in fossil Brachiopods. The shells are bivalve. They existed in vast numbers in the early geological periods. The oldest bivalve shells are of this class; some of which are confined altogether to the lowest fossilliferous rocks, whilst a few are living in the seas of the present period. Among the latter are Lingula and Terebratula. In the New York system the Lingula is the first bivalve that makes its appearance. The genera of this class that are found most abundant in the Silurian rocks are Delthyris, Atrypa, Orthis, Leptæna, and Pentamerus.

Sub-kingdom Radiata.

The animals of this sub-kingdom are distinguished, as the name implies, by having their parts so arranged as to radiate from a centre. The common star-fish is a good example. They are soft and naked, or covered with calcareous plates symmetrically arranged.

Those who visit the coast of this State have ample opportunities of studying the interesting living forms of this sub-kingdom. The soft and lower forms may be seen floating, at certain seasons, in the water. The star-fish is left in numbers by every tide, and the scutella is found slightly covered in the sand. The echinus and rarer spatangus are torn from their sandy beds and thrown on the strand by every storm. It is only, however, with those furnished with hard coverings that the Palæontologist is concerned, and these belong to the *class Radiaria*, and to the group *Echinoderma*. These have, for the most part, either an external shell, composed of alternating rows of perforated and imperforated plates, fitted together so as to form a globular covering, or a calcareous skeleton, covered with a rough integument.

Prof. Agassiz, who studied this group with his usual skill, has divided it into five families, as follows.

1. *Spatangoidea*, which have the shell oblong, the mouth placed anteriorly, and the anus or vent at the posterior end.

2. *Clypeastroidea*—shell oblong or circular; mouth near the centre, open; vent posterior.

3. *Cidarides*—shell globular; mouth central, below; vent in the centre of the summit.

4. *Asterides*—are more or less star-shaped—have the mouth and anus central, below; rows of pores or *ambulacræ* on the under side of the rays.

5. *Crinoidea*—animal sessile; supporting column, round, oval or angular, articulated; cup containing the viscera composed of plates; arms proceeding from the upper edge of the cup, divided into tentaculated fingers, which surround the mouth.

These families are again divided into numerous genera; but as Prof. Agassiz is about to revise the Echinoderma from all our formations, it will be better to present nothing further on the subject at this time.

Class Polypi.—In this class we find the Anthozoa, or flower animals—the fabricators of corals. It would be difficult to estimate the influence that these silent little workers have exerted upon the rocky strata of our globe, during the vast period since their first appearance in the early seas. Even in the present seas changes are produced that are sufficient to show us that that influence must have been very great. For besides the calcareous frame work of the animals themselves, which often makes up entire strata of rocks, there is a white calcareous mud deposited in the vicinity of coral reefs that must, of itself, form very thick beds. On the coast of Florida such beds are at this time accumulating, and are composed of the mud just mentioned, and of comminuated corals. The islands, of which corals form the foundation, and the harbors obstructed by these little architects, are familiar knowledge.

If there be no other modifying circumstance than that of temperature to affect the existence of these animals, their remains, embedded in the rocks of former periods, afford us the means of estimating the temperature of the seas in which they lived. The temperature required for the existence of the coral-building polypi, as ascertained by the Exploring Expedition, is about 75°, and hence we have but few corals north of Florida. Another curious fact in their economy is that they do not live at great depths in the ocean, but within a few fathoms of the surface. Nevertheless, soundings off coral reefs show that they extend to a great depth—a fact that cannot be well accounted for but by supposing a gentle subsidence of the reef to take place, at the same time that the coral insects continue their operations above, and the mass increases at about the same rate at which the subsidence takes place.

Class Infusoria.—The exquisite forms of the covering of the astonishingly minute fossil shells that belong to animals of this class, are abundant, and consequently pretty well known. They are often found forming pretty thick beds at the bottom of ponds and pools of stagnant water, but the most remarkable deposits occur at Richmond and Petersburg, Va. At the latter place the bed is at least forty feet in thickness. It is a marine deposit, and encloses numerous fossil shells of the genera Pecten, Venus, Crassatella, &c. of miocene species. What is quite remarkable, the carapaces of these little beings are all silicious. Their forms are various and highly curious.

For the information of those who may be in possession of a good microscope, and who may wish to observe these beautiful forms, I give Prof. Bailey's mode of preparing infusorial earth for examination.

A little of the substance supposed to contain infusoria—a little of the surface mud from the wharves in Charleston, for instance, which is rich in these little shells—is placed in a glass of water; the heavier particles are allowed to subside, and a portion of that part found floating on the surface or suspended in the water is placed on a slip of glass, which is held over a spirit-lamp until the water is completely evaporated and a whitish powder is left behind. A drop of Canada balsam is now placed on the glass, and the heat of the lamp applied until the balsam is evenly spread over the powder. The heat must be applied with care, or else air bubbles will be found in the balsam, which may deceive the inexperienced. It is now ready to be placed under the microscope.

Fossil Plants.

The lowest form in which a plant can exist is that of a cell, and a congeries of such cells arranged in a definite form, gives rise to a higher plant. Plants thus made up of cells alone are called *Cellulares;* they are further distinguished by not producing visible flowers, and hence called flowerless plants. Algæ, Lichens, Mosses and Ferns belong to this division of the vegetable kingdom; and a large portion of fossil plants are found here also.

When cells are elongated and their contiguous ends absorbed, they give rise to long vessels, which when united in the structure of plants are called vascular bundles, and the plants thus organized are called *Vasculares.* Nearly all the lignite, or petrified wood, of recent formations belongs to this division.

When the seed of vascular plants is composed of one piece or *cotyledon*, they are called *Monocotyledonous* plants, and are characterised by other peculiarities. The stems are composed of bundles of vessels, and increase in diameter by the addition of new vessels at the centre and among the old ones: there are consequently no concentric layers; the leaves are not articulated with the stem; the veins are arranged in parallel lines, and never reticulated. Such plants are said to be *Endogenous.*

Those plants which have seed composed of two lobes are called *Dicotyledonous* plants. The woody fibre is deposited between the old wood and the bark, in concentric layers, arranged around the pith, which occupies the centre. The term *Exogenous* is applied to these plants.

The coniferous plants, or those which bear seeds in cones, such as pines, cedars, &c. have a peculiarity of structure, that may be observed under the microscope, and which enables the Palæontologist to detect such plants in the fossil state. If a very thin, translucent shaving of pine be placed under the microscope, there will be seen between the opaque longitudinal vessels others ornamented with dots enclosed in circles. These are called glandular vessels, and are peculiar to the wood of coniferous plants. In this way, if a thin chip be broken from a piece of silicified wood, we may determine readily whether it be coniferous or not; having first, however, settled the fact as to its being Dicotyledonous, which is, in general, readily done by observing the concentric layers. If a cross section of the specimen under examination, instead of a concentric structure, presents the woody fibres disposed in irregular spots—it belongs to a monocotyledenous plant. If opaque circular segments, with the ends turned outwards, be observed, the plant belongs to the arborescent forms. Persons unacquainted with the structure of plants affect to know, from external appearance, even the species to which silicified trees belong. The facts stated above are all that could be determined with certainty, from the structure of the wood, even with the aid of the microscope.

Fossil plants in general present, particularly in the older rocks, other characters, upon which generic and specific distinctions are founded.

Vasculares.—We find among the dicotyledonous fossil plants of this class numerous common genera at present existing, principally confined to the Tertiary system, such as Nymphæa, Ulmus, Carpinus, Castanea, Betula, Salix, Populus, Comptonia, Juglans, and Acer. Dicotyledonous plants are known, however, to exist in the coal formation, where it seems they have, in this country at least, played an important part in the formation of that mineral, as was ascertained by Professor Bailey.

Of the coniferous plants we have, in the fossil state, the well known living genera Pinus, Abies, Podocarpus, and Thuya. To this division also belong the interesting genera Zamia and Cycas, so beautifully characteristic of the Oolitic and Liassic formations.

Sigillaria, which was once considered as belonging to the cellular plants, must, according to more recent researches, be placed here. And if the observations of Mr. Dawson, made in Nova Scotia, and of Mr. Binny, in Lancashire, be correct, which go to show that *Stigmaria* is the root of a tree, probably of Sigillaria, that fossil must also be referred to this class.

Mr. Logan has established the interesting fact that Stigmaria is confined to the bed of clay that underlies the coal, whilst Sigillaria is almost as constantly found in the sandstones above. This would show that the two may stand to each other in the relation of trunk and root. They are found in the coal fields of Alabama, occupying the same relative position.

Sigillaria is distinguished by having the stem deeply furrowed, and not jointed; scars, when present, are placed between the furrows.

Stigmaria may be known by its external surface being marked by round tubercles; and before the specimen is detached from the rock, rootlets may be seen extending from each tubercle. I mention these genera more particularly because they will be met with by the student more frequently than almost any other.

Endogenous Plants.—There are numerous fossil plants of this division of the Vasculares; among these the most remarkable are the Palms, which seem to be divided between the Tertiary and coal formation. Some fruits or seed vessels are also placed here.

The absence of all traces of the family of grasses is quite remarkable. Before the existence of herbivorous animals they may not have been necessary in the economy of nature; but after the appearance of these animals we are naturally led to look for some evidence of the existence of those plants which at present constitute so large a portion of their food.

Prof. Lindley has indeed shown that the relative number of the various species of fossil plants does not depend so much upon the number in which they once grew as upon their relative power of resisting decomposition when first enclosed in the mud in which they were embedded. And it appears pretty evident that ferns once occupied the same relation to other plants in the primeval Flora, that the grasses do to the present.

Cellulares.—Flowerless Plants.—Of all fossil plants these are the most numerous in genera and species. In the coal formation scarcely a fragment of shale can be broken that does not exhibit numerous fossil ferns exquisitely preserved.

The cellulares are divided into families corresponding with those of recent plants. Among the *Equisetaceæ* we have the genus Equisetum, which is also a living genus. Calamites is a very common fossil, resembling the latter in being jointed and closely furrowed, but it is sometimes found one foot in diameter.

The *Filices* constitute an exceedingly beautiful family of fossil plants, that abound in the coal measures. Their most minute parts, with the fruit and veins, are often preserved in a manner that would rival the herbarium of a Botanist.

Lycopodiaceæ includes genera that are at present represented by living plants only in the tropics. It is in this and the preceding family that we find those magnificent fossil tree ferns that are met with in the coal formation, and which must have attained the height of ordinary trees. The *Lepidodendron*, a plant of this family, is one of the most numerous of the characteristic plants of the coal strata. It is known by the regularly deposited lozenge shaped scars that cover the bark of the plant.

The *Algæ*, or sea-weeds, have also their fossil representatives; and *fucoides* are among the earliest organisms found embedded in rocks. In New York they occur in great numbers in the Silurian rocks.

The distribution of living plants in relation to climate, temperature, and other atmospheric conditions, has been studied with extraordinary philosophic ability by Humboldt; and, guided by these researches, it becomes no very difficult problem for the Botanist to determine the climate of a country from its Flora. That this analogy existed in former periods, we have every reason to believe; but that the geographical range of species was far greater than at present, is quite certain. We have no living plants common to this continent and to Europe, and yet many of the fossil plants of Pennsylvania, Virginia, and Alabama are identical with British fossils. Uniformity of climate, then, as indicated by ancient Floras, must have extended over vast zones—so that there would be but little coincidence between the *Isothermal* lines of the carboniferous period and those of the present day.

Researches in Fossil Botany, presented by Brongniant, Lindley, and other distinguished Botanists, have shown that the ancient Floras mark three well defined periods. The first begins with the oldest rocks that contain any traces of fossil plants, and ends with that of the carboniferous rocks inclusive. The plants of this epoch, as a group, are characterised by the predominance of those of the class *Cellulares*, consisting of fuci and ferns in vast numbers and of great size, such as tree-ferns, lepidodendra, &c. Besides these we find in the Flora of this first epoch, Monocotyledonous, as well as Dicotyledonous plants, such as palms and coniferous trees.

The whole Flora represents one belonging to the moist and warm climate peculiar to intertropical islands. Such it seems was once the climate that included the region extending between Nova Scotia and Alabama on our continent.

The second epoch embraces the period between the new red sandstone and the chalk inclusive.

The characteristic plants are the coniferæ, related to Cycas and Zamia. The ferns have diminished in numbers, and Calamites and kindred genera have nearly disappeared. Such a Flora is found at the Cape of Good Hope and near the coast of New Holland.

The third epoch is distinguished by the prevalence of Dicotyledonous plants of existing genera. A few Cycadeæ and ferns occur, together with the remains of palms; the whole group, indicating a climate a little warmer than that of the Southern United States, where the palms are represented by the palmetto and sabal, which are found growing with the ash, elm, willow and cypress. Such is the Flora of the Tertiary period.

The following table* shows the number and distribution of fossil plants, according to the recent researches of M. Goppert. In 1836 only 527 fossil plants were known; at present the number amounts to 1792, which shows the rapid progress made in this department of Palæontology.

Of living plants there are known to Botanists 80,000 species; of these a large number are Fungi and Fucoids, which, on account of their destructible nature, could rarely occur in the fossil state—so that the proportion of fossil to recent plants is quite large.

Middle and older Palæozoic rocks	52
Carboniferous	819
Permian	58
Triassic	86
Oolite	234
Wealden	16
Cretaceous	62
Tertiary	454
Unknown	11
	1792

CHAPTER IV.

Fossilliferous Rocks.—Classification.—Palæozoic Series.—Lower Silurian.—Upper Silurian.—Old Red.—Carboniferous System.—Coal Measures.—Secondary Period.—New Red.—Lias.—Oolite.—Wealden Formation.—Cretaceous System.—Tertiary Period.—Eocene.—Miocene.—Pliocene.—Post Pliocene.—Succession of Organic Remains.—Mosaic Account of Creation.

We have next to consider an exceedingly interesting class of rocks, comprehending a large series of formations, composed of sedimentary deposits, called fossilliferous from the fact that they contain organic remains—an evidence that they were formed since the appearance of life on the

*Brit. Ass. Reports.

earth. The oldest of these formations pass, by insensible gradations, into the metamorphic rocks, from which they can only be distinguished, as I have already remarked, by the presence of fossil remains. In mineral character they are generally less chrystalline, and the comparative abundance of carbonate of lime also serves, in some measure, to distinguish them from the metamorphic rocks. As we ascend in the scale the lime increases, the strata become less consolidated, until we reach the beds of loose sand, clay, &c. that characterise the deposits now in process of formation.

The earliest classification of these rocks consisted of a division into three great groups or systems, designated the Transition, Secondary, and Tertiary Systems. The Transition rocks included those that were deposited during that period in which the earth was supposed to be in a state of passage from an uninhabitable to a habitable state, and these rocks consequently contain the remains of the earliest inhabitants of the globe.

The rocks of the Secondary period give evidence of a second great change in the physical condition of our planet, which affected, in a remarkable degree, the character of its Fauna and Flora. And the fossils entombed in the rocks of the Tertiary present a nearer approach to the living forms of the present period.

More extended investigations have shown each of these great divisions to contain many groups quite distinct and well characterised. The distinctive characters of these groups are derived from the combined evidence of superposition, mineral contents, and organic remains, but principally from the latter.

TABLE,

Showing the order of superposition of the Fossiliferous Rocks.

RECENT PERIOD, OR POST PLIOCENE.		
Systems, Formations, and Groups.	Localities of characteristic deposits in America.	European Equivalents and Localities.
Alluvium, *Stratified beds of clay and sand,* containing the remains of extinct mammals and recent shells.	Superficial deposits. Northern States. Atlantic coast.	Found in all countries.
Drift, or Diluvium.		Northern Europe.
TERTIARY PERIOD.		
Newer Tertiary, or *Pliocene.*	South Carolina.	Till of the Clyde valley, Norwich crag. Subapennine beds.
Middle Tertiary, or *Miocene.*	Maryland, Virginia, North Carolina.	Red crag, Basin of the Rhine, Molasse of Switzerland.
Older Tertiary, or *Eocene.*	Maryland, Virginia, South Carolina, Alabama.	London clay, Paris Basin, Auvergne.

Systems, Formations, and Groups.	Localities of characteristic deposits in America.	European Equivalents and Localities.
NEWER SECONDARY PERIOD.		
Cretaceous System.		
Upper chalk, (with flints.)		Maestricht beds.
Lower chalk, (without flints.)		
Chalk Marl.		Craie tufau.
Upper Greensand.	New Jersey.	
Gault.	South Carolina.	
Lower Greensand.	Alabama.	Neocomien.
MIDDLE SECONDARY PERIOD.		
Wealden Formation.		
Weald clay.		Portland.
Purbeck beds.		Surrey, Kent & Sussex.
Oolite System.		
Portland stone.		Oxford, Bath.
Kimmeridge clay.		Jura chain.
Forest marble.		
Great Oolite.		
Inferior Oolite.	Virginia?	
Lias Group.		
Upper Lias.		Lyme regis.
Lower Lias limestone.		Whitby.
OLDER SECONDARY PERIOD.		
Upper New Red, or Triassic System.		Keuper.
Saliferous, or New Red Sandstone.	Massachusetts.	Muschelkalk.
	Connecticut.	Bunter sandstone.
Red Sandstones and Conglomerates.	Virginia.	(Gres bigarre.)
	N. and S. Carolina.	
NEWER PALÆOZOIC PERIOD.		
Magnesian Limestone, or Permian System.		Permia, Russia, Zechstein.
Magnesian Limestone.		
Lower New Red.		Rothe-todte-liegende.
Carboniferous System.		
Coal Measures.	Pennsylvania.	Coal Measures of the North of England.
Millstone grit.	Virginia.	
Carboniferous, or Mountain Limestone.	Ohio.	
	Alabama.	
Lower Carboniferous Shales.		
MIDDLE PALÆOZOIC PERIOD.		
Devonian System, or Old Red Sandstone.	New York.	
Yellow quartzose sandstone.	Pennsylvania.	Devonshire.
Flagstones.	Ohio.	
Limestones.	Michigan.	
Conglomerates.		

OLDER PALÆOZOIC PERIOD.

New York System.

Systems, Formations, and Groups.	Localities of characteristic deposits in America.	European Equivalents and Localities.
Upper Silurian Rocks.		
Chemung Group.		
Genesee Slate.	New York and Western States.	Wales.
Marcellus Slate.		
Ludlow and Wenlock Series.	Alabama.	Russia.
Hilderberg Series.		
Lower Silurian Rocks.		
Caradoc Sandstone.		
Llandeilo Flags.	Vermont.	Wales.
Champlain Division.	New York.	Scandinavia.

PALÆOZOIC SERIES.

Pursuing the ascending order which has been adopted in this outline, we have next to take a rapid glance at the succession of the fossiliferous strata, beginning with the Palæozoic Series, which consists of the Silurian System, the Devonian, or Old Red Sandstone System, the Carboniferous System, and the Magnesian Limestone, or Permian System.

Lower Silurian Strata.—The term Silurian, (from *Silures*, the name of the ancient Britons, who inhabited Wales, where these rocks are extensively developed,) was first applied by Mr. Murchison, to designate the oldest of the fossiliferous rocks. Local names are useful, because they point to localities that can always be examined when any doubt arises as to the meaning of the author; for such names are taken from places where the rocks to which the names are applied occur in their most characteristic form. Hence, in England, the names Caradoc sandstone and Llandeilo flags, and in this country, Trenton limestone, Potsdam sandstone, &c. applied to the Lower Palæozoic rocks.

The Lower Silurian rocks, for the most part, consist of sandstones, conglomerates, impure limestones, and shales. Argillaceous and silicious matter is far more abundant than in the newer rocks, and the presence of mica proves that they owe their origin to the disintegration and abrasion of the granitic or the metamorphic rocks.

In New York, where these rocks are finely developed, and where they have been studied with great care, they are known under the names of Potsdam sandstone, Birdseye limestone, Trenton Limestone, Utica slate, Hudson River group, &c. The principal of these formations extend along the Alleghanies, from New York to Alabama. Commencing at Vermont, they appear at intervals on the shores of the lakes, to the Mississippi River; and they are also found both in Ohio and Tennessee. They are seen again in the Southern part of South America. In England, as well as on the Continent, these strata are widely spread. They are well known in Germany, and have been traced over a considerable extent in Russia, by Mr. Murchison. They occur in Norway and Sweden of vast thickness, and in Southern Africa they have also been recognized.

In America the oldest of the Silurian rocks are represented by the Potsdam sandstone of the

New York Reports, and it is remarkable that the first appearance of life on our continent, as presented in this rock, occurs in the form of the shell of a marine animal, the *Lingula*, a genus of which there are a few species living at the present day—a fossil which is also found in great abundance in Russia. Fucoids, or sea-weeds, are generally the first organic remains found in these rocks; and in Norway and Sweden, according to the researches of Prof. Forchammer, they have played quite an important part in the formation of the oldest fossiliferous strata. As we ascend in the series fossils become more abundant: in the Trenton limestone there are more than twenty genera.

The Hudson River group Mr. Hall considers the true equivalent of the Cambrian system of Great Britain. It marks, in the New York system, a very important point, for scarcely any fossil species are common to it and the superincumbent rocks in that State.

The chief characteristic of the Fauna of the lower Silurian rocks is the great development of Brachiopod molluscs of the genera Terebratula, Orthis, Delthyris, Atrypa, &c. and a remarkable family of Crustaceans, the Trilobites, now extinct. It is supposed these ancient articulated animals stood in the same relation to the fucoidal plants of the Silurian seas that the numerous small crustacea of the present day do to the sea-weeds, among which they abound. Some corals and other remains are also found among these early inhabitants of the globe. They exhibit, however, as a group, animals of low organization—not extending higher in the scale of being than the class Articulata. And no vestige of land plants or of any vertebrate animal has yet been discovered in these rocks.

Upper Silurian Rocks.—In America this division of the Palæozoic series is represented by the formations between the Niagara group and the Chemung group of the New York Reports; and by formations Nos. 7, 8, and 9 of the Pennsylvania and Virginia Surveys; in Ohio, by the Cliff limestone and Waverly sandstone; and in Michigan, by the Mackinac limestone, and the sandstones of Point aux Barques.

In England they include the rocks known as the Ludlow and Wenlock formations, which consist of beds of great thickness of shales and limestones. On the continent of Europe they have been traced at intervals from Norway to Constantinople. They are found in South America and in the Polynesian Islands.

These rocks abound in Trilobites, Crinoidea, and a peculiar chambered shell, called Orthocera. In the upper, or Wenlock, formation scales and teeth of fishes, and an ichthyodorulite, (a part of the fin of a fish,) have been found in the coniferous limestone of the New York system. These are the sole remains yet found of vertebrate animals in the Silurian rocks of this country.

Land plants, such as ferns, make their appearance towards the uppermost groups of the series. The rocks of the New York system resemble the Silurian rocks of Russia, in reposing horizontally and without disturbance on the metamorphic rocks.

The absence of any disturbing cause for so long a period is remarkable. The Silurian system, as developed in New York, presents the enormous thickness of eight or nine thousand feet, and in England these rocks are equally extensive. The organic remains found entombed in them on the spot where the animals to which they belonged lived and died, show that they were deposited gradually and slowly. So that the period of time necessary for the deposition of so great a mass of sedimentary matter must be immense.

Devonian or Old Red Sandstone System.—The rocks of this system consist of slates, limestones, conglomerates, and sandstones, of a brick-red colour. In New York this system is best developed in the Cattskill group, where it rises into mountain peaks. In Pennsylvania and Virginia it is seen dipping under the conglomerates of the carboniferous system, but thins out towards the West. In Michigan it occupies a considerable space, and is found underlying the coal measures in the Western States.

In England this system is well developed, and until a comparatively recent date it was thought to be a local deposit confined to that country. In Westmoreland, and Herefordshire the Silurian rocks are seen passing into the Devonian rocks. In Scotland the system appears resting upon gneiss, the lower beds consisting of conglomerates of enormous thickness. It is here that these rocks have been studied with greatest care—a ground rendered classic by the genius of Miller.

The Old Red Sandstone system of Russia bears a strong analogy to the English rocks of the same age, and many of the fossil shells are common to both. Previous to the study and correct determination of the British rocks, much difficulty was experienced in referring the Devonian system of Belgium and other parts of Europe to its place in the series; but its true position in England once settled, its peculiar fossils rendered the task less difficult elsewhere. The thickness of these rocks in America is at least ten thousand feet, but in Europe it is far greater.

Corals were quite abundant during the period of the formation of the Old Red, and the molluscs number some genera of higher organization than any that preceded them. The genus Clymenia seems to connect the Nautilus and Ammonite. On the other hand, the Trilobites, which were so abundant in the Silurian system, have disappeared so rapidly as to become quite rare. It is the remains of fishes, however, that afford the most striking characteristic of the system. Some of these Placoids, a family of cartilaginous fishes, the rest Ganoids. Some of them so singular and so unlike all the known forms of these animals as to require the genius of Agassiz for their determination and distribution in their proper place in the scale of creation. One of the most remarkable of these, the Cephalaspis, strangely reminds one of the common Limulus or King Crab, of our coast. The Pterichthys and Coccosteus were covered with beautiful and regular plates, forming a scaly armour of great strength. The Holoptychius was another of those strange fishes, found in the Old Red sandstone of Scotland, differing as much from all the rest as they did from the forms of the present day. Of fishes of this latter genus, Mr. Hall has figured the scales and a tooth in the Geological Report of the Fourth District. He has also figured, in the same Report, some bones, which he supposes the remains of a Saurian—the first of the type known in this system.

Carboniferous System.—This system is composed of strata of limestone, of great thickness, called *Mountain Limestone*, and an immense group of rocks, composed of shale, coal, and sandstone, which are found resting upon beds of conglomerates, and a white or gray sandstone, called mill-stone grit. The mountain limestone, which is found at the base of the system, is very generally, in this country, interstratified with beds of hornstone and cherty limestone; towards the top a stratum of magnesian limestone is found, and another bed of the same rock occurs near the base of the group, on the southern flank of the Cumberland Mountains. Prof. Troost has shown that the uppermost beds pass into an Oolite rock, on the mountains just named, and in St. Clair County, Alabama, similar beds occur, that are entirely silicious. The mountain limestone is extensively developed in the United States, being every where found underlying the coal measures. Dr. Troost estimates its thickness on the sides of the Cumberland Mountains at 200 feet, but near

Huntsville, Ala. some little mounts occur, composed almost entirely of this rock, which Dr. Newman informed me are 1000 feet high. In general it assumes its greatest thickness towards the South. It is in this rock that the great caves of the West are found.

Two characteristic fossil corals are abundant in this formation, *Stylina Perroni* and the *Archimides of Lesueur*. Besides these, innumerable crinoideans of the genus *Pentremites* are found studding the weathered surface of the rocks.

Next above this limestone we have beds of sandstone and conglomerate, that in the Western and South-western States vary from 50 to 200 feet in thickness. The beds furnish mill-stones in every country where they occur, and hence the name mill-stone grit, by which they are every where known. The sandstone is also equally noted for furnishing good fire-proof stone for iron furnaces and similar purposes.

Resting immediately upon these, we find the *Coal Measures*, which consist of beds of shale, clay, coal, and sandstone, and from which this system derives its name and importance. The coal is found in seams, alternating with beds of shale and sandstone, and varying in thickness from an inch to many yards.

In some of the English coal-fields the number of these seams amounts to seventy-five, making a total thickness of 150 feet of coal.

The great coal-field on the West of the Alleghany Mountains, extending from Pennsylvania to Alabama, must be 800 miles long and 200 miles wide at its greatest width. While the coal-field of Illinois must equal (Dr. Owen) in extent the whole of England. There are from six to ten seams of coal in these coal fields.

Although coal is found enclosed between beds of sandstone, in general it is found resting on beds of clay, called under-clay, which is more or less mixed with carbonaceous matter, and containing Stigmariæ, with rootlets extending in all directions through the clay. The coal presents a jointed structure, which causes it to break into prismatic fragments. The upper surface of the coal is often covered with vegetable impressions and even charcoal. The shale which overlies the coal is laminated, and between the laminæ impressions of ferns are found in great abundance and in fine preservation. Both in the shale and overlying sandstones fossils of the genera *Sigillaria*, *Stigmaria*, Calamites, and Lepidodendron, are quite common.

It is now universally admitted that coal is of vegetable origin—wood, &c. carbonized under great pressure. Whenever the carbonization of the vegetable matter took place under circumstances that prevented the escape of the gases the result is bituminous coal, but where they were allowed to escape, anthracite is produced. We have abundant proof of this wherever the coal measures are much fractured—as, for instance, along the anticlinal axis of the Alleghany Mountains, where the anthracite of Pennsylvania occurs, and in the New Red sandstone of North Carolina, where the bituminous coal is converted into anthracite in the vicinity of the trap dykes, by which it is intersected.

The structure of wood may be detected in coal by the aid of the microscope, and it appears that coniferous trees formed no inconsiderable portion of the mass. Drifted wood, accumulating in estuaries and at the bottom of seas of limited extent, has been proposed to account for the carbonaceous matter of coal; but the perfect state in which fossil plants of the most delicate structure are preserved in the overlying shale, seems, in most cases at least, to forbid this, for it is difficult to suppose that they could have been removed from the spot where they grew, without having their forms entirely destroyed.

That the greater portion of the coal plants lived and died where we find them, there can be no doubt. Many of our swamps present such a state of things as may be supposed to have existed in those ancient coal-fields while their plants were yet growing. We have a depth of vegetable matter, often amounting to 20 or 30 feet, composed of the trunks of fallen trees, roots, and leaves, in all stages of decay; and upon this a dense growth of ferns, reeds, vines, and other luxuriant plants that love shade and moisture. These swamps are sometimes partially submerged by the muddy water of our rivers during freshets; a deposit of mud is often left, which is quite sufficient to show us how the most delicate plants may be enclosed, and their impressions preserved with great accuracy. If a subsidence of the whole be now supposed to take place, so as to allow of its being overflowed by the waters of the sea, it would, in time, be covered by sedimentary matter, which would enclose marine shells and fishes, such as we find in the sandstones of the coal measures. Heat applied below, under these circumstances, would char the vegetable matter and convert it into coal.

So far this hypothesis is plain; and very rationally accounts for the formation of *one* bed of coal, but where there are several beds, one above the other, we are obliged to suppose the elevation of the submerged coal-field sufficiently above the water to allow of another and a similar accumulation of vegetable matter: subsidence must again take place, and this matter be converted into coal. This alternate subsidence and elevation must be repeated for every seam of coal present in a coal-field. The difficulty is to account for this repeated, and often apparently regular, oscillation of the earth's surface.

The basin shaped depressions in which coal is found, is remarkable, but is far from being universal, and is probably accidental, and not necessarily connected with the formation of coal. The long trough-like coal-fields of Alabama are the result of the elevatory forces that upturned the edges of the underlying Silurian rocks.

The Flora of the Carboniferous System is characteristic of a damp, warm climate, such as at present is peculiar to the islands within the tropics, for the luxuriant tree ferns of the coal formation have no representatives elsewhere.

Speculations upon the causes that have reduced such a climate to that of the present period, would lead us beyond the limits of a mere outline. Mr. Lyell,* who has treated this subject with his usual distinguished ability, attributes these changes of climate to an alteration in the relative distribution of land and water. The milder climate of insular, compared with main land, in the same latitude, is well known; and there can be no doubt that groups of islands such as marked the carboniferous period, would have the temperature of their atmosphere, and consequently their climate, greatly altered by being converted into continents. But it may be doubted that such a cause is alone sufficient to account for the extent of the changes of temperature that have taken place in past periods.

As may be inferred from what has been already said, the characteristic feature of the organic remains of this system, consist in the vast number of fossil plants, which amounts to one half of all the known species.

* Principles of Geology.

Corals of various genera and species abound in the calcareous strata, and even compose entire beds. And Crinoideans were scarcely less numerous. Of Brachiopodous molluscs the genus Productus seems to be most abundant. As a group the fossil molluscs resemble those of the existing seas, far more than any that preceded them. The fishes of the period included Ganoids of huge size, of which the Megalichthys was one of the most extraordinary.

Magnesian Limestone.—This formation is also known as the *Permian* system, from Permia, in Russia, where it is extensively developed. It rests upon the coal measures, or in depressions in the carboniferous limestone. In England it is included as an upper member in the *Lower New Red.* In Germany, where it forms a more important rock, it is known under the name of Zechstein, and the lower beds, which correspond with the Lower New Red of England, are called *rothe-todte-liegende.* It is not known to occur in the United States.

The fossils are not numerous, with the exception of fishes, of which there are some remarkable and characteristic genera. In England the first appearance of reptiles is observed in these rocks.

Secondary Period.

Upper New Red, or Triassic System.—This system is known in England, but, like the preceding, it is more extensive on the Continent, where the upper portion is known under the name of *Keuper.* This is separated from the lower beds by a band of limestone called by the Germans *Muschelkalk.* The lower part of the system is called grès bigarré.

In the United States the New Red occupies a portion of the valley of the Connecticut River, and extends through Connecticut and Massachusetts. It is found again in New Jersey, and extends through Pennsylvania, Maryland, Virginia, North Carolina, and terminates on Clay Creek, in Chesterfield District, South Carolina.

It is very uniform in mineral character, being composed of a brick-red sandstone. It is intersected through its entire extent by trap dykes.

The organic remains found are few—the most important, if we except the bird tracks, being the Ganoid fishes, discovered in the Connecticut valley. True heterocircal fishes are lost in the formations above this.

In North Carolina some beds of coal of workable thickness are found in this system, on Deep River. The beautiful *encrinites moniliformis* and *ammonites nodosus* are characteristic fossils of this system, in Europe. Reptilian footprints occur in England, and the remains of *Rhynchosaurus* and *Labyrinthodon* belong to the New Red.

The bird tracks of Connecticut show very conclusively that birds existed during the deposition of these rocks. Some of these foot-prints were of enormous size, as mentioned in the preceding pages; and the bird to which they belonged must have been capable of a stride six feet in length. It seems that there yet exist some doubts in the minds of English Geologists, as to the age of the Connecticut Red Sandstone.

Lias.—This and the succeeding group are included by the Geologists of Continental Europe, under the name of the *Jurassic System.* The rocks of the Lias are composed of beds of shaly and argillaceous limestones, marl and clay.

Of European rocks this group may be considered as among the most interesting to the Palæontologist, whether we consider the number and beauty of its fossils, or the strange and anomalous forms found among them. It is here that those huge and extraordinary Enaliosaurians, the Ichthyosaur and Plesiosaur, first make their appearance on the stage of their existence.

The Pentacrinite is found here in great abundance, as well as the *Belemnite* and *Ammonite*. The genus Gryphæa is so abundant in some of the strata as to give the name Gryphite limestone to certain beds of the group.

Gryphæa incurva is a characteristic species.

Oolitic System.—The Lias passes gradually into the overlying Oolitic beds. In England, where this system has been studied with most care, it has been divided into three well marked groups—the upper, middle and lower Oolite. The latter is represented by the "Bath Oolite," "Bradford Clay," and "Cornbrash;" the middle by the "Oxford Clay;" and the upper by the "Kimmeridge Clay." The Portland stone also belongs to the upper group of the system, as well as the noted "Dirt bed," which is composed of a bed of earth containing stumps of trees in the position in which they grew.

Like the preceding, the fossils of this group are numerous and interesting. The fossil plants consist of coniferous plants, together with characteristic species of Zamia and Cycas.

The Echinodermata are numerous both in genera and species. Encrinites are also found.—Insects also occur in this system—a fact indicative of the proximity of the shore to the spot where they are found.

In portions of these rocks the Cephalapoda are exceedingly numerous, whilst they are almost wanting in other parts. Reptiles of the orders *Crocodilia* and *Dinosauria* are found throughout the system, and the latter order is represented by the gigantic *Megalosaurus*.

The *Pterodactyle* was one of the strange organisms that marked this period; and what is still more interesting, the first mammal is found here. It is curious enough that no other traces of mammalian existence should be found till we reach the Tertiary period.

With the exception of the coal-beds of Eastern Virginia, no Oolite has been yet discovered in the United States. These beds have been referred to the lower Oolite by Prof. Rogers, and recent examinations of the organic remains of these beds, made in England by Mr. Lyell and others, seem to confirm this determination. It is, at all events, almost certain that they cannot be of greater age than the Lias.

Wealden Group.—This is an interesting deposit that overlies the Oolite in England. It is composed, for the most part, of beds of sand, clay, and gravel, supposed to be brought down by a river. The most remarkable animals of its Fauna were the gigantic herbivorous reptiles. The Iguanodon, discovered here by Dr. Mantel, must have been twenty-eight feet in length, and supported upon the most extraordinary legs, the femurs of which equal in size those of the elephant. Remains of fishes occur here, and fragments of the bones of Pterodactyle are also found. The Mollusca are confined to fresh water species, and a minute Crustacean, also an inhabitant of fresh water, is sufficiently abundant to form entire beds. The whole group is well characterized as a fresh water formation.

Cretaceous Group.—Next in order we have the very remarkable rocks which include the chalk of Europe, from which the formation derives its name. English Geologists have divided this group

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into three parts. The upper includes the Maestricht beds, and the chalk; to the middle belong the Upper greensand and Gault; and in the lower is placed the Lower greensand.

In Switzerland the lower division is represented by the *Neocomien* formation, which is found near Neufchatel.

In the United States the Cretaceous group is well represented along the coast of the Atlantic States, beginning at New Jersey. It is found in North Carolina, and it is exposed on the banks of the rivers in the Eastern part of South Carolina.

Mr. Lyell, who had examined these beds nearly throughout their entire extent, refers them to that part of the formation included between the Maestricht beds and the Gault inclusive. In this country the formation is every where characterised by Belemnites Americana, Exogyra Costata, Gryphæa Mutabilis, and two or three species of Ammonites. In Alabama a very large species of Hippurites occurs, which is often a foot in diameter.

The most remarkable reptile is the Mososaurus, a genus common to this continent and that of Europe.

The Ammonitidæ, after existing here in vast numbers, disappear forever. It is remarkable that the beds of chalk that every where characterize this formation in Europe should be entirely absent in America. In some of the New Jersey beds calcareous matter is abundant, but in North and South Carolina it forms not more than 25 or 30 per cent. of the mass, and in Alabama the formation becomes again highly calcareous.

Tertiary Period.

The Tertiary rocks are every where very variable in mineral composition and state of aggregation. Loose sands, gravel, clay, limestones and marl, are the principal materials which make up these rocks. Although widely distributed, they are not often found in continuous strata, but filling depressions in the underlying rocks. For a long time much confusion existed in relation to the relative age of the numerous formations comprised in the Tertiary period. The opening of the beds of the Paris basin, and the investigation by Brogniart and Cuvier of the organic remains brought to light, directed attention to this interesting field of enquiry. Tertiary fossils were collected, studied with care, and compared with living types; it soon became evident that many of the fossils were identical with living species. Of 1122 species of fossil shells, found in the Paris basin, 38 were identified with living forms by M. Deshayes, who first suggested that the Tertiary formations may be divided according to the relative proportion of extinct and living fossil shells which they may contain.

But it is to Mr. Lyell that we are indebted for a classification founded on this principle. At the time that this classification was proposed there were known from the Paris basin and other contemporaneous beds 1234 shells, of which 42, or about three and a half per cent. were living species. To such beds Mr. Lyell has given the name "Eocene," which implies the dawn of the present state of things on the earth; for it is here that we find the first species that has a living representative; besides, the whole group resembles those now inhabiting our seas.

In other deposits Mr. Lyell found that the proportion of living to extinct species amounted to seventeen per cent. These beds he designated as "Miocene"—"less recent," from the small number of recent species found in this formation. Of 1021 species examined, only 176 are living.

The next division consisted of those beds in which the recent species were present in great number, compared with the Miocene formation, and was therefore named "Pliocene"—"more recent." This formation was again sub-divided into older and newer Pliocene.

In the newer Pliocene, out of 226 fossils, 216 were found to be of living species, and in the older Pliocene, of 569 species, 238 were found to be of recent species. In general the proportion is found to be about one half.

Mr. Lyell estimates the number of species common to the Miocene and Pliocene at 196, of which 114 are living, and 82 are extinct.

In this country the terms upper, middle, and lower Tertiary, by which these divisions were formerly known, have given place to Mr. Lyell's nomenclature, and although many objections have been made to it, nevertheless it is found quite convenient. The objections that I have heard amount to this, that with the progress of discovery the "per centage" must alter; but it must be recollected that the distinguished author never intended to limit it strictly to that found among the fossils first examined. Had he done so our Eocene would necessarily be referred to some other formation, for it contains not a single recent species.

The divisions of the Tertiary in general use with American Geologists are Eocene, Miocene, Pliocene, and Post Pliocene.

Eocene Formation.—The principal foreign localities of this formation are the London and Paris basins, and numerous others in various parts of France and Italy.

The Paris basin is deservedly the most noted, as the grand depository of the materials from which Cuvier restored so many strange Pachydermata.

The remains of fishes are numerous, particularly those of the family of Sharks, Ray and Sword fish. Turtles and other reptilia are not uncommon, and some remains of birds have been found. Among the Mammalian remains are those of Cetacea, the Monkey and Opossum.

Of mollusca, Gasteropods, and, with the exception of the Nautilus, the Cephalopoda, have disappeared.

In the United States this formation may be traced from Maryland to the Mississippi. The characteristic and most common fossils are Ostræa Sellæformis, Cardita Planicosta, and Turritella Mortoni.

Miocene Formation.—The beds composing this formation are generally made up of loose materials, such as sand, clay, gravel and marl, rarely indurated. It is seldom thick or continuous, being for the most part found in detached patches of limited extent. In the United States the thickest beds do not exceed 80 feet.

The formation designated in England as the "Crag," is Miocene. On the continent of Europe this formation is widely distributed.

In this country it is found extending along the coast of the Atlantic, from New Jersey to the Savannah, beyond which point, towards the South, it has not yet been recognized.

In genera the fossils differ but little from those of the preceding formation.

Post Pliocene.—In mineral composition the beds of this formation differ but little from those of the Miocene, excepting that they contain less lime. The fossils, with a few exceptions, are identical with the forms at present existing on the coast. The fossiliferous portion of the beds does not exceed four or five feet in thickness.

In the northern States beds of gravel, containing rounded and angular boulders, which have received the name of "drift," belong to this formation. The boulders have generally been transported from a distance, and have left markings on the rocks over which they passed in their journey, which indicate the direction from whence they came. These markings consist of striæ and grooves on the surface of the rocks. They bear so strong an analogy to similar markings on the rocks over which glaciers are known to have passed, that they have been referred to the same cause.

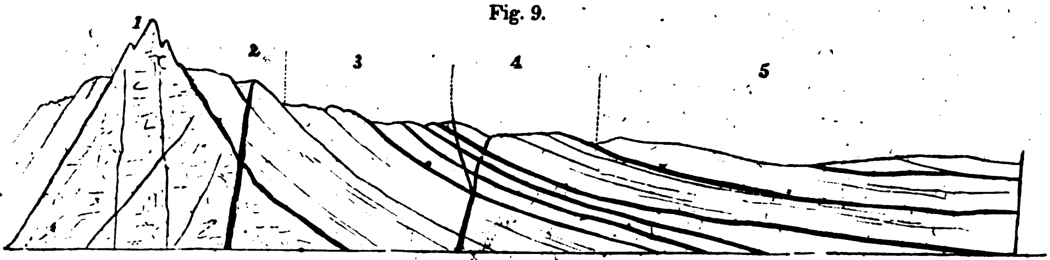
The glaciers consist of vast fields of frozen snow, covering the sides of mountains and extending into the valleys. Whenever the temperature of the air is sufficient to melt the surface of the snow, the water thus produced percolates into the glacier, where it is frozen. During this, expansion takes place, and the glacier moves onwards, tearing up, like a plough, the surface of the mountains, and bearing along with it vast masses of rock, intermingled with clay, earth, and gravel. Rocks are frozen into the bottom of glaziers, which score, by the immense weight of the mass, the surface of the underlying rocks. When the glaciers reach the point where the temperature is too high for them to exist, they melt and leave behind them their immense burden, consisting of the debris of the rocks over which their track lay. The melting of the snow and ice often produces floods that inundate the neighboring valleys, and have sufficient force to carry forward vast quantities of the materials brought down by the glaciers. Such a cause as this has been proposed to account for the transported rocks, where glaciers no longer exist.

The well known transporting power of icebergs has also been proposed. When the vast masses of ice that are constantly accumulating during winter in high northern latitudes, break loose from the shore, they carry with them masses of rocks and soil, which are distributed over the bottom of the sea, as the icebergs melt on their southern passage. This hypothesis, however, does not account for the striated surface of the rocks, for as the bottom of the ocean is covered with sand and mud, it is difficult to conceive how it could be striated or grooved. Besides, deposits thus formed would contain the remains of marine animals, which does not seem to be the case with the drift beds. On the other hand, the glacier hypothesis does not satisfactorily account for the vast amount of rounded and smooth water-worn pebbles, which abound in these beds, and which could only have resulted from the long continued action of water. It is highly probable, then, that the force which transported these beds was the result of the combined action of ice and water.

Alluvium.—This term has been applied to those sedimentary deposits that are going on at present on the banks of rivers and along the sea coasts. Such deposits, besides the remains of fluviatile and marine animals, sometimes contains works of art and human remains. They are, indeed, the only rocks in which the latter have as yet been found. The skeleton found in the West Indies some years ago was embedded in a deposit of recent shells, such as is at this moment in progress of formation on the coast of Florida.

The following section will convey a correct idea of the relative position of the rocks composing the crust of the earth, so far as it has been examined.

Fig. 9.



1—Granite. 2—Metamorphic rocks. 3—Palæozoic series. 4—Secondary series. 5—Tertiary series.

Succession of Organic Remains.—We may now take a slight restrospect of the Geological succession of organic remains, as developed by Geologists in all parts of the world. Commencing with the Potsdam sandstone of New York, which is the oldest fossiliferous rock of this country, we find that the first organic forms that occur are those of cellular plants, such as sea-weeds, and a small Brachiopodous mollusc, the Lingula. As we ascend in the Silurian series, corals and Crinoidea make their appearance in vast numbers, and the Brachiopods of various genera multiply.

The sub-kingdom Articulata is represented by numerous Trilobites, and the Cephalopodous molluscs by species having chambered shells.

Remains of fishes are found in the Silurian rocks of Europe, but they are exclusively those of the cartilaginous family; and no perfect forms occur till we reach the Old Red.

Towards the Upper part of the Silurian rocks of New York, plants that indicate the existence of dry land appear for the first time.

During the Carboniferous period plants seem to have attained the greatest development, and two species of Poa, the only fossil grasses known, are found in the coal formation of England; and, what is equally curious, the first insect appears here.

The Trilobites disappear altogether with the carboniferous rocks, while voracious fishes, of great size, inhabited the seas throughout the entire period.

In the Magnesian limestone remains of reptiles are found for the first time.

In the New Red we find the earliest evidences of the existence of birds; and, in Europe, Batrachian reptiles have left their tracks and some bones in this formation.

In the Lias and Oolite the class Reptilia is represented by the most extraordinary forms. The Enaliosauria of this period have left behind them no representatives, unless the "Sea-serpent" should turn out to be a veritable inhabitant of our seas. In the Oolite we find the first mammalian remains, the jaw of an Opossum.

The noble tree-ferns of the Carboniferous period have disappeared, and a few palms are found lingering behind. Insects are now, for the first time, abundant; and in the Wealden formation the remains of lizards of enormous proportions exist.

In the Cretaceous system some remains of the Saurians of the preceding groups are found, but the most remarkable reptile peculiar to this period, is the Mosasaurus.

Cartilagineus fishes, of the Shark and Ray tribes, are numerous, but the fierce Ganoids begin to give place to the Ctenoids and Cycloids, which make their first appearance here. With the exception of two genera, the existence of the Ganoids terminates with the Cretaceous system, and, with a solitary exception, the Cephalapods disappear altogether with these rocks.

In the Tertiary, Gastaropods abound.

The Cetacea, such as Zeuglodon, Manatus, and other genera, are found here. But the most remarkable feature in the Fauna of this period is the great number of huge Pachydermatous mammalians which seem to have suddenly started into existence, bearing the same relation to this period that the enormous reptiles did to that of the Lias and Oolite. Remains of the rattlesnake, opossum, horse, and monkey belong to this series, and towards its close the mammoth, mastodon, and megatherium make their appearance. And last of all man appears on the earth.

In taking a general view of this sort, questions as to the origin and extinction of species force themselves upon the mind of the most thoughtless. Did species first come from the hand of the Creator in the form in which we find them, or did they pass through a series of metamorphoses, by which they were gradually changed and perfected? A superficial observer, in casting his eye over a collection of organic remains, would no doubt be struck with the evidences of progression that it presents. But a thorough examination, supposing he had the patience to make it, would satisfy him that this progression, so far as it exists, is the result of a design, having for its object adaptation to external existing circumstances, and not giving the slightest countenance to any development by metamorphosis or transmutation.

Some writers have attempted to account for the origin of life by supposing that animalcules were living atoms of elementary matter, which, by their aggregation or coalescence, produced higher animals.

Akin to this theory is that of "spontaneous generation," which is often flippantly expressed by the phraseology—"Matter placed under favorable circumstances may produce life." The experiments of Cross, who it was supposed had produced living infusoria by galvanic action, and existence of the intestinal and other worms where it was once found difficult to account for their presence, have all been adduced in proof of this theory.

With regard to animalcules, it is now well known, from the labors of Ehrenberg and others, that the most minute of these little forms are well organized animals, presenting the relations of parent and offspring just as distinctly as they are found in higher organisms. Ehrenberg and Agassiz have repeatedly seen them laying eggs, and studied the form and growth of the young within these eggs. These facts were not known to these who first proposed the theory of "living elementary atoms." We have not the slightest evidence, any where, of the union of organized beings, to form a *higher* animal. Had such existed, it would have been long since discovered, if it were not sufficiently opposed to the whole plan exhibited in animated nature.

"Spontaneous generation" takes for granted what it should prove, for it supposes matter endowed with the attributes of life, and capable of performing one of its highest functions, before life has yet existed, which is sufficiently absurd.

Cross's experiment proves too much: for the animal supposed to be produced belongs to the class Articulata, which stands high in the scale of being, and includes forms of high organization. It should have commenced lower in the scale. Besides, the experiments, or rather their results, are far from being considered as conclusive, by those best capable of appreciating such processes.

The worms found in the intestinal and other cavities of animals are frequently alluded to, and are even supposed to originate in those cavities. It is not surprising that such opinions once existed, when science could offer no better theory—and the uninformed are most given to theorize.

Darwin mentions that on a certain occasion, during his researches in South America, his guides, who had long known of the existence of the skeletons of the mastodon, buried in a cliff, on the Pampas, puzzled to account for their position, at length came to the conclusion that the mastodon was a burrowing animal!

Modern researches have removed every doubt connected with the origin and history of intestinal worms. The *Distoma hepatica*, an animal confined to the livers of animals, particularly to those of the Ruminantia, has been supposed to offer peculiar difficulties. Sheep, when they graze in low, wet pastures, are subject to diseases caused by attacks of these animals.

A Swedish naturalist has the merit of being the first to point out the origin of these worms. He observed that at a certain season a species of fresh water mollusc was infested with small worms. He found them at first attached to the skin, at a time when they abounded in the water. They bury themselves in the animal, where they remain until one of those changes takes place, to which insects are subject. It is now provided with the means of penetrating the body, which it does till it reaches the cavity where the viscera are contained, to which it attaches itself, and where it continues to live and propagate.

Prof. Eschrich has investigated with equal success the history of intestinal worms. He observed that periodically fishes were found with long worms in the alimentary canal, while at other times they disappeared altogether. Following up these investigations, he traced these worms through all their stages of growth, until they became long worms with articulated bodies and a small head. He observed that they shed the greater portion of the body at certain seasons; he found, moreover, that each joint of the portion thus cast contained hundreds of eggs, which, escaping into the water, would be swallowed by fishes along with their food, and would of course re-appear in the form of worms in the alimentary canal.

One of the most curious facts observed during the investigation of the Natural History of Distoma, is that this animal is subject to several metamorphoses, and it requires several generations for the newly hatched animal to arrive at the state of the original parent.

If, then, some of the most difficult cases connected with the origin of these obscure forms of being, have been thus successfully investigated, is it not reasonable to conclude that every case may admit of a like satisfactory explanation? Let us now take a brief glance at the transmutation theory.

Life somehow commenced, Maillet and Lamark supposed the earlier organisms endowed with a power which they called appetency. This power, exerted for a long time in a particular direction, produced new organs or modified the old ones. For instance, one can suppose that a primeval oyster, tired of lying on its side, might entertain an intense desire to promenade the beautiful coral groves in its neighborhood. Such a desire, long continued, say these philosophers, would produce an extension of the abdominal muscles, which, after a while, would be protruded like a foot, by means of which the oyster could move about. The shell of the oyster would be inconvenient, on account of its unequal valves: some strong desires to remedy this, would no doubt occupy the mind of the oyster, and the result would be that, in a few generations, this shell would be altered to one of symmetrical form, such as that of the clam, which is far more convenient for locomotion.

The desire to feel and to see would next be felt, and the tentaculæ and eyes of the gasteropod would appear. These causes continued, the oyster, in its upward progress, would arrive at the organization of a well developed Gasteropod. And in this way the process from an oyster up to a man seems quite easy.

But the following extract from the Teliamed of Maillet will serve as a specimen of their own logic on this subject.

"Winged or flying fish, stimulated by the desire of prey or the fear of death, or pushed ashore by the billows, have fallen among reeds or herbage, whence it was not possible for them to resume their flight to the sea, by means of which they had contracted their first facility of flying. Then their fins, being no longer bathed in the sea-water, were split, and became warped by their dryness. While they found, among the seeds and herbage among which they fell, any aliments to support them, the vessels of their wings being separated, were lengthened and clothed with beards; or, to speak more correctly, more justly, the membranes which before kept them adherent to each other, were metamorphosed. The beard formed of these warped membranes was lengthened. The skin of these animals was insensibly covered with down of the same color with the skin, and this down gradually increased. The little wings they had under their belly, and which, like their wings, helped them to walk in the sea, became feet, and served them to walk on land."

It is proper to state that modern philosophers of this school have given up the "appetency" portion of the theory, and only insist upon a series of gradual transmutations or metamorphoses, such as that which the frog undergoes in its passage from the egg to the perfect animal—all the result of external circumstances.

The coarse hair of the dog of warm climates, becomes fur in high northern latitudes; and the evergreen of the South becomes deciduous when removed to the North. What was at first accidental, in time becomes permanent.

The setter is taught to set game, but the puppy, its offspring, sets by instinct: what was at first a mere habit, acquired by education, now becomes a permanent principle.

Such facts as these, when strained beyond their legitimate application, become absurdities. Does it follow that because the hair of the dog is changed, to adapt it, as a covering, to external circumstances, that he would ever become a lion or a monkey? or that, because the educational habits of the setter are transmitted to its offspring, in time it would be able to solve a problem in geometry? Yet it is reasoning very like this that those employ who teach changes by development from lower to higher forms of existence.

There is a dangerous ambiguity lurking behind this word "development," that, I am persuaded, has deceived many. In the geological succession of animals, there is very evident gradation from the lowest *groups* to the highest, and this has been mistaken for development. The changes that take place in the egg, from the commencement of incubation to the production of the living bird, are called development. The changes that take place in the life of the insect, between the caterpillar and butterfly states, are metamorphoses. Now neither of these changes can be applied to the gradation observed in the scale of being.

When the frog first leaves the egg it has gills for breathing in water, a tail, and all the habits of a fish; after a while legs appear, and the tail, after another short interval, disappears: the tadpole now begins to breathe air, and finally leaves the water, a small but well formed frog. Here is an example of metamorphosis, which, if it could but be seen to take place between two species, it would be all that could be desired to account for the gradation observed in nature. But these changes are as much a part of the nature of a frog as its long legs and aquatic habits. The frog emerging from the tadpole state is as much a frog as its parent. Had it appeared with the rudiments of wings, we could at once see how it may, in time, become a bird.

There is, however, some analogy between the succession of fossil fishes and reptiles, and the changes that take place during the embryonic development of these animals. Agassiz has observed that the changes that take place in the embryo of fishes represent the order in which fishes occur in the older fossiliferous rocks.

The embryo fish is first cartilaginous and heterocircal, from this it passes to the homocircal and osseous state. Now we know that the first fishes were heterocircal and cartilaginous, and were succeeded by homocircal families.

Reptiles, too, in the egg, begin with biconcave vertebræ, and terminate with the concavo-convex articular surfaces, which is the type of living saurians. Now we have seen that the prevailing form of the earlier reptilian vertebræ was biconcave. These analogies are curious and interesting, and afford characters that determine at once the order in the scale of organization that the forms thus typified should occupy. As the development in the egg is from lower to higher forms, the reptiles with biconcave vertebræ, and fishes with heterocircal tails, must stand below the others in the scale. But such facts afford not the slightest evidence of the transmutation or self-development of species.

When it is urged that no Naturalist has seen in existing nature any such passage from one species to another, the reply is that the time is not sufficient for their observation—"the metamorphoses of species proceed so slowly with regard to us, that we can neither perceive their origin, their maturity, nor their decay." But to the organic forms preserved in the solid crust of the earth, this want of time, cannot apply: with them there was time enough. Let us then see whether any evidences of such metamorphoses present themselves. The first organisms belong to the Mollusca and Articulata: now if we compare the Brachiopods of that period with the few that exist at the present day, we cannot perceive that any progress has taken place in this oldest of families. Cephalopods have made no advances in organization or numbers, but, on the contrary, almost entirely disappeared with the upper part of the Cretaceous system. Besides, the first of the Cephalopoda belonged to the higher and not the lower division of the class.

The same is true of Reptiles: the Labyrinthodon of the New Red, was far from being the lowest of Batrachia. The long period during which the Enaliosaurs peopled the Liassic and Oolite seas, presented a good opportunity of observing any transmutation that may have taken place in these reptiles. The Ichthyosaurus, for instance, might be expected to lose some of those characters that indicate affinity with fishes, and become a Plesiosaurus; but no such change can be observed; on the contrary, they were, from the beginning of their existence, contemporaneous, and from the very beginning presented the same characters that distinguish them at the last.

After a profound examination of the reptiles of this period, Prof. Owen comes to the conclusion "that the different species of Reptiles were suddenly introduced upon the earth's surface." "Upon the whole, they make a progressive approach to the organization of the existing species, yet not by an uninterrupted succession of approximating steps." "But, on the contrary, the modifications of osteological structure which characterize the extinct Reptiles, were originally impressed upon them at their creation, and have been neither derived from improvement of a lower, nor lost by progressive development into a higher type."

And the same conclusion is true of the other groups. The gradation is not from one species to another, but a progression of classes, which was adapted to a corresponding progression in the state of the earth's surface; and although we cannot show what the actual condition of the inorganic world was, at the time of the introduction of each of these classes, we have every reason to believe the classes introduced were created with express adaptations to those conditions.

We find everywhere among fossil groups of successive formations marks of adaptation to preceding conditions. Crustacea follow the fucoids upon which they fed; the voracious Sauroid fishes are introduced after a supply of food was prepared by the existence of other animals. Huge Reptiles next appear, which preyed upon these. Birds come into existence after the appearance of dry land, as indicated by land plants. Insects precede the Insectivora. Herbivorous animals appear still later, when plants were in number and kinds sufficient to afford them proper food, and are followed by carnivorous animals, which prey upon them. Last in the series man appears.

Consistency of Modern Geology with the Mosaic account of the Creation.—When Geologists first announced the fact that deposits of great thickness, abounding in the remains of animals that once lived, existed in the earth's crust, and that all this could not be explained on the supposition that the age of the earth was only 6,000 years, Geology was considered, for a while, as opposed to the Bible.

Time was when Astronomy stood in the same relation; and although it is now known that it is the motion of the earth and not that of the sun that produces the phenomena of day and night, yet no one thinks the authority of the Scriptures lessened, or has his belief disturbed by this—and for the simple reason that he knows that the Bible was intended to be a code of moral and religious laws, and not a text book of Astronomy. And this science is now properly regarded as the handmaid of religion, in expanding and ennobling the mind, by elevated views of the Creator's works.

It is not to be supposed that Moses, in the account he gives of the creation, intended a system of chronology: his great object seems to be to impress his readers with the fundamental truths that the world was not eternal, but the work of the Almighty, and that man, like the rest, had a beginning—in a word, to show them how, and not when, the world was made.

It must be borne in mind that the question is not between the facts of Geology and the credibility of the Mosaic Account of the Creation, but between those facts and the literal interpretation of that account.

It is acknowledged on all hands that the deposition of strata of rocks six or seven miles in thickness, containing organic remains, must have occupied, according to all the laws governing matter, an immensely great period of time. It was usual, at one time, to refer the phenomenon of the distribution of organic remains in these rocks to the Deluge; but no one, who has ever examined a fossiliferous deposit for five minutes, can hold such an opinion. The manner in which fossil shells are embedded shows most conclusively that the animals to which they belonged lived and died where we find them, and that they could not have been disturbed by the waters of a deluge.

There are, I believe, those who suppose that the world is not the result of a long continued series of events, but that it was created at once, and as we find it. Such an opinion can only be held in direct violation of all natural laws and analogies, and by forfeiting all the arguments and principles of Natural Theology. For if, when we examine the curiously organized eyes of the Trilobite, embedded in the older rocks, we are not allowed to infer adaptation to light and other external objects, why then Paley's "watch" presents no evidences of design, and the arguments drawn from it are worthless.

The interpretation of the Mosaic narrative of the creation that is most in accordance with the discoveries of Geology, is that which supposes the "beginning," mentioned in the first verse, to be a time immeasurably distant from the "first day," mentioned in the fifth verse, and that in the interval between this "beginning" and the "first day," all the phenomena of Geology were brought about; and that the subsequent days refer to the present state of the earth's surface, and to the creation of existing races of animals and plants. This is the view taken by many Geologists, and by those Divines who have examined both sides of the question.

This interpretation was not first proposed by Geologists: some of the Fathers of the Church separated the "beginning" from the days of creation; and the notation of Luther's Bible goes to show that he supposed the creation to commence with the third verse of the Mosaic narrative.

Others suppose that the days of the Mosaic narrative are to be understood figuratively, for periods of time, of indefinite length. But whatever view be taken of this subject, no one need attempt to press Geology into any irreligious service. No science can be more worthy of the attention of the Christian student, for none can lead him more directly to the Creator, as the First Cause. It takes him back to the time when neither man nor beast nor bird nor creeping thing nor plant existed, and when even the oldest rocks had a less permanent form. In a word, it shows him that all save the Almighty had a beginning—that He alone is eternal.

REPORT

ON

THE GEOLOGY OF SOUTH CAROLINA.

CHAPTER I.

Granitic Rocks.—Mineral Contents.—Basaltic Rocks.—Trap Dykes and their Distribution.—Flat-woods of Abbeville.—Meadow-woods.—Black-jack lands of Chester.—Mineral contents of the Trap Rocks.

It has been common to designate that portion of South Carolina above the falls of the rivers as the granitic region, yet granite proper forms comparatively but a small portion of the entire surface. The precise limits of the granite of the State is defined with difficulty, for this reason, that while it occurs in numerous localities, it no where spreads out so as to form a continuous area of any considerable extent, and never rises into any thing approaching a mountain in elevation. For the most part it appears on the surface only, in patches of irregular outline, where the slates and other overlying rocks have been removed by the streams and rivers on whose banks it most frequently occurs. It sometimes appears as if its irregular surface had protruded its most prominent points through the superincumbent rocks, by which the other and more depressed parts are yet covered. With a few exceptions, where it rises in masses of twenty or thirty feet in height, it seldom forms a conspicuous or picturesque object in the scenery where it occurs. Perhaps the position in which it presents the greatest continuity, and certainly where it has exerted the greatest influence on the topographical and physical features of the State, is where it is seen along the northern boundary of the Tertiary series, in a low range of hills extending, with occasional interruption, from the source of Horse Creek, on the Savannah, to the Congaree, below Columbia, and forming the watershed between the Saluda, which is turned aside from its course, and the head waters of the Edisto. The granite forms here a short anticlinal axis, having the clay slates dipping towards the North, and the Tertiary plane towards the South. And although it is generally concealed from view by the sandy Tertiary beds, yet wherever it appears it is found in the relative position just mentioned, showing clearly its agency in raising the overlying rocks to their present inclined position.

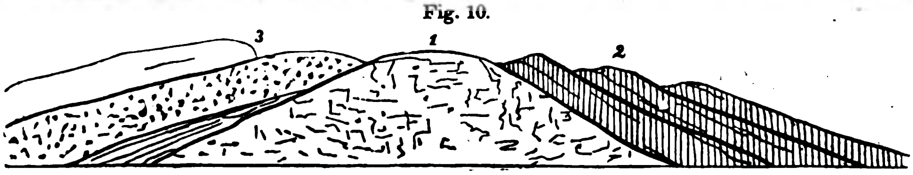
Graniteville, on Horse Creek, is the most southern locality of granite in the State. The rock is laid bare on the banks and in the bed of the stream, by the removal of the sand and clay by which it is covered up to the right and left. It is a hard, compact, bluish rock, composed of quartz and feldspar, with very little mica—the feldspar generally predominating. On the right bank of the creek it is much disintegrated; the feldspar is white, and in a state of decomposition, and even where the rock is solid, it seems to have lost its peculiar lustre.

A little higher up, and on the opposite bank of the stream, a quarry has been opened, where the rock presents its normal character. It is intersected with veins of feldspar, and the surface broken up into prisms by jointed structure. The direction of the principal joints is about N. 25° W. It is also separated into laminæ, two or three feet in thickness, parallel with the surface. Near the dam a similar structure prevails, but where the rock is disposed to disintegration, the iron of the decomposing feldspar, which is set free, forms, by segregation, yellow bands, parallel, not with the horizon, but with the surface of the rock, giving it a curious striped appearance; sometimes these bands or stripes are much curved, yet they preserve their parallelism.

Along the banks of the stream, for a distance of four miles, to the head of the pond at Vaucluse, this rock is exposed, and near the Factory it presents a fine locality for the examination of the prismatic structure, which results from the intersection of joint lines.

The following diagram represents the relative position of the granite and overlying rocks between Horse Creek and Edgefield.

Fig. 10.



1.—Granite. 2.—Clay slate. 3.—Tertiary beds.

On Cloud's Creek is a locality of Porphyritic granite, with white feldspar and black mica, noted for the mill-stones it furnishes for the neighboring Districts. It occurs in round weathered masses, but little elevated above the surface.

A coarse, crystalline granite occurs on a small stream West of S. Edisto, where the Columbia road crosses it; it is overlaid by gneiss and hornblende slate. Thick beds of gneiss, having but little mica, and which are consequently but slightly fissile, cross the river.

On Lightwood Creek, at Gen. Quattlebum's mill, granite comes to the surface, and in the mill-race it is covered by a series of talcose and mica slates, together with beds of feldspathic rock. On the margin of the pond masses of rough, porous quartz rock, presenting almost a vesicular structure, is strewed over the surface. On examination this rock seems to be the result of the decomposition and consequent disappearance of crystals of feldspar which were disseminated through the quartz. Could it be found in sufficient quantity, it would make a good substitute for burr-millstone, which it somewhat resembles.

Higher up the river the granite assumes a gneissoid character, and stretching across the bed of the stream, forms a series of picturesque cascades over a distance of a quarter of a mile. The thickness of the strata exposed here, and consequently the fall of the stream, is about 40 feet.—Towards the sources of the river the rock is covered and hid from view by Tertiary sandstone.

On Twelve Mile Creek, near Lexington, crystalline granite is found forming the fall at the mill; it underlies the village, and appears at the surface to the East, and along the creek, to where the latter is crossed by the road to Youngner's Ferry.

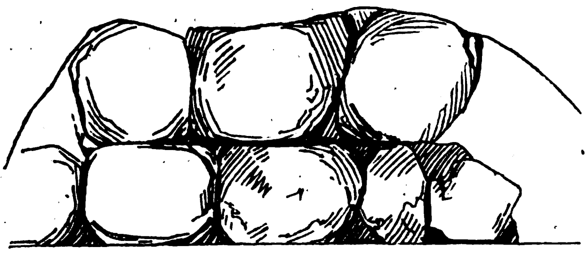
At Granby, on the Congaree, disintegrated granite covers the surface, and from this place to the junction of the Saluda and Broad River, excellent localities are every where seen, of a fine-grained, compact, grey granite. At the Factory broad veins of red granite, resembling the Egyptian variety, penetrate the rock, and a fine sienitic granite is found at this place. On the canal the rock is intersected, in various directions, by flesh-colored feldspar.

Near Fisher's Mills granite is found outcropping from under the beds of clay and gravel upon which Columbia stands. Round masses of this Rock occur on the surface, and embedded in loose earth, near the bridge over the Saluda, and in various places north of the city.

The rounded form and apparently detached position which they occupy in the banks of loose earth in which they are embedded, have caused them to be referred to true transported boulders. They are, however, masses of granite rounded in place, by disintegration.

The rock originally presented a jointed structure, the seams dividing it, by their intersection, into cubic blocks of various sizes. Disintegration commences at the angles, which, being the points of least resistance, are removed by exfoliation, or converted into a slightly cohering mass, which finally becomes a loose earth, enclosing the rounded pieces of rock. This earth is frequently removed from the crevices, and the globular masses remain standing alone, or piled upon each other, as they are often seen. It is in this manner that all the rounded masses of granite in the State have been formed; which can always be distinguished from transported rocks by their identity with the rocks with which they are associated. The sketch, Fig. 11, shows the mode in which these pseudo boulders are formed.

Fig. 11.



Besides the granite range thus briefly indicated, there are other localities in this region, which have little more than a local interest, and need not be minutely described.

About four miles north of Cambridge, on both banks of the Saluda, extending as high up as Neily's bridge, huge weathered hemispheric masses of granite are seen, which frequently rise above the surface, to the height of ordinary houses. Their angles are completely rounded, and the masses are frequently fractured throughout their entire height. These fractures are the result of the disintegration which takes place at the surface of the ground: an undermining of the rock commences, and is continued until the projecting portions, by their weight, overcome the cohesive force of the rock, when of course they break off. The piling up of rocks upon each other, so often noticed, on account of their resemblance to works of art, is also the result of this cause.

At such localities as Stone House Creek, in Chesterfield District, the rocks assume the form of vast tabular masses, and are supported like lintels or architraves, forming commodious shelters for cattle; and tradition even says that persons, during the Revolutionary troubles, followed their daily avocations in these natural houses. They are the result of horizontal joints in the rocks: the lower portion crumbles away, leaving the roof projecting, or supported on pillars, as described.

West of Edgefield Court House, near Martin Town, granite is seen in rounded masses, and in disintegrated beds on the road side, where it seems to have protruded through the slates. At Richardsonville another extensive exposure occurs. In Fairfield, below Ruff's Ferry, a fine sienitic granite crosses the river. The mica, when present, is black, and curiously distributed; and, contrasted with the white feldspar, it gives the mass a striking appearance. It is doubtless intrusive, for it appears again at Montecello, associated with the Trap rocks of that locality. Although it appears at the surface, in some places quite hard, it is found on the plantation of the Rev. Mr. Davis, so entirely disintegrated as to offer but little resistance to the spade. Around Winnsboro' it passes into gneiss.

The road from Dutchman's Creek towards Sawney's Creek, on the Wateree, passes a granitic ridge, intersected by wide veins of quartz, which are seen near the mill, protruded through the slates that cover the granite on the creek.

A few miles farther up the river from this point, a beautiful porphyritic granite occurs. The feldspar of this fine rock is grey and flesh-color—the latter predominating, determines the color of the mass. The large black crystals of mica give the whole the appearance of sienite. Specimens from this interesting locality may be seen in the base of the DeKalb Monument, at Camden.

At Liberty Hill and at various other places in Kershaw, rounded blocks of coarse granite are seen, as if pushed up through the sand, where they are not covered by the talcose slates of the gold formation.

On Buffalo Creek, in Chesterfield District, a rock similar to the DeKalb Granite may be seen, which is much used for mill-stones. The ground is grey and the embedded crystals reddish.

About thirty-six or forty miles from Columbia, a granite occurs, in Newberry District, that claims special notice. A few miles from the Edgefield line, and two or three from the Saluda, a coarse feldspathic granite rises into a conspicuous hill, which has lifted the slates on each side, giving them an N. and S. dip. For some distance beyond this it continues, till it passes into a fine-grained rock of uniform color, having the materials distributed equally, which give the rock, at a distance, the appearance of a coarse variety of marble. It splits readily into pieces of any required size, and is dressed with ease. I saw, on the spot, lintels fifteen feet in length, one foot wide and six inches thick. It has not been explored beyond the weathered masses, that cover the surface over an area of five or six square miles.

I have already alluded to the granite found in the south-east corner of Abbeville, between Swansey's Ferry and Cambridge. The Court House also stands upon a bed of disintegrated granite.

Between Laurens Court House and the mountain shoals of the Enoree, granite, both solid and disintegrated, is seen along the road.

Localities of granite are quite numerous around Union; towards the North-west, on Rocky Creek, and onwards to Pacolet.

In Spartanburg District, on the road from Glenn's Springs to the village, some fine localities occur. Between Cowpens and Limestone Springs granite is exposed at the surface, and two or three miles north of the latter place an interesting section is presented, where gneiss is seen reposing against the granite. In some of the wells near the springs a white and fine porcelain clay has been excavated, which shows that the granite has been reached.

At McMullen's Mills, and other places between the Cowpen's battle ground and Greenville District, this rock is exposed; on Wildcat, and again on Rocky Creek, twenty miles south of the village. In Lancaster, north of the Court House, near Waxhaw Creek, and on the Catawba, at Landsford, granite may be seen.

Yorkville stands on a granitic ridge, and this rock comes to the surface again on Fishing Creek, and other localities between that and King's Mountain. In the vicinity of the village good examples of the granite of this region may be seen, spotted with crystals of black mica.

Between the Stump House Mountain, in Pickens, and the Estatoe, granite is frequently laid bare on the surface; and further on, at the base of the mountains, near Burton's.

I have thus barely enumerated some of the principal localities of this rock. It would be no easy task to point them all out, if to do so were of any consequence. It is very evident that the portion of the State between the mountains and the Tertiary series rests upon a foundation of granite, having a very uneven surface, which was once entirely covered by the superincumbent slates. These are removed in patches by denudation, and the underlying granite is exposed, to a greater or less extent—often at widely distant localities.

It is still more difficult in every case to separate true granite from gneiss, into which it passes by such insensible gradation as to make it impossible to say where the one begins and the other ends. For instance, at Van Patton's Shoals, on Enoree, a portion of the rock is granite, whilst the rest presents the true planes of stratification of gneiss.

Mineral Contents.—The beds of porcelain clay, derived from granite, and the auriferous veins found in it, on Wildcat Creek, in Greenville District, and on the Pacolet in Union, are nearly all the economic minerals found in the granite of South Carolina, if we except the mill-stones and excellent material for building purposes that it every where affords.

Basaltic or Trap Rocks.

Although I was previously acquainted, from personal observation, with the series of trap dykes extending from Virginia through North Carolina, yet I was not prepared to find these rocks so extensively developed in this State; and it seems not a little surprising that they should have hitherto excited so little attention as to be scarcely known. I have since traced these dykes through Georgia, and as far as the Coosa River, in Alabama, which is their South-eastern boundary.

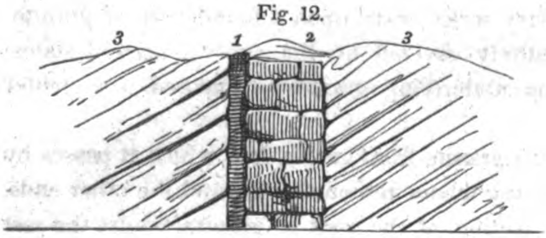
Both the trap and other rocks, with which it is associated, are so much disintegrated that it is impossible to observe the form presented by the dykes at the surface. I have not met with a single instance where this rock presents any thing like an escarpment, although the manner in which it penetrates the rocks through which the dykes pass may be observed at many places, in ravines and such localities. On the surface the dykes are readily traced by the long lines of black or dark green, and ferruginous, spheroidal masses of trap, scattered along in the direction of the dykes, often for miles in extent. The direction of these dykes is exceedingly uniform, varying between 15° and 35° East of North, and in general they are but slightly inclined from vertical.

I have no where observed the very decided columnar structure characteristic of these rocks, but they often occur sufficiently prismatic to present the idea of an artificial wall, and this impression is strengthened when the stones forming the dyke remain, as they sometimes do, piled up a few feet above the surface, while the surrounding rocks are washed away.

A remarkable wall of this description was pointed out to me by Mr. Nesbit, at the Mountain shoals of Enoree, where the straight lines of the faces of the dyke, together with the "breaking of joints," presented by the four-sided prisms which are laid across the wall, very forcibly suggests the remains of some ancient military work.

At one of the mines in Kershaw District a dyke, about twelve feet thick, completely divides the auriferous rocks, which have been worked on each side of it, to the depth of thirty feet, leaving the dyke standing undisturbed. Between the dyke and walls of talcose slate there is about two feet of yellowish green *wacke*, and some of the fissures are lined with crystals of sulphate of alumina. The slates at the point of contact with the dyke are blackened and otherwise much altered, a circumstance not common in the talcose slates.—Fig. 12 represents this dyke.

Fig. 12.



1.—Wacke. 2.—Trap, having jointed structure. 3.—Talcose slate.

Wacke, which seems to be decomposed trap, is not unfrequently associated with the dykes of the State. It is sometimes white, like chalk, may be cut with a knife, and is often mistaken for soapstone. Such is the case at a locality on Hard-labor Creek, where a reddish variety has been cut for hearth-stones, under this impression.

Ezell's mine, in Lancaster, is intersected by a dyke, which, at the surface, and for some feet below, is nothing but red clay. In exploring the mine, it offered a tempting site for a shaft, but it had not been prosecuted far before the trap assumed its true character, and put an end to further operations in that direction.

The dykes of South Carolina vary in thickness from a few inches to several miles: in the latter case, however, it is probable that the rock is spread out over the surface by overflowing from the fissure through which it was ejected from below, in a molten state.

It will be unnecessary to describe all the dykes of the State, particularly as they present but few peculiarities, and a description of one will apply, with certain limitations, to the whole. I have indicated, on the map, nearly all those that I have examined; but many more must have escaped me. A glance at the map will give a very correct idea of their relative position and distribution. The smaller dykes are of course not conspicuous, and would pass unnoticed by any one but a Geologist. In those Districts, however, where the trap rocks abound, they have impressed themselves so distinctly on the soil and physical features of the country, as to suggest particular, but by no means descriptive, names: such as the "Flat-woods," of Abbeville; the "Meadow-woods," of Union, and the "Black-jack" lands of Chester.

A considerable portion of the surface of the latter District is composed of trap rock, intersected by veins of porphyritic feldspar, quartz, and graphic granite. Wherever the feldspar abounds the soil is of a lighter color, so that bands of olive and chocolate-colored soils may be seen alternating. There is but little opportunity of observing the character of the rocks of this part of the District, owing to the flat nature of the surface. The usual spheroidal masses are, however, scattered on the surface, and the clay sub-soil is not to be mistaken.

In Abbeville District a fine locality occurs, which is known as the "Flat-woods:" a name that conveys an erroneous impression, when applied to the whole tract designated; for, unlike the unbroken plain, called the "Black-jack lands," in Chester, it is undulating, and even, in some places, broken. Concretionary nodules of carbonate of lime often occur in washes and ravines in trap rocks. Such nodules are quite common in Abbeville and Chester, and sometimes lead persons to expect deposits of marl.

Between Tyger and Enoree, in Union, masses of trap are strewed over the surface for miles in extent. This tract is called the "Meadow-woods"—for what reason I cannot see, as there is not a rood of meadow in the whole region.

After crossing Tyger, and ascending the hill, a series of dykes of porphyritic feldspar occurs, with embedded specks of limpid quartz, and crystals of a bluish feldspar, almost opalescent.

These are among the most important localities in the State.

In Fairfield, on Dutchman's Creek, and on Beaver-dam, they are quite numerous. In Union, north of the village, a dyke may be traced for miles in length. A dyke extends, almost without interruption, from Van Patton's shoals, on Enoree, to Young's P. O. a distance of six miles. Near Cambridge dykes are numerous; and porphyritic feldspar, much disintegrated, may be seen crossing the public road.

Near Fellowship Meeting House, I examined, in company with my friend, Dr. Barratt, a continuation of this dyke. It is quite hard, and contains embedded crystals of flesh-colored feldspar. I have received recently from the doctor, beautiful specimens of this rock, covered with dendritic crystalizations of oxide of manganese.

There are other rocks which, from having a similar origin, are placed here: among these the most important is *sienite*, which has been defined as a granite, with hornblende substituted for mica. So far as I have observed this rock in South Carolina, it appears to be, with a few exceptions, always intrusive; and in all its relations to other rocks, very similar to trap.

In the vicinity of Abbeville Court House large masses of this rock occur above the surface, and are composed principally of grey feldspar, black hornblende, and quartz—bearing a striking resemblance to the well known Quincy granite. Blocks of this rock are scattered along the surface, marking the course of the dyke to which they belonged. In the immediate vicinity other masses occur, in which the hornblende predominates.; the feldspar has a lighter color, and the quartz has nearly disappeared. This variety is known as hornblende rock. This rock occurs in Pickens, and it is only mentioned here because, from its dark color and great weight, it was taken for iron ore.

In other localities in the State the feldspar is white, which contrasts strongly with the black feldspar.

In the N. East corner of Lexington I saw some porphyritic sienite, that was taken from a well, which may be a continuation of the Montecello sienite, already mentioned. On the plantation of E. G. Palmer, Esq. a dyke occurs of great interest, from the light it throws on the origin of this rock. The dyke has embedded in it angular fragments of hornblende slate, of various sizes, evidently torn from the rock which it intersects, in its passage through it, in a molten state. The rock resembles a coarse breccia, and would be a beautiful ornamental building material.

A sienitic vein occurs three or four miles from Smith's Ford, Broad River, York District, which deserves notice, from the fact that it is intersected by veins of quartz, which have been worked for gold, to a depth of twenty feet. At Meansville, Union District, a sienitic granite occurs, upon which the slates of that region rest, as may be seen at the Fair Forest mines, as well as at those of Nuckols and Nott, near Pacolet, where the rock is intersected by auriferous veins.

Eurite, which is a compound of quartz and feldspar, is found in many localities, forming conspicuous veins. In the village of Edgefield one is found, which furnishes, by disintegration, a fine, white sand. And, near Abbeville Court House, Mr. Speirin pointed out to me a fine locality of porcelain clay, derived from this rock. North-west of the village I saw another vein, which contained garnets.

The dykes of the State present many illustrations of the igneous origin of trap rocks. In the vicinity of some of the dykes of Edgefield, the clay slates are altered to porphyry. At Hale's mine the slates are converted into a black scoria to the distance of four or five inches from the walls of the dyke. In Chesterfield the New Red sandstone is altered to a hard, black, compact rock, and portions of it resemble over-burned brick. The bituminous coal of the New Red in North Carolina, is converted into anthracite, wherever it is intersected by dykes.

The dislocations and disturbances produced by the intrusion of the trap rocks, are rarely, in this State, sufficient to throw any obstructions in the path of the miner. The beds of magnetic iron ore, of York District, are sometimes dislocated by dykes, without producing any off-cast of importance. Many of the beds and veins in the gold-mines are intersected, and completely divided, by dykes, without producing any displacement, or in any other way affecting the productiveness of the mines.

Mineral Contents.—The trap rocks of the southern portion of the Atlantic slope are singularly destitute of minerals of even scientific interest. Large quantities of magnetic iron ore, in the form of black sand, are washed out of the decomposing trap of Chester and Abbeville Districts. In Chester I found masses of compact magnetic ore, near Cornwell's, that indicated a vein of considerable size; but no further examination was made. The wacke which occurs at Durn's, on Hardlabor Creek, near the Edgefield line, is easily dressed, and may be useful for a variety of purposes; but I imagine that it will not stand the fire like soap-stone, which it resembles.

CHAPTER II.

Stratified Rocks.—Gneiss.—Hornblende Rock.—Mica Slate.—Limestone of the Gneiss.—Limestone of the Mica Slate.—Quartz Rock.—Iron Ores.—Magnetic Ores.—Specular Ores.—Brown Hematite.—Bog Ore.

After this brief survey of the unstratified and igneous rocks of the State, we have next to consider the relations and extent of the stratified rocks, beginning with the metamorphic series.

Gneiss, it will be recollected, is, like granite, a triple aggregate of quartz, feldspar, and mica—these ingredients varying very much both in size and proportion. In the southern portion of the primary region of the State, the strata composed of this rock are thin, fine-grained, and very distinctly stratified. As we proceed upwards towards the mountains, as a general rule, the rock becomes coarser, more feldspathic, and very frequently porphyritic—having large, lamellar crystals of feldspar embedded, which frequently preserve a certain degree of parallelism of their axes. It is less subject to disintegration than the unstratified rocks of the State, and, when weathered, the feldspar, and not the quartz, is found in relief on the surface, after the other constituents have crumbled away. Among the mountains of Pickens gneiss is sometimes seen with the feldspar lenticular, as if compressed between the laminæ of the rock, or as if it had been introduced during the consolidation of the rock, and had thus pushed the layers of mica apart. Gneiss is often much contorted, and where the mica is black and the other constituent minerals of a light color, the appearance presented by the rock is striking. Localities of this variety may be seen at Morton's Mill, on Long-cane, Abbeville District, at the Mountain Shoals of Enoree, and higher up, at Van Patton's Shoals.

Fig. 13.

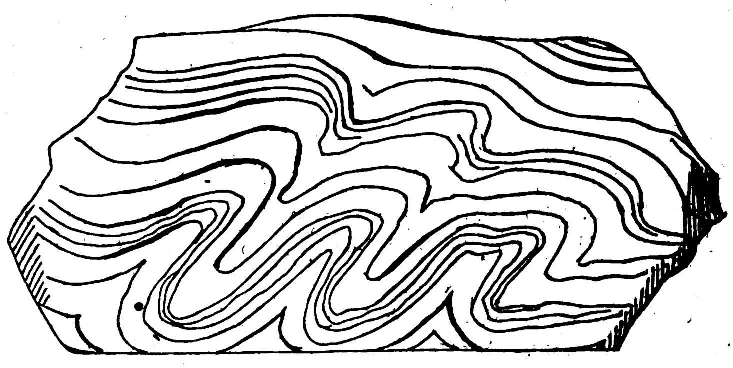


Fig. 13 represents a specimen of contorted gneiss, from Long-cane. Such an effect as this can only result from lateral pressure, while the rock was yet yielding.

Of all the metamorphic rocks, gneiss is best developed in South Carolina; for, although its continuity is often interrupted, by the protrusion of the underlying granite, or the alternation of

From Cæsar's Head there is a magnificent view, having Table-rock directly in front, brought out against a back-ground of mountains that fade away into the blue and far distance. To the left the eye wanders far and wide over the plain of foliage below; and from the right the hum of a little stream is heard, as it takes its fearful jump over a ledge of rock on the side of the mountain.

Returning about a mile down the mountain to gain a point from which the base of the rock is accessible, I found thin hornblende slates—proving the continuity of the beds of this rock, that underlie the escarpment on Glassy.

After a pathless and toilsome ramble of four miles, over rugged masses of rock, accompanied by my young friend, Oscar Lieber, I reached the base of the rock, which is protected from further undermining by the talus which it has formed of its own ruins.

From the Saluda to Table-rock a similar section is presented, with the exception that the slates occupy a greater space.

At the foot of the mountain a coarse, feldspathic granite, with veins of porphyritic granite, occurs, which seems to have produced a fold in the overlying rocks: the usual S. E. dip, however, prevails to the top.

The enormous mass known as the Table-rock stands on the summit of a mountain, on the west side of the valley of the Saluda. A terrace passes round the base of the rock, made up of loose fragments that have fallen from above, making a slope that extends into the valley, and which completely hides the mountain side. From this terrace the relation of the underlying rocks to this stupendous mass, can be better examined than elsewhere. The rock itself is undoubtedly an outlyer from the stratum at Cæsar's Head, and which is found capping the entire range.—The escarpment exposed by this rock is vertical or even a little overhanging, and measures, as I was informed, in perpendicular height, 800 feet. It rests unconformably upon the edges of the hornblende slates already mentioned. The dip of the latter is 30°, while that of Table-rock is not more than 10° or 15°. The exact line of junction of the two is not well defined, although in the space of a yard or two the passage from one to the other may be observed. The hornblende slate is seen running up into the gneiss in wedge-shaped beds.

The face of the escarpment is east and west, while the strike of the strata is N. 30 E. so that the dip can be observed sufficiently well at this place. At the east end of the rock the slaty strata are well exposed, for they are not yet covered by the fallen fragments. At this point the dip is S. E. 30°.

On the top of the rock I found beds of hornblende slate, another point of identity between it and Cæsar's Head, on the summit of which similar beds occur. On the brow of the rock channels of considerable depth are worn by the drainage-water, which, in its descent, is divided into drops, presenting the phenomenon of rain; and on the terrace, immediately beneath the highest point of the rock, is a clear pool of water, supplied from this source.

Leaving this interesting locality, for the present, we pursue our route along the base of the Estato, to Jocassa Valley, where the White-water takes its headlong leap down the slope of the enormous beds of gneiss which we have examined elsewhere, and which must be, at these falls, at least three or four hundred feet in perpendicular height. At the lower falls the rocks are shelving, caused by the giving way of the more destructible underlying rocks. In the centre, where it has been exposed to the full force of the stream, the rock is more worn than on the sides, which gives it the form of a horse-shoe. Very large pot-holes are worn in the surface of the rock, which in some instances is completely perforated, and the water finds a passage through the fissile rocks below.

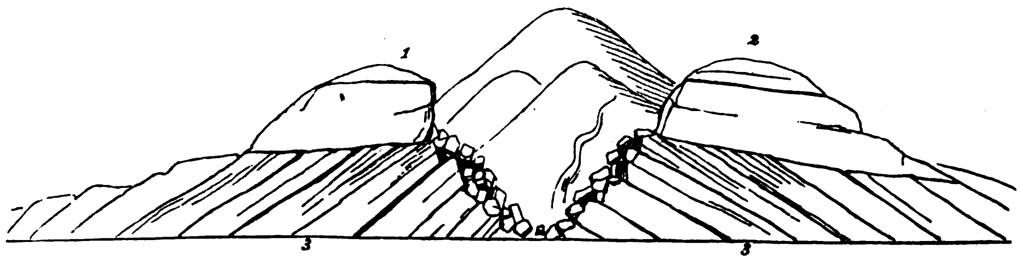
From the moment we enter this beautiful valley till we reach the foot of the falls, we have, on our right, the outcropping edges of the gneiss, like an enormous wall, high above the tall hemlocks that cover the sides of the mountain.

It is quite obvious that all these mountains are due to this enormous and indestructible stratum of gneiss: they have very generally a vertical side turned towards the S. E. and on the opposite side the ascent is often quite gradual. One may ride a horse to the summit of White-side, one of the loftiest peaks of the ridge, but on the other side it requires some nerve, even to look down. We have here the anticlinal axis of the Blue Ridge, and at our feet the waters that flow into the Gulf of Mexico separate from those that take their course to the Atlantic.

The direction of this axis coincides with that of the valley of the Saluda, which separates Cæsar's Head from Table-rock, so that we have these mountains on opposite sides of this axis, and dipping in contrary directions, leaving no doubt that they were once continuous.

The section, Fig. 15, across the valley of the Saluda, represents the structure of these mountains:

Fig. 15.



1.—Table-rock. 2.—Cæsar's Head. 3.—Underlying slates.

The difference of the angle of inclination between the lower rocks and the overlying thick beds, is due to two distinct uplifts, separated by an interval of time sufficient for the deposition of the thick upper stratum.

When the slaty strata were first elevated they had a dip of about 20°; the superincumbent beds were then deposited upon their upturned edges; the whole was now elevated to its present position, or about 15° or 20° more. During such movements as these vast fissures and gorges would occur, through which air and water would be admitted to the destructible beds below; their disintegration would follow, and the overlying rocks would be left projecting, till brought down by their own weight; the debris would form a talus, which, in time, would reach the top of the destructible beds, and protect them from further encroachment—presenting one of those beautiful balancing of forces so common in nature. Such a cause as this may be found yet in operation at the S. E. corner of Table-rock: where the inferior slaty rocks are not entirely protected undermining takes place, and vast pieces of the rock have fallen at no very distant period. At Cæsar's Head a mass has separated from the main rock, to the distance of three or four feet, and a little more wasting of the rock at the base will cause it to come down.

Another mode in which the destruction of these rocks takes place, is the separation of thick slices from the face of the escarpments, by what may be termed exfoliation on a grand scale. Both at Cæsar's Head and Table-rock immense tablets may be seen standing erect, as they dropped from the face of the rocks.

Towards the West, beyond the Jocassa Valley, the mountains, capped with these enormous strata, leave the State and are succeded by a series of hills, covered with mica slates.

Hornblende Slate.

This rock, which is a slaty compound of feldspar and hornblende, is often found passing into gneiss, and alternating with it; and, although it occupies no very great or continuous area in the State, it holds quite an important place in relation to the soils of the Districts where it occurs.—The connection of this rock with gneiss has already been shown, and where they alternate the latter rock always assumes a slaty structure. All rocks containing hornblende are, in a peculiar degree, subject to disintegration, from the decomposition of that mineral. It generally occurs in fissile beds; it is sometimes quite tough, and the feldspar is often absent. Along the base of the mountains, from the upper part of Spartanburg District to Oconee Station in Pickens, a wide belt of this rock occurs. It passes into a slaty hypersthene rock, which may be distinguished by its bluish, bronze lustre. About ten miles north of Greenville a strip of hornblende slate may be traced east, to the branches of Tyger, and from Pendleton to West Union alternations of the rock occur nearly all the way. There are numerous other localities, some of which will be noticed in another place; but it would be tedious, as well as useless, to enumerate all the isolated patches of this, and other rocks, that are scattered over the State.

Mica Slate.

Judging from the wide-spread localities of this rock, it must once have occupied no small portion of the upper part of the State. It is found in spots of limited extent, from the Tertiary boundary to the mountains. It alternates with gneiss and hornblende, but it is not before we reach Pickens that we find it occupying any considerable portion of the surface of the country. In the N. W. corner of the State it is the prevailing rock, and has given a soft and rounded character to the hills of that region, which, instead of the long ridges of the gneiss, appear in the form of smooth, rounded knobs. Very similar to this is the region around the Cowpens, in Spartanburg District. The surface is covered with small, lenticular bits of quartz, coated with mica, which are left after the finer particles are washed away. The Districts where mica slate prevails, although undulating, are rarely so much broken as those Districts where the other rocks abound, for the reason that it is not so easily disintegrated. There are several little mountain knobs scattered over the State, which are principally composed of this rock, such as Ruff's Mountain, Gelkey's Mountain, and Henry's Knob; but these, and other localities, will be noticed in another place.

Mica slate is found passing, by insensible degrees, into talcose slate, by the substitution of talc for mica; when both minerals are found in the same rock, it is called talco-micaceous slate. This and the talcose slates are confined to that portion of the State known as the gold region, and to the belt in York and Spartanburg that contains the magnetic iron ores. The finest specimens of talcose slate are found near Cherokee Ford, associated with the ores of that locality, and at Hale's mine, in Kershaw. In Lancaster it passes into talco-micaceous slate, which is the gold-bearing rock of the District. In describing the gold formation the precise limits of these rocks will be defined more particularly.

Associated with gneiss and mica slate are beds of limestone, which may properly be described here.

Lime-rock of the Gneiss.

In Laurens, on a small stream, about a half mile below Ware's mill, on the Saluda, this rock is seen outcropping between ledges of Gneiss, which appear both above and below it in the bed, and upon the banks of the stream. The strike of the rocks at this locality is N. 30° E. and the dip S. E. 40°. Of the thickness of the bed of lime-rock, about fifteen to twenty feet are exposed, rising above the water; but as the stream flows along the strike, and has worn away the rock to the level of its bed, and covered, on the opposite bank, the rest of the stratum, it is difficult to ascertain its entire thickness. Nothing has yet been done to develope its extent, for the quarrying, so far as it has proceeded, has been confined to the most accessible portions of the rock—the mere outcrop.

With the assistance of Dr. Waits, who discovered this locality, I was enabled to trace the outcrop from sixty to eighty yards up and down stream.

The rock is white, compact, and crystalline, and from its situation almost on the banks of the navigable portion of the Saluda, it must, at no distant period, become highly interesting to the Districts on the river between this point and Columbia.

On a branch of Walnut Creek other exposures occur, being evidently prolongations of the stratum just examined. The character of the rock is, in every respect, similar, and the indications of its extent equally favorable. On Clurdy's land the rock rises ten or twelve feet above the level of the creek; and on Wait's there are two or three other localities. A slight excavation made here exposes the surface of the rock, which is much water-worn, and even excavated into pot-holes. Small veins, containing actinolite, pass through the rock, and occasionally streaks of chlorite are seen, contrasting finely with the white color of the base. So that it is probable handsome slabs of marble, for ornamental purposes, will be found at this locality, when fairly explored. A few miles distant, and in the direction of the strike of these beds, it is exposed again on the left bank of one of the branches of Reaburn's Creek, where rock has been quarried and used for the manufacture of lime, to some extent. At one of the quarries the rock may be examined to advantage, near the lime-kiln, where it is interstratified with gneiss and soap-stone. A few hundred yards from the creek, and at the foot of the hill, a bed has been explored: it is a crystalline, compact, blue rock, of much better quality and of greater thickness. But in every case care should be taken to select for burning only the unmixed portion of the bed.

Above the bridge the underlying beds are exposed over a considerable space, on the opposite bank of the stream; they have but little economic value, being nothing more than gneiss, containing, among its other constituents, calcareous matter. They prove, however, that the beds of lime-rock are contemporaneous with the gneiss in which they occur; that the calcareous matter was held in solution or suspension in water, as were the constituents of the rock, and that they were deposited under similar circumstances, the calcareous matter gradually accumulating, until it constituted the entire mass of the deposit to a considerable depth, and then disappearing in a similar manner, being replaced by the quartz, mica, and feldspar of the gneiss.

LIME-ROCK OF THE MICA SLATE.

The most noted as well as the most extensive bed of lime-rock in the State occurs at the Limestone Springs, in Spartanburg District. This bed is found near the junction of the mica slates and gneiss, and is exposed, like every bed in the State, on the banks of a stream. It is laid bare for two or three hundred yards on the outcrop, and to nearly half that distance across the stratum, in the bed of the creek. At each extremity it passes into a hill, by which it is hid, and it is only seen where the superincumbent rocks have been washed away—even then it appears but little elevated above the surface, excepting at one extremity, where it seems to rise on the hill side. The rock is blue, rather compact, and stratified; but at the western end of the exposure it is white and clouded, forming a handsome marble. This portion of the bed is smooth on the surface and grooved in lines corresponding with the dip, giving the rock the appearance of the "*slickensides*," so often seen among the slates. At another locality I observed the same appearance in the quartz rock, as if exhibiting a tendency to a coarse crystallization. And as a bed of this rock overlies the limestone, I suppose it impressed this peculiar structure, while cooling upon the more yielding lime-rock.

A few miles distant, but in the direction of the strike of this rock, two localities occur—one on the land of Mr. Watkins, and the other on Dr. Otterson's plantation, adjoining it. At each of these localities the rock has been quarried, but, as usual, only on the outcrop, and not sufficiently to develop its extent. At one of these localities the rock is blue, and at the other white and crystalline, and passing into hornblende rock towards the top of the bed. At Watkins's the rock passes under a bank of loose materials of considerable thickness, but at Dr. Otterson's it is exposed on the surface, up and down stream, for a space of a hundred yards or more.

Between the Limestone Springs and Broad River another locality may be seen, where the rock is quarried for the use of the iron-works. It is entirely below the surface, and has been explored below water level. It seems, however, to rise in the hill toward the West, and should be pursued in that direction—keeping, at the same time, the present level open. The rock at this place is blue and intersected by veins of calcite.

Lime-rock is found on Cherokee Creek, but so impure, from mixture with the rocks in which it is found, that it is almost useless for all economical purposes.

On the opposite side of the river, in York District, this bed may be traced. Where I examined it, on Black-rock Creek, it was much mixed with talcose slates, and consequently of little value.

There must, however, be another locality at this place, where rock has been quarried for burning lime.

Between the river and King's Mountain numerous excellent localities are known, and some of them are explored to furnish lime for architectural and other purposes. They occur on or very near an anticlinal axis, and dip between vertical and 30° towards the N. W.

Throughout this entire region the limestone is confined to comparatively low situations, a level to which they have been reduced by the denudation under which the whole country suffered. The thickness of the beds towards the North varies from ten to one hundred yards—so far, at least, as they are exposed; but where the country, for the greater part, is covered with a dense forest, it is evidently impossible to ascertain the extent of these beds.

In the mica slates of Pickens at least two distinct strata of limestone are found.

On the Georgia side of the Tugaloo, on Panther Creek, about three miles above its mouth, a fine exposure occurs, where the rock is seen rising boldly and outcropping on the hill side. Strike N. 15° E. dip S. E. 45°. About forty feet of this bed is pure enough for any purpose—the rest is mixed with the associated rock. Following the direction of this rock along the old Indian line, in Pickens, we find it again on Brass Town Creek, nine miles from its mouth, near the head of a long, narrow valley. Thickness of the bed, twenty feet—strike N. 30° E. dip 45°. Limestone is found again South of this, on Chauga Creek. A kiln was erected here, many years since, and the limestone was taken from the side of the creek, in a narrow valley; but the debris from the hill sides have fallen down and covered every thing in such a manner that I could barely satisfy myself of the existence of limestone at this place.

That many more promising localities than those already known in this interesting portion of the State will be brought to light, when the country is settled and the land cleared, no one can doubt.

Quartz Rock.

The rock designated by this name is readily distinguished from common or massive quartz, so abundantly scattered over the State, generally by its granular structure, and always by the distinct planes of stratification which it presents when seen in large masses. It seems to be the result of the gradual disappearance of the matter forming the micaceous or talcose portion of the rock in which it occurs, and the introduction of a proportionably large amount of siliceous or arenaceous matter, during its deposition; for it is seen gradually passing into mica slate, and it often contains a considerable amount of talc. It is rarely found so completely silicious as not to exhibit scales of both talc and mica, particularly on the surface of its bedding planes. From a solid, compact rock, resembling massive quartz, it passes into an arenaceous variety, so little coherent as to crumble between the fingers. At one locality the weathered surface of the rock presents the appearance of a conglomerate, composed of small spheroids, having their longer diameter in the direction of the strike of the rock, but the hammer soon reveals the true structure, and shows that this appearance is confined to the surface, and that it is probably the first step towards crystallization. Before the consolidation of the rock, the silicious matter, obeying the tendency to collect around centres, formed these spheroidal masses; the iron also contained in the mass, obeying the same laws, collected between the spheroids; but it does not become evident until it is highly oxidised by exposure at the surface, when it is washed out, leaving the small spheroids in relief, on the surface of the rock: yet not a vestige of this structure can be seen in a fresh fracture. Another remarkable structure presented by this rock may be seen on the Union road, near Limestone Springs, where the surface of the stratum is quite smooth, and grooved in the direction of the dip, suggesting the idea of a confused, columnar structure.

The finest example of this rock that I have observed is found on the peak of King's Mountain, forming the great escarpment at its eastern extremity, in North Carolina.

The sharp, irregular and notched outline of the crest of this mountain, when seen from the battle-ground, and which contrasts so strikingly with the softened and undulating contour of the other mountains of the blue ridge, is due to the indestructible nature of this rock, which has preserved its angles and fractured surface as sharp as if it had but yesterday been torn and upraised from its original horizontal bed.

Following the ridge into this State, we find the rock passing into mica slate, but re-appearing again near Broad River. At the head of one of the islands, opposite the iron-works, it may be seen in large rhomboidal masses, which have fallen down, and lie scattered, in confusion, on the surface. On the right bank of the river it rises gradually till it reaches the top of Gelkey's mountain, where it appears as if piled up above the slates, which lie on each side of the mountain. To the north of this other spurs are found capped with this rock, which also present, on their surface, the appearance of a conglomerate. Towards the South-west it subsides with the surface of the country, and re-appears in the talcose slates, on the edge of Union and Spartanburg. It is here quite arenaceous, having barely sufficient coherency to form blocks for the hearthstones at the furnaces—a use for which it is highly prized. Henry's Knob, an isolated little mountain in York District, presents a fine example of this rock, which protrudes in a thick stratum from between the mica slates. Ruff's Mountain, in Lexington, affords another good locality. Both here and at Henry's Knob the surface of the rock is occasionally studded with crystals of kyanite.

The arenaceous quartz, so common in the auriferous rocks of Chesterfield and Lancaster, may be referred to a variety of this rock; but at a certain distance below the surface, beyond the influence of atmospheric agencies, it becomes a true hornstone.

Another remarkable form presented by this rock, is the itacolumite, or flexible quartz, which is found in one or two localities in the State. The most remarkable of these occurs very near the Limestone Springs, about a hundred yards north of the point where the road to Cherokee Ford crosses the Union road. The rock is seen on the way side and extending into the woods, in the direction of the Springs, and can at once be recognized by its smooth and striated surface. On examination portions of the rock will be found to split readily into flexible laminæ, varying from one-eighth to an inch in thickness; the surface of the laminæ being covered with thin plates of mica. It passes even in the same mass into compact quartz, to be distinguished from common quartz only by its stratified structure.

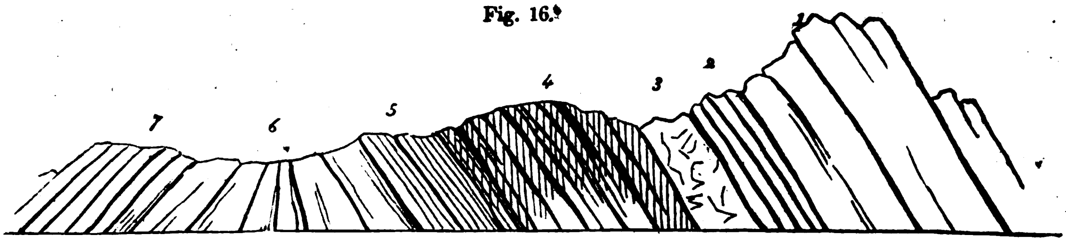
The flexible portions of the rock seem to be in the incipient stages of disintegration, evidently produced by the oxidation of the iron. This rock, in its compact form, is seen surmounting the limestone at the Springs.

The other locality is in Pickens District, between West Union and Oconee Mountain, on the land of Dr. McElroy: It is not very prominent, but may be observed crossing the road, and on a small branch near the house.

Prof. Shepard has recently directed attention to this rock, on account of its connection with the diamond-bearing rocks of Brazil and the East.

In South Carolina quartz rock is certainly associated with the most interesting group of rocks in the State, as will appear from the following section.

Fig. 16.*



1.—Quartz rock of the King's Mountain range. 2.—Red iron ore, to some extent specular, and extending from Gelkey's Mountain to North Carolina—explored at all the iron-works. 3.—Gold ore associated with iron ore. 4.—Grey or magnetic ore, in talcose slates. 5.—Flexible quartz, Itacolumite. 6.—Lime-rock. 7.—Iron ore.

On the North Carolina side a very valuable gold mine occurs very near King's Mountain, and the precious metal may be traced through York, as at Carroll's mine and other localities; in Spartanburg, at Lockhart's and other mines, not far from the itacolumite locality, and thence into Union, to the Fair Forest mines. In Pickens gold is also found in the branch where this rock occurs.

The resemblance between this group and the Brazilian rocks described by Humboldt, is sufficiently striking to invest them with a considerable degree of interest.*

In Pickens District rutile is abundant, but as yet neither platinum nor diamonds have been found in this State, although thousands of the latter may have escaped with the refuse gravel at the gold mines, as hitherto no attention has been paid to the subject.

In the transactions of the Geological Society of Pennsylvania I find the following notice.

"We have just had an opportunity of examining a fine diamond, weighing one carat and a half, recently found in the washings of a stream, in Carolina. It is in the possession of Mr. T. G. Clemson, whose intention it is to favor the society with a more particular account of this discovery. Sept. 10th, 1835."

In 1836 I saw, in the possession of Mr. Simms, a diamond found in the Portis mine, near the corner of Nash, Franklin, and Warren Counties, North Carolina. Prof. Shepard has described, in the American Journal of Science and Arts,† and figured a diamond found in Twitty's gold mine, Rutherford County, North Carolina; and in a paper read before the Association of Geologists and Naturalists,‡ he mentions two diamonds found in a deposit mine, in Hall County, Georgia, one of which is said to be in the possession of Dr. Daniel, of Savannah.

At the latter locality, and in Habersham and Rabun Counties, Mr. Schrieber found flexible quartz. In North Carolina it has been found by Drs. Hardy and Irwin, and in Lincoln by Prof. Olmstead.

The localities in Burke, N. C. Pickens, S. C. and Rabun, Habersham, and Hall, Ga. belong to the same range, and the localities in Lincoln, (N. C.) and Spartanburg, (S. C.) to another.

Speaking of the specimens collected in Rabun, Habersham and Hall Counties, Georgia, by Mr. Schreiber, Prof. Shepard says "several of the specimens collected by him possessed a decidedly secondary aspect; and Prof. S. inferred from the account given him by Mr. S. that in some of the localities its primary character was less certain than at others." This is the first time that I have

* Essai Geognostique sur le Gisement des Roches.
† Vol. II. No. 5, second series.
‡ Proc. Am. As. Geol. and Nat. New Haven, 1845: p. 41.

heard any doubts expressed as to the age of the gold region. Mr. Schrieber describes this rock as "interstratified with talcose and mica slate;" precisely the position which it occupies in South Carolina. In Spartanburg it occurs near the junction of the mica slate and gneiss, having an immense thickness of mica slate resting upon it; and in Pickens it is found in a similar relation.

The term "sandstone," applied to this rock, is calculated to mislead, by suggesting a newer formation: it might, with equal propriety, be applied to arenaceous quartz. "Itacolumite formation" is also objectionable. Quartz rock formation is a well known name, and is sufficiently definite; besides, it is the appellation applied by Humboldt to the same formation in Brazil. The itacolumite is not at all extensive; it is confined to a few localities. I have traced quartz rock in South Carolina, for miles, but the best locality of flexible quartz in the State does not occupy the space of one square yard. It is indeed but small portions of the quartz rock that present this peculiar structure. In this respect, also, it agrees with the South American rocks.

Without advising any one to commence a regular search for diamonds, I have repeatedly recommended those engaged in working for gold, in branch or deposit mines, to collect and examine the refuse gravel, which is seldom noticed, before it is thrown away. The vast deposits in Pickens seem to me to offer the most favorable localities for such examinations.

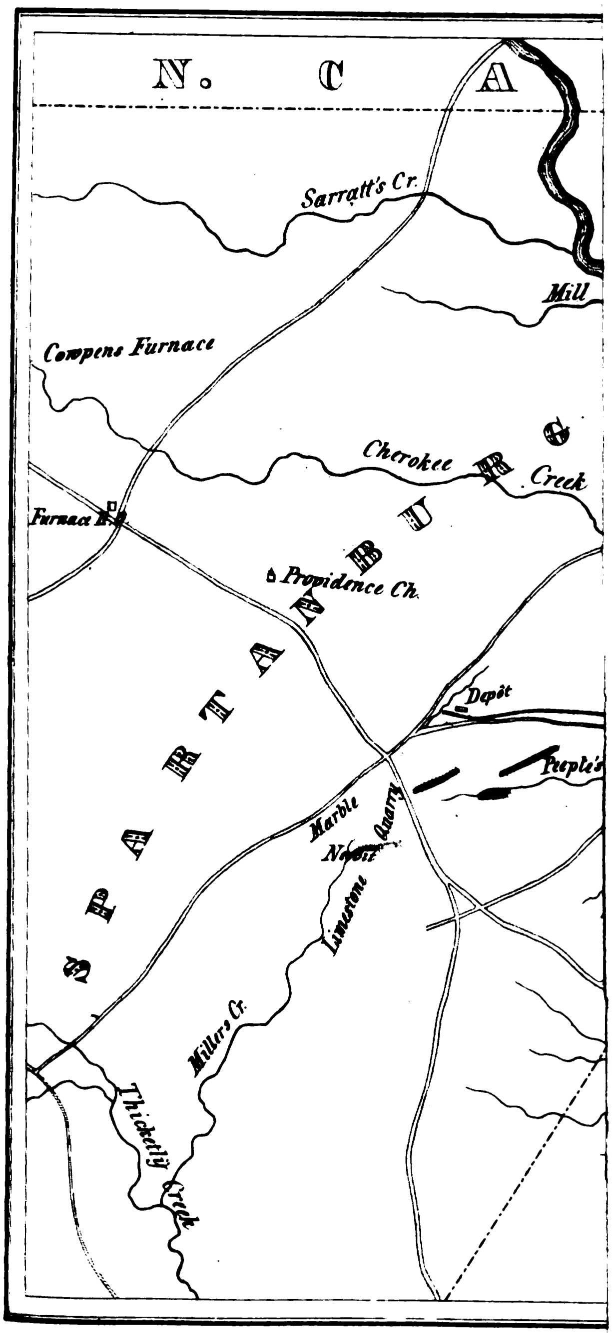
Iron Ores.

The iron ores of the State that have been explored and used at the iron works are the magnetic oxide or grey ore, specular oxide or red ore, and the brown species known as hematite, limonite, or hydrous peroxide of iron. The magnetic and specular ores are chiefly confined to a narrow belt of slates in York, Union, and Spartanburg Districts, extending along the northern side of King's Mountain, crossing Broad River at Cherokee Ford, and terminating on People's Creek, in Spartanburg, a distance of six or eight miles, being underlaid by the lime rock and surmounted by the mica slates of the King's Mountain range. Strike N. 50° E. dip 45° to 70° S. E.

The magnetic oxide or grey ore occurs in a band of talcose slate, which, at its widest extremity, scarcely exceeds one half a mile. It is found in a series of beds between the slates, following their foldings and irregularities—swelling out to a thickness of fifteen or twenty feet, and again contracting to the dimensions of one foot, or thinning out altogether. These beds often occur side by side, separated by a portion of the slate, and so completely insulated that a bed may be worked within a few inches of another without affording any clue to its presence. The thinning out takes place both vertically and horizontally, so that the masses of ore are generally somewhat lentiform.

Through the whole of this range the ore appears to be contemporaneous with the slates, being frequently intermingled with them in such a manner as to make it difficult to distinguish one from the other, excepting by the greater specific gravity of the ore; a circumstance not readily to be explained upon any other supposition than that both slates and iron were deposited together.

The topography of the country, along the iron region, is quite favorable to mining operations, being broken and rather hilly. On the right and left banks of Broad River hills rise boldly, and the ore has been traced, on their sides, almost to the water's edge; yet I have not perceived that any advantage has been taken of this circumstance, presenting, as it does, so many facilities, both as to


N. C A
Sarratt's Cr.
Mill
Cowpens Furnace
Cherokee Creek
Furnace P.O.
Providence Ch.
SPARTANBURG
Depôt
Peeple's
Marble
Quarry
Limestone
Millers Cr.
Thicketty Creek

drainage and other operations connected with the successful exploration of the mines. On the contrary, the ore is taken out along the surface in an open trench, and, with one or two exceptions, only to the depth of a few yards.

A person unacquainted with this ore, and with its mode of occurrence, would be likely to conclude, on examining the country, that the prospect of an abundant supply of ore was not very promising. From the manner in which the ore is mixed with the slates, and its tendency to crumble and break into fragments, it never appears above the surface in solid masses, but is subject to all the causes of disintegration and waste that are constantly acting upon the rocks in which it is enclosed: so that a few rusty pebbles, scattered over the surface, are frequently all that appear to indicate to the practiced eye the rich beds hidden below.

Near Cherokee Ford, in the corner of Union, ore has been extracted, to some extent, to supply the Nesbit Manufacturing Company's works. A short distance north of the ford a fine bed has been opened, towards the hill top; and following the direction of the slates, the ore may be traced along the surface, in parallel beds, some of which have not yet been opened. At one of the beds a shaft has been sunk, and ore taken out, below the natural drainage of the mine. Generally, however, all operations have been confined to within a few feet of the surface, so that the deeper beds remain yet untouched.

On the left bank of the river, at Quin's, ore has been raised on the hill side, at an exceedingly favorable locality. About half a mile farther up the river, on Black-rock Creek, another bed has been opened, which presents greater appearance of regularity in its dimensions than any bed that I have examined. The walls are parallel and the slates not at all contorted. It has just been opened, at the foot of a hill, and should it continue with the same uniformity that it now presents, it will afford a supply of ore almost inexhaustible.

It is probable that this is the lowest level at which ore has been raised in this region, and it is the only locality at which I have observed sulphuret of iron in the true magnetic ores. The ore is black and granular, with fragments that are highly magnetic, and exhibit polarity very strikingly. One or two beds have been opened here, of a considerable thickness, but the ore is of the compact variety, being hard and tough, having a highly metallic lustre, and is not in repute with the workmen. On the top of the hill, near the road, other beds have been explored, to a short depth. The ore is compact and massive, and almost unmixed with foreign matter. Ore to any extent may be raised at these beds at a moderate expense.

Farther on, a few miles, several extensive trenches occur, where ore has been taken out. At one of these a shaft was sunk to the depth of thirty or forty feet. Other beds are explored here very successfully. The ore is of the black and friable variety. The talcose slates extend beyond this a few miles, but they contract and occupy a narrower space, or thin out altogether, towards King's Mountain.

In other parts of the State I found indications of this valuable ore. In Chester District, near Cornwell's large masses of the compact variety are found in hornblende, a rock with which the magnetic ores are often associated. Mr. Speiren, of Abbeville, showed me specimens found a few miles north-west of the village; and on Hard-labor Creek I saw indications of this ore near the bed of peroxide of manganese. Time did not allow me to explore these localities as they deserved, but the proprietors, I trust, will examine them carefully.

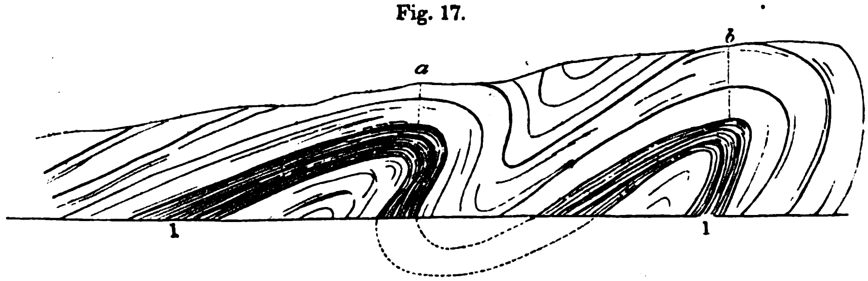
Specular Iron Ore, or Red Hematite.

Immediately overlying the talcose slates containing the magnetic ores, is a belt of mica slates forming the northern slope of King's Mountain, from the North Carolina line to Gelkey's Mountain, in Union District. In these slates we find beds of the red ores, or the specular oxide of iron. To the north of this, and overlying the limestone, in York District, another similar band of slates appears, dipping N. W. and undoubtedly is the corresponding portion of the King's Mountain slates, which were pushed up, and thus appear on the other side of the anticlinal axis, which corresponds nearly with the limestone stratum of York and Spartanburg. These slates also contain beds of specular oxide. On the North side of Gelkey's Mountain we find some beds of ore in the singularly bent slates of that locality—externally black, but having a red streak and powder. This bed has not been explored to any considerable extent, but the openings are sufficient to show that the quantity of ore is very great, and the situation exceedingly favorable, the bed lying on the side of a considerable hill.

Another, and an exceedingly interesting bed, is seen near the furnace. It is two or three feet in thickness, distinctly laminated, and breaks into rhomboidal fragments; but the most remarkable feature in this bed is the transition state in which it seems to exist. Near the surface the ore is red, and rather pulverulent, particularly at the surface of the laminæ. Lower down, or farther into the hill, it becomes grey and somewhat magnetic. Still farther removed from the surface, iron pyrites appears to so great an extent as to lessen the value of the ore very materially.

Following the strike of the beds, we find them again on the opposite side of the river, first at a point near the King's Mountain Iron Works, on Dear Little Creek—a locality which at one time furnished a large amount of ore for these works. It occurs in the state of a red oxide. Along the side of the spur of the mountain that approaches the river, numerous exposures of this ore may be seen on the left bank of Dear Little Creek. A noted and most remarkable bed occurs a short distance north of the meadow branch of King's Creek, which is known as the Bird Bank. The ore has been explored at two points towards the top of a fold in the mica slates, which gives it the appearance of two parallel beds. This sketch, Fig. 17, will illustrate the manner in which it lies in the slates.

Fig. 17.



1.—Bed of ore which has been reached at *a* and *b*, and has the appearance, in the mine, of two beds, one overlying the other.

The ore is black, with thread-like veins of quartz running through it, and in almost every respect resembling the ore near Gelkey's Mountain. The quantity of ore at this locality is immense.

Directly west of this, on Jumping Branch, is the Hardin bank—strike N. 50° E. dip 45° to 80° towards the N. W. This bed is from three to four feet thick, very uniform, both in thickness and direction. The planes of the strata in which it occurs being unusually straight for micaceous rocks. Like the bed already mentioned as occurring near the furnace, on People's Creek, this is regularly interstratified with the slates, splitting readily into laminæ, and presenting every appearance of stratification. Near the surface the ore consists of red and yellow ochres, with harder portions, giving a brown powder and streak—being portions of the bed that have assumed the form of the hydrous peroxide or limonite. For about twenty feet below the surface these ores continue the same; but below that they are grey, showing, however, when indented by the hammer, a reddish streak.—They are also, to some extent, magnetic. At water level pyrites makes its appearance; and even native sulphur is found coating the surface of the fissures in the ore.

This ore is not compact, but rather composed of small, slightly cohering grains, having a grey, dull lustre, excepting where it has been crushed, and there the red powder of the specular oxides is seen.

After a careful examination of the ore of this bed, I am fully convinced that it was originally a sulphuret of iron, or what is known at the mines as iron pyrites; and that if it be pursued to a sufficient depth, it will terminate in that mineral. The shaft sunk on the bed is at present about fifty feet in depth, which is about the level of natural drainage—so that it is placed beyond atmospheric influences.

It is not a little curious that pyrites will resist decomposition, when placed under water, while, if it be exposed to the atmosphere, it is readily acted upon, and reduced to an oxide. Nearly every gold mine in the State offers examples in illustration of this fact. For, wherever oxide of iron is found mingled with the ores, when water is reached, it is invariably found in the form of iron pyrites. At the depth mentioned above the bed is mixed with iron pyrites, and the ore may be traced, through every stage, to the red oxide, of which the bed is composed near the surface.

We have first the sulphuret or iron pyrites, which, by decomposition, becomes probably the protoxide, a portion of which combines with another atom of oxygen and forms peroxide, the mixture of the two now existing together, producing the magnetic oxide. The remaining protoxide is converted into peroxide, and the whole is now the specular oxide or red ore which we find towards the surface. And if, during this change, water enter into combination with the ore, we shall have the hydrous peroxide, or brown ore which, I have already remarked, is found in this mine. Every step in this process may, in like manner, be observed at the furnace bed, on People's Creek.

With these facts before one, and supported as they are by numerous analogies in other mines, it is impossible to avoid the conclusion that these ores are the result of the decomposition of iron pyrites.

In the same range with the Hardin bank, and north of the lime-rock, this ore is exposed on the surface, although I believe it has not been explored.

Hydrous Peroxide, or Brown Hematite.

This ore is perhaps more widely distributed than any of the ores of the State. It is principally confined to the mica slates of Spartanburg and Pickens, and is the only ore used at the Pacolet

Iron Works. It may be seen a few miles north of the furnace, on Pacolet, both on the surface, and in some pits which were sunk a few feet below the surface. Near the Cowpens it is extensively developed, and for many miles west the surface presents infallible indications of the presence of this ore in heavy beds. It has also been explored in the vicinity of Cherokee Ford, where it is found in beds of good quality. On the Western side of Spartanburg, on the Buncombe road, four or five miles North of Van Patton's Shoals, beds of this ore may be seen cropping out at the surface. In the lower edge of Greenville, at McCord's Mountain, in Abbeville, and at Ruff's Mountain, in Lexington, brown hematite is found; but as no examination has been made beyond the surface, I am unable to say any thing of the extent of these beds.

On Crooked Creek, in Pickens District, some extensive beds are found, which were once worked to supply a bloomery. The ore occurs in irregular beds and masses in the slates, and although it is undoubtedly co-extensive with them, it has not been explored beyond a few feet below the surface. It is a compact clean ore, working freely and making good iron.

I have no where in the State observed iron ore in a true vein, with a single exception, which occurs in the upper part of Pickens, near Oconee Mountain. The ore is fibrous hematite, and is associated with a quartz vein, containing crystals of schorl. I traced this vein over a distance of seven miles, but found it no where of sufficient thickness to be of any economic value. It was quarried at one place, as an ore of some of the precious metals, by the owner, to whom it was pointed out by an ignorant pretender.

Dr. Barratt pointed out to me another locality of this ore, in the lower edge of Abbeville, where it was also explored for a similar purpose.

To this species belong the numerous deposits of ore scattered over the surface, in Chesterfield District, and at the localities in the Tertiary formation, composed of iron and sand cemented into a coarse, ferruginous sandstone. It is highly probable that some portion of these deposits contain a sufficient quantity of iron to be used as an ore; but as the State contains already inexhaustible beds of the very best quality, it is scarcely probable that these deposits will ever be resorted to as sources of iron ore.

Bog Iron Ore.

This variety is found in low wet places, and is deposited from solution in water, aided by the decomposition of vegetable substances. I have found this ore in several localities, in sufficient quantity to be worked. I examined, in company with Col. Gillam, a locality of considerable extent, near the Saluda. It occurs in large and irregular masses, composed of globules of ore of all sizes, from that of a pea to a marble. In many places this ore may be seen upon the surface, ln form resembling shot of various sizes. Near Montecello another locality may be seen, where the ore is strewed over the surface and exposed along a ditch-bank, in a low field. There is scarcely a district in the State where this ore is not found in some form or other.

Clay Slates.

There are few rocks in the State whose limits are equally well defined with those of the clay slates. They are seen on the Savannah, a few miles above Hamburg, where they form bold ledges on the banks, and contain veins of calcspar. At this point they cross the river into Georgia. From this locality they may be traced, with but little interruption, along the northern verge of the Tertiary, almost across the State. I examined them on the left bank of the Savannah, from Hamburg nearly to the mouth of Stevens's Creek, and along the creek, and between it and the river clay slate is the prevailing rock to the Abbeville line. Near the bridge, on the creek just named, fine exposures occur. It has been removed by denudation from the ridge on which Edgefield C. H. stands; but N. E. towards Martin Town, it abounds; and on the road from the village to a point within a few miles of Cambridge, it covers the surface nearly the whole way. On Little Saluda and on the Eastern side of the District there is scarcely any other rock. In Lexington, on Dutchneck, and on the right bank of Broad river, it is exposed in bold sections. North of Columbia, on the Fairfield road, and towards the river, it may be seen. In Chesterfield it is the first rock that is found emerging from under the sand of the Tertiary, and thence continues to Clay Creek, in the north-eastern part of the District, where it sinks under the New Red sandstone.

It will be seen, from this brief sketch, that it is confined, as I have already stated, to a band of irregular width, overlying the slates at the verge of the beds of clay, sand, and pebbles that form the lower Tertiary beds of the State. On the surface it is, like the other slates, soft and disintegrated; but where the streams have cut into it to any depth it is hard, and frequently silicious.

CHAPTER III.

Gold Formation.—Deposit Mines.—Deposits of different ages.—On the Blue Ridge.—Tomassic Valley.—Of Tyger and Little River.—Gold Mines of York.—Fair Forest Mines.—Catawba and Lynch's Creek Mines.—Hale's Mine.—Brewer's Mine.—Smith's Ford Mines.—Mines of Abbeville.—Of Greenville.—Of Pickens.

I believe that it is now satisfactorily settled that the gold formation of the United States is confined to a band of schistose rocks, extending from the Rappahannock, in Virginia, to the Coosa River, in Alabama. In North and South Carolina and Georgia, where the auriferous rocks are best developed, they seldom exceed a breadth of sixty to eighty miles. Talcose rocks abound so much throughout this region, that they have been considered the only true gold-bearing rocks; but gold is found in veins in granite, sienite, gneiss, hornblende, and mica slate, both in North and South Carolina.

On the gold-bearing rocks of Virginia an elaborate report, by Messrs. Taylor and Clemson, will be found in the first volume of the Transactions of the Geological Society of Pennsylvania.

The mines explored for gold are of two classes, "deposit" or "branch" mines, and those to which the miners give the name of "vein mines," in which the precious metal is found in the solid rock.

The "deposit or branch mines" generally consist of beds of gravel, and pebbles of quartz, frequently water-worn and rounded, but sometimes angular fragments are intermingled in the beds. They are confined to the beds of streams in valleys and low places, but very often the soil on hill sides is washed for gold. They vary in thickness from two to ten feet, although the auriferous portion seldom exceeds two or three feet.

The gold is not scattered indiscriminately through these beds, but is found very generally near the bottom, resting upon the underlying rock, which, if at all disintegrated, the miners call slate, although it is frequently granite. Occasionally beds of clay, sand, or gravel are interposed between the gold-bearing beds. The space covered by these deposits is frequently quite considerable. In Tomassic Valley a deposit occurs covering an area of many acres; and on one of the branches of Tyger a mine of this character occurs, extending a mile in length, and having a breadth of 100 yards. At this locality the auriferous gravel varies from eight inches to three feet in thickness, and is overlaid by a bed of pebbles six to eight feet thick; the whole occupying a flat between two hills, and covered by a fertile soil of considerable depth. This interesting deposit rests upon mica slate, having a very irregular surface, and exhibiting unequivocal marks of the action of water.

Although these deposits occur upon the banks of streams, yet it is quit evident that these streams, for the most part, had no agency in their formation. The quartzose pebbles, rounded and polished as they are, by attrition, and spread over a large area, cannot be referred to the action of causes at present in operation in the State. Other deposits there are, composed principally of angular fragments of quartz, intermingled with the ruins of rocks from adjoining hills, which can generally be traced to their original site. Such deposits as these belong to the present era. Indeed the operation of the formation of such may be seen in the vicinity of the mines that are situated on hill sides. The small veins that appear at the surface are broken down and washed, together with portions of the slates, by the rains, into the ravines and low places at the base of the hills.

The deposit mines, then, as regards age, may be referred to two distinct periods: those consisting of beds of rounded and water-worn quartz pebbles, of various sizes, but seldom exceeding six inches in diameter, and generally corresponding in size with fragments into which the quartzose veins of the slates break by their natural fissures. These constitute the most extensive beds in the State. Many such are found near the summit of the Blue Ridge, and in such positions as to preclude the possibility of the pebbles being rounded and transported by any stream or other aqueous force that could have existed since that region received its present form.

The gold of those older deposits can rarely, if ever, be traced to its original source in the veins in place. Partly, no doubt, from their being transported from a great distance, and partly from the total destruction of the veins, by denuding forces.

A very interesting example of this sort occurs upon the summit of the Blue Ridge, where the western waters are divided from those that flow into the Atlantic. The deposit is composed of rolled rocks and angular pieces of feldspar, with garnets torn from the adjoining rocks. The whole deposit bears evidence of having been brought from the opposite or northern side of the mountain.

The Tomassic beds: those on the Tyger, already mentioned, belonging to Mr. Carson, are of this character. At the foot of Poor Mountain, and at Rankin's, on Little River, similar deposits occur. At none of these localities could the existing streams have had the slightest agency in the deposition of these beds.

Independent of the comparatively level surface over which the materials of these beds have been transported, and the size of the pebbles, there are other indications that show that the transporting current must have been a rapid one. It is found that where a deposit occupies a depression, and the hills approach, so as to cause the deposit to contract, it is usually found richer below this point. For the water, after passing this barrier, would suddenly expand and lose its velocity, and would consequently have its transporting power lessened, and the gold impelled forward would be deposited. Where depressions occur in the underlying rock, the deposit is found richer in such places; the eddies formed by these obstructions causing the gold to be deposited.

In almost every mine there are peculiar indications known to the miners as favorable or otherwise. At Mr. Carson's the presence of schorl is considered fortunate; and Col. J. E. Calhoun showed me an interesting specimen, consisting of a crystal of schorl containing gold, found in his mine on the Estatoe. At other places the existence of ferruginous matter in the deposit is a favorable indication. It is difficult to conceive how there could be any difficulty in accounting for the gold in these deposits, even if it were not so often traced to the original veins from which it was derived.

The beds of more recent origin are known, as has been already observed, by the angular fragments of quartz that predominate in them. Nearly all the "vein mines," in the State have been discovered by tracing these beds to their sources. Not unfrequently the veins occur but a short distance from the deposit, as is the case with those in the vicinity of the "vein mines," worked at present. Sometimes the soil, in certain localities, contains gold in sufficient quantity to pay for collecting it; and when exhausted it often happens that not a vestige of a vein is found. A rich deposit of this description was worked near the Limestone Springs, but was soon exhausted. In such cases as these the gold was disseminated in the slates and not in veins. And as we know that both veins and beds thin out and disappear, it is not strange that they should not be found always accompanying the deposits.

To this class of deposits must be referred all those around the vein mines; the deposits worked in Abbeville, on Estatoe; on Lawson's Fork, in Spartanburg; and in Cherokee Valley. The latter is a most interesting locality, where the materials of the deposit present a complete view of the geology of the mountains on each side—being composed of precisely the same rocks. The gold is traced upwards in the bed of the stream, after the usual fragmentary beds have disappeared, and nothing remains but masses of gneiss that have fallen down from the mountain sides, and among which gold is found.

The gold of the branch or deposit mines occurs in irregular particles, more or less water-worn, and of larger size and greater purity than the gold extracted from veins. The mines in which the gold is extracted from the solid rock admit also of division: those in which the precious metal is found disseminated in the slates, or in beds between them, and called by the miners "slate mines," and those in which the lodes are true veins. To the former belong, for the most part, the mines of Chesterfield, Lancaster, and some of the Fair Forest mines, in Union. And to the latter class belong Nott's mine, Nuckols and Norris's mine, those near the Limestone Springs, and the mines on the Broad River, near Smith's Ford.

These mines are comprised in two parallel ranges. The one extending from King's Mountain to the Fair Forest mines, and embracing those found along the iron and limestone belt of York, the mines in Spartanburg, and those on the Pacolet and Fair Forest, in Union District. The other range extends through Chesterfield into Lancaster, the southern extremity terminating in Kershaw District, near Sawney's Creek, and in York District, near the Catawba.

Other scattered mines are found beyond these limits, such as the vein on Wildcat Creek, in Greenville District, and those on Allison's Creek, in York.

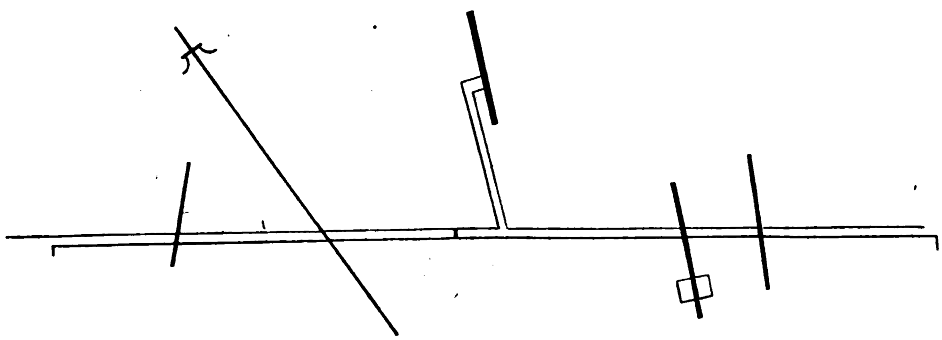
In the King's Mountain range the first mine, towards the North, on King's Creek, is a very remarkable one, being nothing more than a bed of rather poor iron ore and common quartz, about three feet thick, in mica slate. The gold is not disseminated throughout the mass, but is confined to certain portions of it, in which small quartz veins abound. The gold is found, however, in the ferruginous portion of the bed. The iron is hematite, and bears a strong resemblance to the other ores of iron in this range.

In many respects this mine bears a strong analogy to an interesting one in the immediate vicinity of the mountain, on the North Carolina side, where the gangue consists of yellow oxide of iron, with some quartz; the only important difference being in the thickness of the bed, and in the occurrence of the iron as a yellow ochre. Gold has been found in other places in this range, associated with iron ore: as, for instance, near the Bird Bank, and between this point and the iron works.

In *Lockhart's Mine*, which occurs near Limestone Springs, the gangue is coarse common quartz, very irregular in thickness, and cutting the mica slates a little to the East of the strike. This vein, judging from the surface rocks, bids fair to be productive, but hitherto it has not proved so in the extraction of the gold from the gangue.

Nuckols and Norris's mine, a few miles above Grindal Shoals presents one of the very best opportunities of examining the gold-bearing quartz veins, in their relation to the rocks which they intersect. This mine occupies the top and side of a hill, and is therefore exceedingly favorable as a mining ground. A thin stratum of mica slate, in which the veins were first detected, caps the hill and rests upon granite, much disintegrated and decomposed. On the hill side, in this soft granite, an adit level has been driven a distance of eighty feet, which intersects at least some of the veins which are exposed on the surface, showing that they extended from the granite upwards, through the slates.

Fig. 18.



A horizontal plan of this mine is presented (Fig. 18) which shows the relative position of the lodes cut by the level. They are represented by the dark lines crossing the level. They vary in thickness from one to six feet. As this level was driven with a view especially to exploration, the lodes have not been followed, to any extent, beyond what was merely necessary to prove them.

Fig. 19.

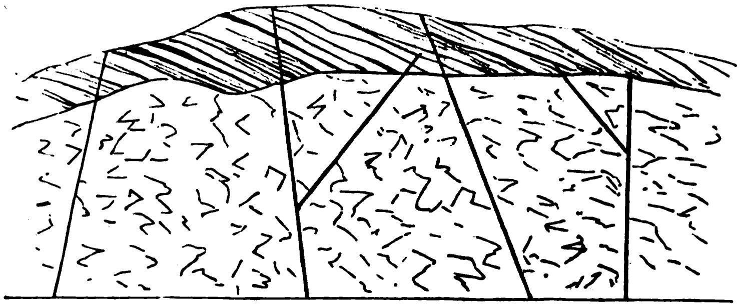


Fig. 19 is a vertical section of a portion of the mine, showing the lodes passing upwards through the granite and overlying slates. The veins must branch, for they are more numerous on the surface than would be indicated by the number cut in the drift below.

This is almost the only mine in the State where any attempt at regular mining has been made. The whole presents a workman-like appearance that was not a little refreshing.

The granite, which is somewhat sienitic, is exposed in the beds of the surrounding streams; but, unlike that in the mine, which may be excavated with a spade, it is quite hard, and this change must be looked for in the mine, when the workings reach so low a level. I do not, however, expect any change to take place in the lodes, which are of massive quartz, and therefore not subject to the alterations that occur in slaty lodes at various levels. If the efficient system commenced here be pursued, it will be productive of much good, both in the development of the mine itself, and the light it must throw upon the structure of the gold mines of the State.

The phenomenon of the passage of auriferous veins through granite, I first had the pleasure of seeing at the Maxwell mine, near Charlotte, in North Carolina. Here beds in the slates were explored near the surface and towards the summit of the hill; a level was afterwards driven near the base, in order to intersect them at a greater depth; veins of quartz and iron pyrites were soon detected, and were thought to have connection with the explored beds on the hill top. I soon found that this was not the case. The rock penetrated was granite, quite soft, while the rock on the hill was talco-micaceous slate. The gold-bearing rocks in these slates were quartzose beds, and not veins. It is true that veins often follow the strike of the rocks, and may be mistaken for beds, but this could not have been the case in the present instance, for the quartzose portions of the beds were laminated and interstratified with the slates, in such a manner as to leave no doubt that they were contemporaneous with them. There must here, then, have been two systems of auriferous rocks; the veins in the granite consisting of quartz, oxide of iron, and pyrites with cavities filled with native sulphur in fine powder and delicate crystals; and the beds in the slates.

One circumstance at this mine it was difficult to account for: the hanging wall of the vein was composed of a thin partition, having a slaty structure, and in every respect resembling the overlying slate, interposed between the granite and the vein. At first I imagined that the slaty matter might have fallen into the interval left between the vein and the granite, on the contraction of the former, but the possibility of this was precluded by the fact that the laminæ of the slaty portion were parallel with the vein, which could not have been the case had it resulted from infiltration from above. Had the vein passed downwards through the slates it might have carried portions of the slate with it, but this was evidently not the case.

Neither could it have resulted from any injection of the granite and veins among the slates, for there was no appearance of disturbance.

A similar phenomenon is presented at the Nuckols and Norris mine, although not to the same extent. The partition of slate accompanying the vein is not so thick, but in other respects it is similar. From a minute examination of these localities, I am forced to the conclusion that this slaty partition is the result of the metamorphic action of the vein, which must have been injected in a melted state. In the homogeneous masses into which both granite and slates are often reduced by decomposition, it is very difficult to distinguish one from the other; and any cause that would produce a slight modification or re-arrangement of the constituents of granite, would convert it into slate.

Some curious mines were discovered a few miles higher up the river, and above Easter-wood Shoals, consisting of talco-micaceous slates, intersected by veins of feldspar, passing into kaolin; the auriferous veins being coarse, crystalline granite. At Littlejohn's, not far distant, on the contrary, the gold-bearing lodes were quartz, and although granite veins were common in the mine, they contained no gold.

Fair Forest Mines.

These mines occur on a creek of that name, north-west of the village of Unionville, and very near the Spartanburg line.

One of the most extraordinary of them is known as Nott's mine, which consists of an enormous and irregular vein of quartz, in some places forty feet thick, crossing the slates at a small angle—dip. 45°. The slates near the surface are much disintegrated, having little more tenacity than ordinary earth. A level of about fifteen or twenty feet in depth was worked open-cast, like a quarry, and an immense quantity of ore taken out; but as the greater portion of it consisted of massive quartz, it must of course have been quite poor—a deficiency compensated for by the quantity. At present a shaft, ninety feet in depth, is sunk on the back of the vein, with which it is connected by a short cross cut. Near the shaft the lode is worked to water level, and only the auriferous portion mined. The slates have become harder, and the granite cannot be far distant, for very near the mine it was reached in an adit which was attempted to be driven in the hill side. It was soft, like that underlying the Nuckols and Norris mine. We may look for much important information from those mines where the lodes pass from the granite through the slates. In all mining districts, important changes are looked for, under such circumstances, and the passage of veins from one rock to another, is noticed with interest. It must be observed, however, that it is only true veins, and these, in the gold mines of South Carolina, are generally massive quartz, that we can expect to trace downwards into the lower rocks. Even the slaty auriferous ores are subject to variation, dependent upon changes that have taken place in the slates in which they are enclosed.

For example, the slates which are quite soft near the surface, become hard lower down; a corresponding change takes place in the lodes, which, with the same treatment, become less productive—not generally because the ores contain less gold, but because it becomes more difficult to extract it.

Such changes are quite common and well known, but they are not those to which I alluded above: there the lodes remain the same, massive quartz; but they often become more or less rich, in passing from one species of rock to another.

Not far from this is the mine known as the Harman mine. The gangue is composed of iron pyrites, oxide of iron, quartz, and sulphuret of copper. The vein, though not thick, is very regular, and the ground favorable. It is exposed at the foot of the hill, so that there is ample room for drainage. Besides, the indications of copper are far greater than at any other locality in the State. At the heaps of refuse ore and waste, near the mouth of the pit, a considerable quantity of sulphate of copper is formed by the spontaneous decomposition of the copper pyrites. In the process of grinding and amalgamation, the sulphate of copper was reduced by the iron wheels, and perhaps also during the process of roasting the ore: the copper was of course taken up by the mercury, and it alloyed the gold so that the whole was worth only about forty or fifty cents the dwt. This did not, in any way, affect the productiveness of the mine, yet I believe it, in some measure, induced its abandonment. I trust that the proprietor will again resume the working of that interesting mine, if it be but merely to explore it for the copper, and it certainly contains gold enough to pay the expense of exploration.

A few miles distant from these are the Fair Forest mines proper, and West's mine. They are on a narrow ridge of talco-micaceous and talcose slates, wedged in, as it were, between strata of compact slaty hornblende rock, and thinning out towards the North. They present very few peculiarities to distinguish them from each other.

The precious metal is disseminated in the slates, but confined to certain limits, that may be distinguished by the quartz, which is generally granular and ferruginous, and more abundant than in the unproductive slates. Both portions of the slates are, however, quite disintegrated, so that the mining proceeds with great ease, until a depth of ninety or one hundred feet is attained, when they become quite hard and difficult of excavation.

An adit level was commenced at the Fair Forest mine, but was abandoned long before the gold-bearing beds were reached, on account of the difficulty of the work—although such an adit would have drained the whole hill. No one unacquainted with the subject would suspect that the slates excavated here were the same as those on the surface; the latter being quite soft—yielding readily to the pick; the others tough and flinty, resembling hornstone. The oxide of iron, which gives a ferruginous character to the surface slates, is, in the adit, sulphuret of iron. Very small quartz veins are found, intersecting the hard slates, and I think it probable that the quartzose portion of the top slates may be due to these veins, although they are not so readily distinguishable in the decomposed slates. It is quite certain that the auriferous portions contain more quartz, for they are readily distinguished by the miners by the mere touch.

The mining, as hitherto conducted here, is most deplorable. The ore is taken out in open-cast workings of considerable extent, carried on in the direction of the strike of the beds, and with the dip. When pursued in this way to the depth of a few yards, of course the hanging wall of the mine falls in, and is abandoned; or, if resumed again, it is with difficulty, and much danger.

West's mine, which is adjoining this, has been explored to a depth of 115 feet: it has therefore the deepest shaft in the state. The water is raised by a whim to an adit driven in the hill side, and through which the mine was at first explored. Like the other mines, the slates are soft near the surface, but become hard below. There are here thick beds of quartz, projecting above the surface, but containing little, if any, gold. These beds are very different from those of massive quartz, so common on the ridges in the gold region of Lancaster. They always present the appearance of stratification, and it seems evident that they are the result of the predominance of quartz over the other ingredients of the slates during their deposition. The auriferous part of the slates at these mines have a strike of about N. 10° E. and dip S. E. 70°, and vary in thickness from a few inches to four feet. Here, as elsewhere, excepting in the true talcose slates, the richest gangues are those that are most ferruginous; and even in the true massive quartz veins, that portion that has the most oxide of iron in it, and is most porous, is the most productive. In Nott's mine an exceedingly rich nest was once found, consisting of brown ochre, from eleven bushels of which 3000 dwts. of gold were extracted.

The Bogan mine is a continuation of this group. The slates are interstratified with hornblende slates, and cut by trap dykes, one of which was struck in sinking a shaft. Granite is found in the beds of the stream near this mine.

Deposit mines are worked with greater or less success in the vicinity of all these mines, the gold being washed down, with the debris of the veins and slates, into the little valleys that intersect this region in every direction. Such deposits are readily distinguished from those already mentioned, where the pebbles, &c. have been brought from a distance, are much water-worn and rounded, and bear evident marks of the action of water long continued. Here, on the contrary, the materials consist principally of the same rocks as those on the hill sides and the surrounding country—furnishing an excellent guide to those in search of mines. Nearly all those of this vicinity were discovered by tracing up deposits to their sources.

On the left bank of Broad River, a few miles from Smith's Ford, some mines exist which belong to this group. They are quite interesting, as showing the connection of the auriferous veins with the underlying granite. At one excavation a vein passes from the latter rock, through the slates, and at another a vein of massive quartz, containing gold, is seen intersecting hornblende. I know of no mine where a larger number of fine hand specimens were found than at this; yet it does not appear to have been worked to any extent.

About ten miles above this, on Guion Moore Creek, other mines have been discovered, where the lodes consist of thick veins of compact, milky quartz. These also gave good promise of productiveness; but hitherto, I believe, the owners have been disappointed. Very similar to these are the mines on Allison's Creek, which were once explored for gold to a considerable extent. Like those on Guion Moore Creek, the veins are large and altogether of massive quartz, in mica slates. I found at this place sulphuret of copper, which occurs in the veins with iron pyrites.

I am also inclined to refer to this range the patches of the gold formation in Abbeville District, at Parson's Mountain, and in Edgefield, near the line. At the base of the mountain washing for gold has been carried on to some extent, but I cannot say with how much success or profit. The gold has been traced to a vein on the mountain side, upon which a shaft has been sunk to the depth of sixty feet. In the bottom of the shaft the vein is one foot thick, composed of massive and ferruginous quartz, having the fissures and cavities coated with small crystals of phosphate of lead. Galena is also found in the lodes, and although these minerals are comparatively rare, they were sufficient to remind one of the splendid crystallizations of the silver mine in Davidson, North Carolina. South of this gold is found in numerous places, but as ground was scarcely broken, I had no means of observing them.

Between the mountain and the village the precious metal may be detected in the common quartz veins that make their appearance at the surface. The cavities in the quartz are often filled with native sulphur, to the extent of a spoonful in a single cavity.

In this direction gold is seen for the last time towards the Savannah, on Ward's Creek, on the edge of the Flat-woods. No vein has been discovered here, but the deposit is a remarkable one: it consists of yellow, ferruginous quartz, which must have been included in hornblende rock or protogine, for these are the rocks associated with it: they are also the rocks of the vicinity. The auriferous gravel varies from one to six feet in thickness, and is overlaid by a bed of red clay and loam, from three to six feet thick; and, from what I saw, I suppose that this deposit may be worked over again with profit.

On a branch of Hard-labor Creek, talco-micaceous slates are found, near the Edgefield line, and some gold has been washed in a deposit, consisting of angular fragments of quartz, little worn, and showing that they have not been transported from any great distance, and that the original veins may be looked for in the vicinity, unless they have been entirely destroyed by the denudation to which the surface has been exposed.

In Greenville District gold is found in a mine which is only remarkable for its lode of smoky quartz, oxide of iron and pyrites, passing through granite. It occurs on Wildcat Creek, a branch of Tyger. The vein is only a few inches in thickness, and the gold, I think, is principally confined to the oxide of iron, which is found in the form of cubic crystals, showing that it was once pyrites. I have seen such appearances elsewhere, but they are here, perhaps, more striking than at other localities; and I am convinced, after a pretty thorough examination of the subject, that all the oxide of iron that occurs in the gold veins, as I have already stated, was once sulphuret of iron, or pyrites, and that at a depth below the surface which is quite variable, the iron associated with the gold exists in that form.

The deposits that occur in the upper parts of Pickens, on the lands of J. E. Calhoun, Esq. and which occupy a considerable area, seem to belong to a third range, which comes into the State from the Blue Ridge.

Gold Mines of the Catawba and Lynch's Creek.

These mines are found principally upon the streams that flow into the Catawba from the East, and upon the branches of Lynch's Creek, in Lancaster, Chesterfield, and Kershaw Districts. The gold formation crosses the river into York, at Turkey Point, and after extending a few miles into that District, it is terminated with the appearance of granite at the surface.

The S. E. corner of it is seen in Fairfield on Sawney's Creek, where the public road crosses it, and again between that point and the Wateree. On the N. E. it extends into North Carolina, being a continuation of the gold-bearing rocks of that State; and towards the South it terminates with the granite of Kershaw, or sinks under the beds of sand of the Tertiary series.

A few miles over the line, on the North Carolina side, an excellent opportunity is presented for the study of the gold-bearing rocks of this part of the State; for the hill, known as Lawson's mine, has been more or less opened over a space of one mile in length, and, in some places, to a depth of forty feet. The slates, which are very hard at that depth, seem to be composed of a flinty talcose rock, somewhat disintegrated towards the surface. Owing to the hardness of the slates, the sides of the open cuts do not fall in readily, and the auriferous beds can consequently be seen to great advantage. Very generally they follow the contortions and windings of the slates, but in one or two instances I saw them crossing the ordinary slates, without veins, or any other appearance to distinguish the productive from the unproductive portions of the slates, excepting the presence of oxide of iron, and the more disintegrated state of the auriferous portion, which gives it an arenaceous character that may be detected by the touch. From what I have seen here and elsewhere, I am convinced that in many of these "slate-mines," the gold is often disseminated through the slates, and only becomes evident where they are somewhat disintegrated, or where the sulphuret of iron, which frequently envelopes the gold, is converted into oxide of iron. The gold, which is often found lining the laminæ of the slates, like a covering of gold leaf, is also in much smaller particles in these mines than in those where the gangue is massive quartz. The productive beds at this mine vary in thickness between half an inch and ten inches.

The slates of this range enter South Carolina at a point a little north of Bellair, Lancaster District. They are composed of a series of white arenaceous slates, containing talc and mica, very rough to the touch, and occupying a belt of country about six or eight miles wide, extending from this point almost to the village. It must not be supposed, however, that all of these slates contain gold: on the contrary, the auriferous portions are confined to patches of limited extent, scattered over this area. Cureton's and Ezell's mines are near the line, and when I saw them they were quite promising. At the latter mine I found as fine hand specimens as I have seen any where. It requires great caution and much skill to judge correctly of mines that change so suddenly from a soft, easily excavated rock to one of flinty hardness, and where, if the difficulty is great in the mine, it is increased ten-fold at the mill; for nothing short of the finest levigation can extricate the exceedingly fine particles of gold from these tenacious slates. So that, as a general rule, other things being nearly the same, the value of these "slate mines" will depend on the depth to which disintegration has proceeded. It is curious to observe how nearly the trap dykes of this region agree with the slates, which they intersect, as to the depth to which they are disintegrated: at the precise point where the slates become solid, there the dykes assume their true character, although above that they may have been nothing more than ferruginous earth.

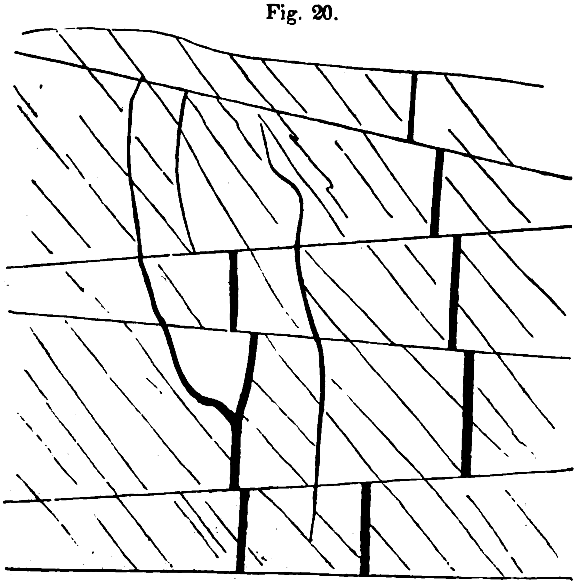
I first observed this interesting fact at Lawson's mine, where a small dyke is exposed in the shaft, from top to bottom. At first it is, like the slates, a loose earth; a little lower, where they become more tenacious, it is a whitish wacke, that may be cut with a knife; still lower, where the slates resemble hornstone, the dyke becomes a true trap rock.

At my second visit to this locality, Ezell's mine was re-opened, and a shaft sunk upon a dyke which, at first, was little more than a red earth, but soon exhibited its true character.

I had an opportunity of observing this mine in a new shaft, about fifteen feet deep, sunk for exploration, on the auriferous beds, which resembled true veins in the manner in which they crossed the slates, yet they differed from such, in having no walls, separating them from the slates, and also in being laminated.

The following section (Fig. 20) will convey a correct idea of this mine at the time I saw it.

Fig. 20.



The vertical dark lines represent the veins passing through the slates, and dislocated by the seams that cross them from right to left.—I think that this phenomenon must be referred to the same cause that produced a similar one in Lawson's mine, namely, the oxidation of the iron and predominance of quartz along these lines; for in the mine it was difficult to distinguish them from the surrounding slates, excepting by their more ferruginous and sandy appearance.

I have not seen a true gold-bearing vein at any of these localities, although adjoining the mines there are large veins of massive quartz capping the hills; but they contain not a particle of gold.

Numerous irregular excavations are seen west of this and below Bellair, but the workings have not been continued to any depth. A few miles lower down, Massey's mine may be seen, not far from the road side. It has little to distinguish it from those just described, excepting, perhaps its very white and soft slates, and the arenaceous character of the gangue, which is so white and pure, when washed in the mill, as to be fit for the manufacture of glass.

At Turkey Point, on the Catawba, near the site of the old Indian village, the rocks of this region are finely exposed. The only mineral, however, that they contain at this place, is sulphuret of iron. From this point they cross the river and re-appear in the south-east corner of York District, where a little gold has been found. South and west of the village of Lancaster nearly one-third of the District is covered with the slates of the gold formation, and mines are dotted along the ridges in various directions.

Blackman's mine is among the first that I examined, where the rock is a true talcose slate. The colors of the rock are striking, being bright green, purple, and silver white. Mines situated in true talcose slates have the advantage of being uniform throughout, and not soft on the surface and hard below. The productive portion of the slates here are thick, wedge-shaped beds, enclosed in the barren slates. A vast quantity of ore seems to have been taken from this mine, and on the whole it seems to have been worked with some judgment. Very similar to this is Hale's mine, on the edge of Kershaw: like it, it is composed principally of talcose slates, and the gold is disseminated in beds of great thickness. The bed worked when I saw the mine, was fifteen feet thick at bottom, thinning out, like a wedge, towards the surface. It was explored only to about a depth of twenty-five feet. In general this mine has been worked in open-cast; and a number of the old, abandoned works may be seen along the ridges—the refuse piles covered with sulphate of iron, the result of the decomposition of the pyrites thrown out of the mines. The mines of this locality have been worked steadily, and I understand profitably, since 1828—a fact that may fairly be attributed to the circumstance that they have remained in the hands of the original owner, and have not been rented to persons having no permanent interest in them, rather than to its being so much richer than other mines.

On a ridge between Hanna's Creek and Gill's Creek, some mines of considerable extent occur. Two of them, known as Belk's and Perry's mines, occupy two parallel beds about 300 yards distant, and have been worked to a depth of thirty-five feet. Stevens's mine is a continuation of these, and can scarcely be distinguished from them. Not far from Taxahaw a mine was opened that gave good promise to the owners. In the ardor of first discovery it was excavated in a wide open-cut, which soon fell in at the sides. It now became necessary to retrace their hasty steps, and take the course that should have been pursued at first, and which now could only be done at great disadvantage, and with much unprofitable labor.

Brewer's Mine.

In that part of Chesterfield District which is drained by Lynch's Creek, slates similar to those in Lancaster are found in several localities. After crossing the creek at Slate-ford, a hill presents itself, which is composed of talcose slates; a little farther onwards, and immediately between Fork Creek and Lynch's Creek, the slates are exposed on the surface. They contain fine beds of soapstone, and groups of beautiful crystals of radiating talc, of red and yellow colors. Protruded between these slates is an enormous bed of what, at first sight, appears to be arenaceous quartz, mixed with talc. Its greatest thickness is nearly 800 yards; and I traced it for a distance of one mile and a half, along the outcrop of the slates. The whole of this vast bed is more or less auriferous, and is known as Brewer's mine.

Before setting out upon the survey I consulted the United States' census of 1840, to obtain some information as to the mineral resources of the State, and copied into my field-book "51 hands engaged in mining." The reader may judge my surprise on finding here 200 hands, employed in a mine of which there was scarcely any thing known beyond the immediate neighborhood.

On the slope of the hill a part of this bed is covered by a deposit consisting of clay, gravel, and rounded pebbles, which was pretty rich in gold, and continued to be worked profitably from 1828 to 1843, when the bed already alluded to was discovered by Col. Craig and Messrs. Anderson and Kinson—a discovery which has added greatly to the mineral wealth of the State, and entitles them to honorable remembrance.

So entirely disintegrated is the rock composing this bed that it continued to be worked, up to the time of my visit, two years after its discovery, without exciting any doubts as to its being at all different from the deposit already known and worked.

On the crest of the hill a bluish, heavy rock is found in masses above the surface, and in fragments scattered around, which is a compact hornstone, and is seen in all the stages of disintegration between the flinty rock and a fine, exceeding white sand, of which the greater part of the bed is made up. It is remarkable that the talc shows itself most in the first stages of the disintegration of the rock. The iron which it contained is converted into the peroxide, which, together with the talc, appears as if cementing angular fragments of the rock, giving it the appearance of a breccia. The change of color is also not a little curious: the dark hornstone becomes, when disintegrated, a snow-white sand. Irregular masses of rock are interspersed, and the bed is traversed by veins of massive quartz.

The evidence of igneous action here is unequivocal. Cubic spaces, once occupied by crystals of sulphuret of iron, are lined with a thin coat of peroxide of iron, beautifully iridescent. The same appearance is presented by the fissures, which are covered by a glazing of iron, as if by the sublimation of that metal. In other parts of the mine the rock is quite vesicular, and almost converted into a black scoria.

When I first saw this mine, open-cast excavations, in several places, were commenced, and in some spots prosecuted to a depth of fifty feet. When I re-visited the place, after an interval of two years, it was scarcely possible to recognise it as the same mine. Had a detachment from an enemy been sent to destroy the mine, I cannot imagine how they could have executed their task more completely. Nor is this the fault of the intelligent and worthy superintendent, who is fully aware of the evils of the miserable system practiced, and as sincerely deplores them. The whole grows out of the system of letting, prescribed by the owners; and truly "killing the goose to get the golden eggs" seems here scarcely a fable.

A portion of the mine equal to about twelve feet square of the surface is let to a company, numbering from three to six persons, who work it as they think proper, and abandon it when they please. It requires no argument to show that where twenty or thirty such companies are working in this independent manner, there can be little system and less mining, in the proper sense of the term. No grinding apparatus has been used to any extent—the soft portion of the gangue alone being washed for the precious metal; and even that is excavated in the most reckless and unworkmanlike manner: and in washing, the worst form of the common rocker is the only instrument used. In a common deposit mine, where the auriferous bed is only a few feet thick, the loss from this mode of working would be very considerable; but where a mine is worked to a depth of fifty or sixty feet it must be incalculable.

The whole of this mine will, no doubt, at some future day, be worked over again. Even at present, in some instances, the ore has been re-washed with profit.

I found here masses of *bismuth ochre*, of ten or twelve pounds weight, which presented strong indications of the existence of a greater quantity. But gold alone engrosses every one's attention, and I could induce no further search for this valuable ore. Bismuth also occurs native at this mine, and is taken up by the mercury during the process of amalgamation, so that it has sometimes happened that when the miner imagined he had in his amalgam a fine lump of gold, it has turned out to be, on driving off the mercury, nothing more than a piece of bismuth. I saw, in Hale's mine, silver taken up in a similar manner, but suppose it may have resulted from lost coins ground up in the mill.

There are some other mines on Lynch's Creek that seem to be connected. They are scattered for a few miles around the country, but present nothing that need be described here. Among the principal are Miller's, Huff's, and Belk's. As might be expected, the streams around the mines contain gold, and the accumulations of loose materials in their beds are washed accordingly.

CHAPTER IV.

Disintegration and denudation of the Primary and Metamorphic Rocks.—Palæozoic Rocks.—New Red Sandstone.

There is scarcely any thing more striking in the face of the country, in this part of the State, than the great extent and depth to which the disintegration of the rocks has proceeded. Were it not for the occasional blocks of granite that lie scattered here and there, a person whose observations were confined to the surface, would scarcely suppose himself travelling over the upturned edges of a series of rocks. It is not difficult to understand how the surface of rocks, long exposed to the action of atmospheric changes and agencies, should every where present evidences of waste and decay, and that these should be in proportion as the materials of which the rocks are composed, are subject to decomposition by such causes. On examining the weathered surface of a mass of granite, it will generally be seen that the feldspar is depressed or worn away, while the quartz stands out in relief; and if hornblende be present this result will be still more striking. This is simply the consequence of the decomposition of those minerals. Feldspar is composed of silica, 66 parts; alumina, 18 parts; potash, 14 parts; and lime, 2 parts. Rain-water contains carbonic acid, and will therefore decompose feldspar by the combination of the carbonic acid with its potash.—The salt thus produced is highly soluble, and is washed away by every shower, leaving behind a white powder, which is the silica and alumina of the feldspar, and constitutes the porcelain clay, which is always found where feldspathic granite is disintegrating. The grains of quartz of the granite being indestructible by such agencies, remain projecting from the surface.

When hornblende is present, decomposition is produced by the oxidation of the iron and by the combination of carbonic acid with the lime and magnesia of that mineral; for the composition of hornblende is silica, 46; magnesia, 16; lime, 14; alumina, 12; and iron, 14.

The first appearance of disintegration of granitic rocks is presented by the loss of the peculiar lustre of the feldspar—a change which takes place long before any signs of crumbling or disintegration can be perceived: a fact that may serve as a guide in the selection of granite for building purposes.

This opaque or milky appearance of the feldspar is often seen extending for several feet into the rock, while the latter yet remains quite solid. At Horse Creek and other localities along the boundary of the Tertiary, instances of this sort are common. Generally, however, when decomposition commences the crystals of feldspar lose their edges, the cohesion of the rock is destroyed, it crumbles to pieces, presenting in its débris the grains of quartz, feldspar and mica; and if it be at all elevated, they are washed down by every torrent.

Sulphuret of iron is also a very common and efficient cause of disintegration. It is composed of sulphur and iron: the sulphur combines with the oxygen of the atmosphere, is converted into sulphuric acid, which unites with a portion of the iron, and produces a soluble salt, which is washed away, leaving a rusty streak of oxide of iron; and disintegration, to a certain extent, follows. But the cause of the great depth to which this disintegration extends is not equally obvious. It is not uncommon to find wells sunk in granite so soft as to require for their excavation no other instrument than a spade. Near Abbeville C. H. a ravine has been washed by the rains, to a depth of thirty or forty feet. In the N. E. corner of Lexington; on Indian Creek, in Newberry; above Union C. H. on the road to Meansville; near Montecello and Winnsboro', in Fairfield, similar excavations may be seen. Sometimes it would be difficult to determine that the mass was in place, and not a heap of transported materials, but for the existence of seams and quartz veins, which may always be traced wherever the section presents a fresh surface. When the contemplated rail-roads are commenced in the upper Districts this soft state of the rocks will be fully appreciated; for while the mass is easily excavated, it makes excellent embankments.

It will be found that rocks are subject to this sort of ruin in proportion as they contain feldspar or hornblende; but there are other causes besides those just mentioned that are producing the same effect: among these may be mentioned the percolation of water between the upturned edges of the slates; the freezing in winter, and consequent expansion of the water, must have a constant tendency to break down and pulverize such rocks.

The changes that occur in the decomposition of the rocks that contain much hornblende, are, if possible, still more remarkable. I saw an earthy mass at the base of Cæsar's Head, that I took, at first sight, for red and yellow ochre, and it required some hard digging before I could convince myself that it was nothing but decomposed hornblende slate.

The trap rocks of the State afford curious examples of this sort, to which I have already alluded. If the spheroidal pieces of trap scattered over the surface be examined, it will often be seen that they have a tendency to exfoliate, and if struck with the hammer they sometimes part in concentric layers. The lustre is quite dull, and frequently the mass is so soft as to be impressed with a knife. If the decomposition takes place below the surface the next step is the production of a yellowish tenacious substance, like wax, but it is not plastic, like ordinary clay—it is this that forms the sub-soil in all the trap regions of the State—and the next is the conversion of this into a warm, chocolate-colored earth. These changes can be studied in nearly every District in the upper country.

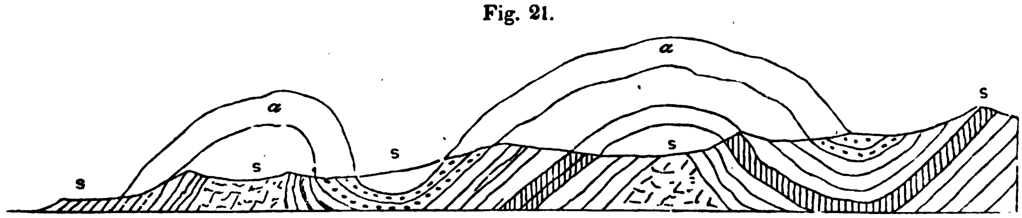
Where rocks undergo such alterations of structure as these, over such wide areas, and to so great a depth, it is easy to see that the configuration of the surface must be constantly subject to change; and there are few persons residing in Edgefield or Abbeville, or in the parallel Districts across the State, that have not had painful experience of the wasting effects of rains. It often requires all the observer's knowledge of the destructive and transporting force of water, fully to appreciate the effects produced by a single Southern torrent of rain upon rocks in the condition just described.

The result of the wasting action of water upon slightly cohering and finely divided matter, particularly when aided by a considerable declivity, is truly astonishing. Deep ravines are excavated in an incredibly short time. The excavations are often deep enough to reach the level of the springs, and then, where there was at first but an intermitting cause of waste—the rains—there is now added a permanent one. Where the surface is protected by any less yielding material, there is an elevation left, while around it the excavation proceeds, and one is presented with the phenomenon of the formation of hill and valley, in miniature. It requires no effort of imagination to perceive how such causes, indefinitely continued, and acting under analogous conditions, may result in the present configuration of the surface of the country. Hills and valleys can only be the result of two causes: an elevatory force, which has raised up the hills, or a force which has scooped out the valleys. The result of these two causes can easily be distinguished. In the former case, the rocks pushed up lean towards the line where the force acted; or, in other words, there is an anticlinal axis there. Instances of this sort I have already mentioned: the ridge running across from Horse Creek to the Congaree is an example, and although not a very conspicuous one, was quite sufficient to produce considerable modifications of surface, as the turning aside the Saluda, whose course should have been along the bed of the Edisto. There are other more important effects of this cause seen among the spurs of the Blue Ridge; but even here the topographical features of the country are due to the joint action of both causes, rather than to one. Beyond these instances nearly all the irregularities of surface presented by the State, are the result of the other cause—the wasting action of water, and atmospheric agencies, or, as it is called, denudation.

To have correct notions of the effects produced by denudation, it is only necessary to study a section of the rocks in any part of the region under consideration. Fig. 21 is a section representing the disposition of the rocks between the villages of Edgefield and Abbeville.

It is not necessary to turn aside from the road in order to observe, that the upturned edges of the rocks are exposed the whole distance, as seen along the undulating line *s s s*, which represents the surface of the country. Now I suppose it to be unnecessary to attempt to prove that rocks could not be deposited with their edges cut off in that manner: we can suppose no cause that could have produced such deposition. Besides, as we find the same strata upon opposite sides of the fold—and this is among the most common phenomena of geology—we are obliged to conclude that these strata were once continuous, as represented by the lines *a a;* and that that portion of the bent

Fig. 21.



strata between *a* and *s* must have been removed, in order to produce the appearances presented by the surface at present. It is also obvious that by noting carefully the thickness of the strata, and their angles of dip, and by joining the corresponding edges on opposite sides of lines of disturbance, it would be quite possible to approximate the restoration of the original surface of a country; and thus determine the extent to which it has suffered by denudation. But independent of all this, there are certain landmarks remaining in South Carolina that enable us to show, if not the whole amount of denudation that the country has suffered, at least that it has been very great.

All the little knobs, called mountains, that lie scattered over the central portion of the primary region of the State, are due to the protecting influence of the indestructible strata of which they are, in part, without exception, composed.

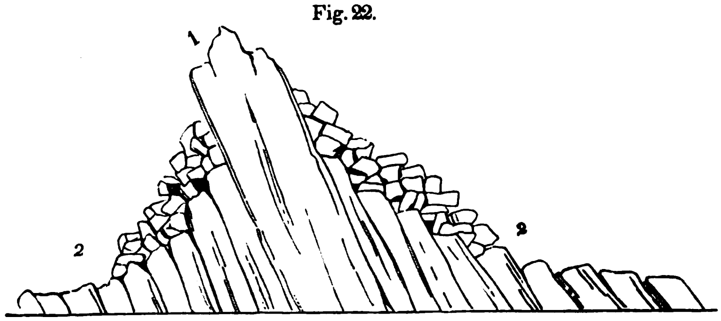
I have, in another place, mentioned the predominance of quartz during the deposition of certain rocks of the State. If we examine Ruff's Mountain, in Newberry District, which is the first, towards the South, of those elevations to which I have alluded, we shall find on its crest, throughout the entire extent, a thick stratum of quartz rock, protruding, like a huge back-bone, and covering with its ruins the talcose and mica slates on its sides, and thus protecting them from further degradation.

There is here no anticlinal axis, nor any marks of disturbance to which the rest of the country has not been subjected. It is impossible to bestow ten minutes' examination on this spot, without being convinced that it is a mountain, not by elevation, but by the denudation, and consequent depression, of the surrounding country. Parson's Mountain, in Abbeville, presents a similar phenomenon.

The thick quartzose stratum that caps Gelkey's Mountain is seen at its south-western extremity, standing up in enormous tabular masses, where the slates have been washed away. From this point it may be traced, at intervals, to King's Mountain.

Henry's Knob, in York District, is another remarkable example of a considerable elevation produced by the waste and removal of the surrounding country. Here the quartz rock stands up in bold escarpments, while fallen blocks are strewed around in every direction, over the sides of the mountain. The following section (Fig. 22) will make this plain.

Fig. 22.



1.—Quartz rock. 2.—Mica slates.

It is obvious that the slates on the sides of the mountain can only suffer denudation where the quartzose stratum is removed, whilst the surrounding slates have no such protection, and are constantly wasting. The course of these little mountains corresponds with the strike of the rocks, varying between N. 20° E. and N. E. and S. W.

I have pointed to these as remarkable localities, but any one may satisfy himself of the truth of these conclusions, by an examination of any of the numerous prominent points that exist in every

District. Among the mountains stupendous examples occur of the effects of this cause. There vast strata are removed, often leaving but an isolated outlier, like Table-rock, to attest their enormous thickness. But it is not always easy, in the mountains, to separate the effects of the two causes, elevation and denudation; and hence I have chosen to illustrate the subject by examples found lower down, where denudation was the sole cause. But the most remarkable instance that I have ever met with, in any country, of the preservation of an isolated spot, while the surrounding surface was depressed by waste, is found about ten miles South of Chesterfield Court House. The whole of that part of the District is, on the surface, a light, poor sand, with beds of sandy loam and clay below. Near the Court House may be seen large sheets of rock, varying in thickness from a few inches to three feet, composed of sand and oxide of iron—the latter acting as a cement to the former. The mass varies between iron ore and ferruginous sandstone. It is very indestructible, and is sometimes used for the construction of chimneys.

This rock is widely distributed over the sandy parts of the District. The locality to which I have alluded, occurs on Mountain Prong of Thompson's Creek. On approaching this little stream, a pretty regular peak is seen rising from the sandy plain, and towering above the tall pines that surround it, which suggests, at first, the cone of a volcano, its sides strewed with black scoria.—Finding, however, that what appeared like scoria is nothing but the ferruginous sandstone just described, and by which the cone is completely shingled from top to bottom, one is next reminded of an Indian mound, so regular and artificial does the whole appear. Some of the stones have fallen down from the S. E. side, and a ravine has been washed out, where the structure of this curious little hill may be studied. It is composed, like the rest of this part of the District, of alternating beds of gravel, sand, common and porcelain clay, beautifully stratified. On the top is a large tablet of sandstone, twelve feet square, which marks the original level of the surface of the surrounding country, but which is now elevated 150 feet above it, for that is the height of the hill. It is not very difficult to understand how the sandstone, which once covered the surface of a particular spot with a horizontal sheet, would fall down as it was undermined by the encroachment of denuding forces, and thus completely protect it from further waste. And when no longer undermined the last flag would retain its original horizontal position. Art could devise no more complete mode of protecting a hill from all washing than this, for besides the perfect and indestructible covering on the sides, the top is protected by a well laid and ample coping stone; and but for the ravine, which seems to be of recent origin, it would be as enduring as the pyramids.

We have here, then, a level-mark, from which we learn that this region has been wasted, by denudation, to the depth of 150 feet; for the regularly stratified and slightly inclined beds of sand and clay, forbid the supposition that the surface could have been originally very uneven. These beds belong to the Eocene formation, and hence this amount of degradation has taken place since that period. Fig. 23 represents this hill.

Fig. 23.

The other instances that I gave were the result of an infinitely longer period of time, and the amount of denudation, as measured by them, is between 300 and 400 feet. We must not suppose that this denudation has always proceeded at the same rate, for we know, when the surface is covered with a dense forest growth, that the washing and waste of surface can amount to little, if any thing; but there was a time when no such protection existed, and when this whole country was laid bare, and so continued long after its emergence from the depths of the primeval ocean.—That the destructive agents were different and perhaps more violent than those at present in operation, we have reason to believe. The beds of rounded pebbles of considerable size, that seem, in their downward passage, to have been entangled among the mountains, and that may be traced still farther south, show that a violent current has passed over the country—perhaps produced by the oscillations to which the surface was subjected during periods of disturbance.

The cultivation of the land and consequent clearing of the surface of its natural covering of vegetable growth, is again accelerating denudation.

If any one wishes to know what has become of the enormous mass of matter removed by this force, let him examine the vast beds of clay, gravel, sand, &c. that make up so large a portion of the Tertiary series, and let him commence this examination at the ferry below Augusta, and around Hamburg; and let him calculate the quantity of mud and finely comminuted matter carried down by the rivers of the State, even in a single season. He will then fully comprehend the double change produced by denudation—a waste in one place, and an accumulation to the same extent in another.

Palæozoic and Older Secondary Rocks.

In Chesterfield, not far from the village, on Thompson's Creek, I observed strata of highly inclined rocks, much more silicious than the clay slates of that locality, and altogether of a coarser aspect. I examined them for some distance above the mill, where they are well exposed, yet I was unable to find any fossils; nevertheless, they may belong to the rocks which occur in North Carolina, not far over the line, and which Prof. Mitchel refers to the Transition series. I saw the same rocks near Taxahaw, where they barely come to the surface on the slope of a hill. With these exceptions I have met with no rocks that can be referred to the Palæozoic period.

New Red Sandstone.

A strip of this rock, which extends, with little interruption, from Massachusetts, through Connecticut, New Jersey, Maryland, Virginia, and North Carolina, terminates on Clay Creek, Chesterfield District, about four or five miles from the line.

In Massachusetts thin seams of bituminous coal are found in this rock; and in North Carolina coal was known to exist in it, and was worked in smiths' forges before the Revolution. Trap dykes are common throughout the entire region occupied by this rock, and the coal in their vicinity is, in many instances, converted into anthracite. At a place called the Gulph, on Deep River, in North Carolina, a bed over six feet in thickness is exposed, which has been worked near the outcrop to supply the blacksmiths. Although bituminous, it has the aspect of anthracite, and scarcely soils the fingers, and burns with a white flame. It is overlaid by shale, containing nodules of clay ironstone, enclosing organic remains. I found a specimen of *calamites* which, if not identical with, is nearly allied to *C. arenaceus*. A few miles distant other beds occur, which, near a dyke, are converted into anthracite, which again become bituminous a few yards distant. I found at this locality, in the shale, several striated teeth of a sauroid fish.

This formation, as it occurs in South Carolina, is of little importance. It is composed of red and grey sandstone, which passes into red clay. The sandstone, in some places, is so coarse as to approach conglomerate. It makes a good building material, and it has been used for grindstones. Good opportunites are presented here of observing the effects of trap dykes. Portions of the sandstone are so altered as to resemble over-burned brick, and occasionally porphyry, with crystals of feldspar, embedded in a black ground, which may be traced for miles on the surface. It overlies the clay slates, and rests upon them unconformably. I found veins of calcspar intersecting the rock, and I believe, so far as this small patch of the District has been cultivated, the soil derived from the sandstone is considered good.

CHAPTER V.

GEOLOGY OF THE UPPER DISTRICTS.

Edgefield.—Newberry.—Lexington.—Fairfield.—Kershaw.—Chesterfield.—Abbeville.—Laurens. Union.—Chester.—Lancaster.—York.—Spartanburg.—Greenville.—Anderson and Pickens.

Granite.—Although granite proper is seen in but few places in Edgefield, yet the granitic ridge, described in the preceding pages as extending from the Savannah to the Saluda, has produced an important effect on the face of the District. It forms the water-shed between the head streams of Edisto, and the tributaries of the Saluda and Savannah, on the North. For the most part the granite is only seen where the lower Tertiary beds are removed, as on Horse Creek, and again on Cloud's Creek. The granite of this latter locality is coarse and crystalline, with black mica. It appears on the surface, and is, in every case, much weathered.

In the S. E. corner of the District it appears again on the Saluda. On the road to Martin Town, from the village, it may be seen in large blocks on the road side, or decomposed and washed into ravines.

Trap Rocks.—These rocks are pretty well developed in the District. A bed of Eurite may be seen in the village, a little north of the Court House, and may be traced, by the white sand, across the street. Descending the hill, on the road to Newberry, a series of hornblende slate, coarse feldspathic granite, and porphyritic dykes occur, which are continued to the right and left, for some distance. About eight miles from the Court House a narrow dyke intersects the Clay slates, and on the eastern side of the District, about five miles from Coleman's Cross-roads, a trap dyke fifty feet wide crosses the public road towards the East West. About twelve miles north of the village, a dyke passes through the clay slate converting it into clay porphyry, with reddish spots. Portions of the altered rock ring like clink-stone. Above Liberty Hill dark gray masses of rock are seen on the surface and extending towards the river, and are all that remain to mark the course of an extensive dyke, now converted, by disintegration, into a fertile and productive soil. But the vicinity of Cambridge presents the most remarkable locality of trap rocks in the District. A circuit of six or eight miles around this place is occupied by a series of trap and porphyritic dykes, yet so completely have the destructive atmospheric agencies done their silent work, that there is barely sufficient solid rock left upon the surface to indicate to the observer the geology of the region.

Feldspar porphyry seems to intersect the trap, and near Fellowship Meeting-house the largest mass of the former rock is found; it may be seen on the road not far from the meeting-house, where it is converted, by decomposition, into a soft, pulverulent earth.

From Cambridge trap may be traced at intervals, on the Martin Town road, and thence to Beaverdam Creek.

The person must be singularly unobservant who passes from the clay slate of this section of the District, without being struck with the difference presented by these formations.

Metamorphic Rocks.—The influence of the underlying granite is seen in the highly inclined position of the gneiss and other rocks forming the ridge upon which the Court House stands.—South of the village gneiss is seen standing nearly vertical—strike N. 40° E. and south-west of this, and towards the Savannah, it is exposed, alternating with beds of feldspar and with hornblende slates. Similar alternating beds are seen on the plantation of P. Brooks, Esq. where they are quite fissile and standing nearly vertical. From this they extend to Horn's Creek; and at Longmier's mill the hornblende slates of the series rise into prominent hills which extend beyond Martin Town to Gunner's Creek.

Near the fork of Cedar and Horn's Creek, and for miles around, hornblende is the prevailing rock. The short and rounded hills and the broken character of this part of the District, is due to the destructible nature of this rock. The brown, warm soil derived from it presents a striking contrast to the cold, gray soils of the clay slates through which Stevens's Creek flows, nearly throughout its entire length.

Mica, Talcose, and Clay Slates.—The geological relation of these rocks is well displayed between Hamburg and the Court House. About three miles above the former place, at the first falls of the Savannah, clay slates are found outcropping on the bank, in bold ledges—strike N. 20° E. dip S. E. 20°. Twelve miles north of Hamburg, and five miles from the river, the Tertiary terminates, and instead of the rounded pebbles and gravel of this formation, the surface is strewed with angular fragments of quartz.

The occurrence of these fragments, and the rapidity with which they accumulate on cultivated land, are often puzzling to those unacquainted with their origin. The clay and other slates are often intersected by numerous quartz veins, which vary in thickness from many yards to a mere thread; and when they come to the surface they are broken down and scattered over it, in fragments of various sizes. being hard, and not readily acted upon by atmospheric agencies, they remain, while the more destructible slates are subject to disintegration and waste from rains and other causes. Every successive ploughing breaks and brings to the surface portions of these veins, and thus the accumulation proceeds until, in some instances, the surface is completely hidden.

The clay slates seen on the river and coming out from under the Tertiary, higher up, are underlaid by mica slate; and about eight miles south of the Court House, strata of talcose slates, enclosing beds of soap-stone, come to the surface. The strike of the rocks at this point is N. 60° E. dip S. E. 40°. Proceeding upwards, a ferruginous gneiss, much disintegrated, is found, upon which these rocks repose, and this is again underlaid by a blue, compact, and fine-grained gneiss, standing nearly vertical. If this section be pursued still farther and north of the Court House, towards Abbeville, we shall find the counterpart of the rocks we have already traced from Hamburg. After passing the gneiss and hornblende in the immediate vicinity of the village, clay slate occupies the surface, to where Turkey Creek, after encircling the ridge on which the Court House stands, scoops out its channel to Stevens's Creek. On Mountain Creek the micaceous and talcose slates rise into a conical hill, above the surrounding surface. A suit of specimens collected at this locality by Dr. Barratt shews the hill to be composed of talcose rocks, enclosing beds of soap-stone with talc of a variety of colors, sometimes in groups of radiating crystals. At the base of the hill, beds of kaolin are found, which result from the disintegration of veins of coarse, feldspathic rocks. The slates extend across the District, from this point towards the West.

A strip of talco-micaceous slates, of the gold formation, crosses the north-west corner of the District on the Savannah.

For the most part, the section of the District drained by Stevens's Creek is composed of clay slates, which may be seen to advantage both on Turkey Creek and at the bridge over the former, where it occurs in large angular blocks. It is more silicious and less fissile than is usual with clay slates in other parts of the State. It would make an excellent building material. The strike, at this locality, is N. 40° E. dip 80° towards the North. The direction of the joints is east and west; and the thin, thread-like veins of quartz, by which the rock is much intersected, have for their course a line N. 6° W.

This whole region is much washed and broken by ravines; and in almost every instance the hills are due to the protection afforded by the immense veins of common quartz scattered over their surface.

On Turkey Creek, particularly where Log Creek empties into it, the slates are well exposed, at a noted whetstone locality. At this place the rock is fissile and broken up, by joints, into prisms of a convenient size and form for whetstones, which, when selected with care, make good oil-stones, for edge tools. I found here specimens of the polishing material known as rotten-stone. It seems to result from the partial decomposition of the rock—a portion of the alumina being washed out, while the finely divided silica remains cemented by iron and the remaining alumina.

On the eastern side of the District these slates may be traced from Cloud's Creek to Half-way Swamp, their edges being raised by the granite on the creek. They dip towards the North. In various places throughout this distance there are barren, elevated spots found, upon which scarcely any thing will flourish, or even grow. From their whitish color, and other fancied resemblance to certain bald places found in the prairies of the West, they have been said to indicate the presence of limestone; and their barren aspect is supposed to result from the well-known action of that mineral on vegetable matter. After a very careful examination of these localities, I was unable to find any thing on which to base a hope that lime would be found any where in that region.

I also observed numerous excavations made in search of gold, but I am sorry to be obliged to state that the indications of the precious metal are not more trust-worthy than those supposed to indicate the presence of limestone.

On the whole, the clay slates of Edgefield are more extensively developed, and have affected the surface and soil in a more striking manner than in any other District of the State. Their limits are every where sufficiently well defined by the cold gray soils they produce, and which contrast, in so marked a manner, with the soils of the other rocks. In the north-eastern corner of the District some rich tracts of alluvial occur, but their fertility is derived not from these, but from the hornblende rocks that occur higher up the river.

The most promising mineral deposit that I have found in Edgefield, consists of the bed of pyrolusite, or peroxide of manganese, which I found on Hard-labor Creek. Should future exploration prove it to be as extensive as I have represented it, from appearances on the surface, it cannot fail to be a valuable addition to the mineral wealth of the State. The ground on which it occurs is very favorable, and its vicinity to the river must add greatly to its value. Both here and in other parts of Edgefield there are beds of iron ore; but as they have not been at all explored I can say but little of their extent.

Besides the deposit gold mine already known, there are other patches of talcose rocks a few miles south of the village, that resemble those of the gold formation.

Beds of clay, suitable for the manufacture of stone ware of the best quality, are numerous, independent of those found in the Tertiary portion of the District, to be described farther on. The fine, thick-bedded gneiss near the village, furnishes an excellent building material; and the fissile variety should be examined for flagging stones.

LEXINGTON AND NEWBERRY DISTRICTS.

Although there is but a corner of Lexington covered by granite and the metamorphic rocks, it furnishes a good illustration of the geology of that portion of the State bordering on the Tertiary formation.

At Twelve-mile Creek, near the Court House, a light-colored crystalline granite is found, near the mill, and at other localities in the vicinity of the village. Towards the Saluda, on the road to Youngner's Ferry, gneiss is found reclining against the granite at an angle of 80° towards the N. E. strike N. 6° E. Between the mill, on the creek, and the ferry, clay slates, containing beds of red ochre are seen. At Lorick's these rocks pass into mica slates.

East of this, and on the right bank of Broad River, a gneissoid rock appears in bold bluffs that encroach upon the river. At some points the mica and feldspar are absent; the rock becomes quite rough to the touch; it forms a fine, sharp grit, which is used for whetstones, and may have some value as a material for grindstones. However, it is only near the surface that the rock presents these characters. The slates throughout the region known as the Fork, which is included between the Saluda and Broad River, are noted for "whetstone" localities. Between the river and the public road white massive quartz is found encumbering the surface, and obstructing the roads that lead towards the river.

About fifteen miles from Columbia a greenish, argillaceous slate appears at the surface, nearly vertical. This continues for a distance of two miles, till it meets a fold which changes the dip to the South. Not far from this another fold produces an anticlinal axis on a small scale, and the slates are now found dipping towards the North-west. I found, at this place, a trap dyke about fifty feet wide.

On the Wateree Creek the talcose slates, which immediately underlie the rocks just described, come to the surface. Some beds of excellent soapstone are found at this locality. A little farther on, and we come to beds of mica slates dipping towards the South, at an angle of 45°.

On the hill-sides, above the creek, the slates become silicious and fissile, being intersected at intervals by veins of common quartz. A section of about twelve miles in length, along the "Fork," presents a series of folds in the strata, that changes the dip every few miles.

The clay slate formation of South Carolina can no where be studied with equal facility with that presented by this section, which extends from the boundary of the Tertiary to a distance of twenty miles from Columbia.

Near the Newberry line, and midway between the Saluda and Broad River, is an elevation called Ruff's Mountain, which is sufficiently remarkable for its isolated position. The mountain is principally composed of mica and talcose slates, with a crest consisting of a thick stratum of quartz rock, very similar to that of King's Mountain, which is broken down and scattered over the eastern side, in large angular blocks, having their weathered surfaces occasionally studded with crystals of kyanite. The talcose slates can be seen very advantageously on the western side, where the base of the mountain is washed by a little stream. Near the mill the slates are seen crossing the race, and rising up on the side of the mountain, being pushed into a position nearly vertical—the bedding planes so straight and even as to present smooth surfaces where the rock is split, and often so hard as to offer inducements for opening a quarry for flagging stones for pavements and other similar purposes. Near this spot a remarkable vein of quartz penetrates the slates, which I had a good opportunity of observing, as some persons, having more industry than skill in mining, had explored it to some depth for gold and silver. The walls of the vein are lined with pure, white talc, as if the quartz had contracted, leaving spaces which were afterwards filled by the talc. The fissures and seams in the vein are also coated, in a similar manner, with that mineral. Cubical cavities are interspersed throughout its mass, which are lined with hematite, beautifully iridescent. The fissures, too, are often coated with a thin film of iron. Crystals of iron pyrites undoubtedly once occupied the cavities. The sulphur, once a great portion of the iron, has disappeared, leaving a little of the latter mineral to line the cavities once occupied by the crystals. Crystals of pyrites, unaltered, still remain; and doubtless these crystals, as they often do, have suggested the gold and silver sought after in the vein.

That this curious and interesting locality should have attracted the attention of searchers after gold, is not surprising, but it seems strange that the pursuit should be continued so long and so laboriously, where not a particle of the precious metals was ever found.

Higher up the mountain side promising indications of iron ore present themselves, and to this and the slate quarry, at the base, we would direct the attention of the owners, whose perseverance and industry deserve a better reward than the quartz vein is likely to afford. There is a prolongation of this mountain extending into Newberry, but it differs little from its southern extremity, where its structure can be best studied.

If we now resume the section traced nearly to the Newberry line, we will find the soil and aspect of the country entirely changed. At the very threshold of the District we find an extensive series of trap and porphyritic dykes, with occasionally a patch of hornblende slates which extends to Crim's Creek, at the foot of the hill. The feldspar porphyry can be examined on the road side, where its light grey color distinguishes it from the trap, with which it is associated. The deep ravines in the hill sides, which were scooped out by the surface-water, and the peculiarly broken character of this portion of the District, attest the readiness with which rocks, abounding in hornblende, disintegrate and suffer by denudation, from atmospheric causes.

These dykes continue beyond Mr. Summer's to the 30-mile post, where, on ascending a conspicuous hill, we find a coarse, crystalline, feldspathic gneiss, alternating with hornblende slate, and dipping towards the S. E. On the other side of this ridge, about a mile farther north, we find the same series of feldspathic and hornblende rocks, dipping in an opposite direction, or towards the N. W. The frequent undulations noticed among the rocks of this section, mark the inequalities in the granitic floor upon which they rest, and by which they were lifted into their present position. One or two trap dykes intersect the granite a few miles beyond this, where the latter rock may be examined in the huge hemispheric masses that seem to be protruded above the surface, but which, in reality, are portions of the rock more durable than the rest, which resisted the wasting influences constantly doing their destructive work.

This coarse granite occupies the surface for about four miles farther, till it passes into a fine-grained and very handsome light-colored rock. The mica is present in small, black scales; the feldspar and quartz are a light gray, and very regularly distributed, giving the rock a uniform color; so much so as, at a distance, to have the appearance of common marble. There are few rocks in the State that present, in an equal degree with this, all the requisites of an excellent building material. It is very durable, splits readily in any required direction, and is worked with great facility. Some idea of its adaptation to architectural uses, and the great ease with which it splits, may be formed from the fact that on the spot we saw lintels twelve to fifteen feet in length, and six inches thick by one foot wide. Rough posts, for fences, are also split out, five inches square, with surprising regularity, and requiring no other dressing to fit them for use, than the drilling of the holes by means of which the rails are fastened.

Fine masses of this granite appear above the surface for several miles square, extending towards the river. It is strange that such a building material as this, almost on the banks of a navigable river, and so near the Capital of the State, should be so little known.

A great portion of the middle and eastern portion of Newberry is granitic, and nearly the entire route between the village and Ashford's Ferry lies over this rock.

On the western side of the District, on the Saluda, gneiss and hornblende are the prevailing rocks; and much of the fertility of the soil, as well as the ease with which the "worn out" lands of that part of the District are reclaimed, depends upon the presence of the latter rock. The low, alluvial lands on the river, noted for their great fertility, are composed of the ruins of these rocks, brought from this and the adjoining Districts by every flood.

Between the Saluda and the Court House a few trap dykes occur; and I observed a stratum of a chloritic rock, containing beds of soapstone. Towards the South the clay slate enters from Lexington, but does not occupy much space. That portion of the District drained by Indian Creek is covered by slaty gneiss and hornblende, intersected by beds of coarse, crystalline granite—the whole disintegrated in place, to a considerable depth; and hence the broken surface of the country. On Duncan's Creek the thick gneissoid strata, characteristic of the upper strata, make their appearance near the mill, where they are intersected by trap dykes of some extent.

Fairfield, Kershaw and Chesterfield Districts.

There is but little in the geological features of Abbeville, Newberry, Fairfield, and the southern parts of Union and Laurens, to distinguish them from each other; and yet they are, in many respects, very dissimilar. The principal distinguishing features in the topography of Fairfield are due to the predominance of feldspar and hornblende in the rocks, and their consequent tendency to disintegration and waste. No small portion of the District presents a striking miniature representation of a mountain region, that must be referred to this cause. Were particular examples necessary, one need only point to such localities as Montecello, Beaver Creek, the very streets of Winnsboro', and the vicinity of Peay's Ferry, where I saw whole fields in danger of being overspread by the debris from the granite on an adjoining hill side, which is brought down by every shower of rain.

This cause renders it extremely difficult to point out the exact limits of the patches of true granite scattered over the District. The Montecello granite, with base of white feldspar, has black mica so disposed as to give the rock the appearance of marbled paper. In the northern part of the District numerous localities occur; and near Peay's Ferry a crystalline granite, with reddish feldspar, is seen, which resembles the Kershaw granite.

But perhaps the geology of Fairfield will be best shown by tracing one or two sections, so as to exhibit the relations of the rocks to each other as they present themselves.

After leaving the band of argillaceous rocks, in Richland, which has already been described, as it occurs in Edgefield and Lexington, we pass over the edges of strata of mica slate, intersected by veins of quartz; and occasionally, as we approach Montecello, it is interstratified with hornblende slate. Around that village the granite already mentioned is laid bare in masses upon the surface, but to a far greater extent on the declivities of the hills, where it may be examined in the ravines, and followed through every stage of disintegration.

Associated with the trap found in the granite of this locality, there are others of sienite, composed of snow-white feldspar and crystals of hornblende, a continuation of one seen on the opposite side of the river, near the corner of Newberry and Lexington. Pursuing this section along the western side of the District, from Montecello to Beaver Creek, gneiss and hornblende are the prevailing rocks. I have more than once alluded to the fact that wherever gneiss is associated with hornblende, it becomes at once slaty; so that instead of the thick beds, characteristic of the gneiss in other parts of the State, we have fissile and highly laminated slates: and this part of the section presents numerous examples in illustration of this fact. Several extensive trap dykes are found here; one immediately after leaving Montecello, others on Terrible Creek; and to the left, near Ashford's Ferry, they are seen crossing the river. On Rock Creek a very considerable dyke may be seen, having its direction indicated by the usual globular masses of the rock strewed along the surface.

On Beaver Creek it is difficult to say whether trap rocks or hornblende slates predominate—for it rarely happens that an opportunity offers of examining the rocks in their solid form; and although there is no mistaking the brownish soils of these rocks, still it is not always easy to distinguish one from the other. The hornblende soils, however, incline more to a reddish brown than the trap soils, which are characterised by their warm, dark brown color, sometimes inclining to yellow.—This color is often modified, as well as the soil itself, by the porphyritic rocks so frequently associated with the true trap rocks. For miles along the creek these may be traced, wherever the soil is removed, with the occasional interruption of a patch of granite.

A section from Beaver Creek, through Winnsboro', to the Wateree Canal, passes over the outcrop of the rocks nearly at right angles to their strike. For several miles the same series of hornblende slates and fissile gneiss continues; but as we approach the ridge upon which the Court House stands, the subjacent coarse gneissoid rocks occupy the surface for some distance around. On the branches of Jackson's Creek trap is again exposed in some extensive dykes, which extend to a point not far distant from the village. Beyond this, large veins of quartz are seen broken down and scattered over the fields; and on the brow of the hill, before descending to Wateree Creek, the ruins of a dyke are piled up, to remove them from the surface. On the creek, strata of mica slate occur, containing a bed of soapstone. Leaving the ridge, and descending towards the valley of Dutchman's Creek, we find, at the bottom of the hill, what appears, at first sight, to be pulverised granite, covering the surface to some depth, and consisting of crystals of feldspar, but little altered; grains of quartz, and plates of mica, washed down by the rains from the surrounding hill sides.

The high grounds bordering the creek are composed of mica slates, worn into rounded hills, together with beds of hornblende slates; at the same time that the creek has scooped out its bed in a dyke of trap, and the low grounds are for a considerable space based upon that rock.

When a level tract of land is thus situated, it is not always easy to perceive its connection with the subjacent rock. I have, in another place, described the changes presented by these rocks during disintegration. All these may be seen here, both on the immediate banks of the creek, and on the hill sides.

In the process of the conversion of these rocks into soil, a considerable quantity of lime is liberated, which collects into irregular nodules, and may be seen in ravines, wherever disintegration is going on. I have explained this in another place, and only refer to it here, because these nodules have been supposed to indicate some connection with beds of limestone, in this region. Their origin, however, is as I have stated, as any one may satisfy himself by a few minutes' examination of any locality where trap or hornblende is in a state of disintegration. Small, rough, irregularly globular pieces of stone of a whitish color, will be found, which will effervesce on the application of an acid. These are the nodules to which I have referred, and which are quite common, in similar localities, all over the State.

On Mr. Palmer's land there is an interesting locality of highly fissile mica slate, having the planes of stratification so even as to leave the surfaces quite smooth—an important quality in flagging stones, that would render these valuable, were they nearer a market.

Near the creek fragments of ferruginous quartz, which have been subjected to abrasion and the transporting power of water, lie scattered over the surface. They are not rounded into pebbles, but the angles are worn off, and the whole polished in such a manner as to preclude the possibility of its being the result of the action of any aqueous force that could exist in the present state of the surface of this part of the District.

I have also observed beds of pebbles on Broad River, above Ashford's Ferry, that are far removed from the influence of that stream, in its present state. These must all, I suppose, be referred to the same cause that rounded and transported to their present position the beds of pebbles of the Tertiary formation. Marks of this force may be traced to the mountains.

From Dutchman's Creek our section passes along a granitic ridge, penetrated by quartz veins, particularly on the descent towards Sawney's Creek, where it enters Kershaw. Near the mill it intersects strata of micaceous slates, which form the extremity of the gold formation, to which I have already referred.

About a mile lower these slates are explored for gold; but I did not learn with what success. A good opportunity occurs here of observing the relation of trap dykes to the rocks they intersect.

Beyond the creek the argillaceous rocks occur in their usual position, beneath the overlapping edge of the Tertiary beds. Some trap dykes are seen at this place, and on the right bank of the Wateree red argillaceous slates are laid bare by the removal of the superimposed beds of sand and clay, by the river.

The granite of Kershaw is noted for its great beauty and remarkable crystalline structure. The well known locality of the DeKalb granite, as it is sometimes called, occurs about fourteen or fifteen miles above Camden. The beauty of this rock consists in the lively color of the feldspar, and the form and disposition of the crystals of jet-black mica; it is coarsely porphyritic. On Liberty Hill a gray and hard granite occupies the surface and may be traced to Peay's Ferry.—This is not unlike the porphyritic granite of Buffalo Creek, which is explored to furnish mill-stones. The bald heads of the masses of granite, as they are protruded through the sand, which covers the greater part of the District, present a curious appearance.

Nearly all the streams that empty into the Wateree, in the Northern part of the District, flow over beds of granite.

In the north-east corner of the District the talcose slates of the gold formation appear, near Little Lynch's Creek, where they dip under the beds of sand that cover the greater part of the District.

The only granite that I have observed in Chesterfield is found on Stonehouse, a branch of Thompson's Creek, which rises near the District line.

The banks and bed of this little stream present a scene wild enough. Granite rocks lie scattered in every direction—some piled on each other in curious forms, whose projecting masses afford shelter to cattle in inclement weather, while others are placed, like enormous capitals, on single pedestals—affording matter for speculation to those who pay but little attention to such things.

A short distance above Cheraw clay slates may be observed on the Marlboro' side, crossing the river, and dipping towards the North, showing that the anticlinal axis of the verge of the Tertiary is south of this point. About a mile higher, some wide trap dykes occur, and may be seen on the left bank, where the sand and clay beds are washed off, which hide the slates between this and Thompson's Creek, near the Court House, where they are again laid bare on the hill descending towards the creek. The persistency of these rocks is extraordinary. While all other rocks in the State have suffered from decay and denudation, so as to have their continuity every where broken up, this holds its place, almost without interruption, from the Savannah to this point. It is only where the rivers have cut through them that they have disappeared. With this exception, they are every where seen coming out from beneath the overtopping edge of the superincumbent Tertiary.

On the creek, and nearly at every other locality, the slates are variously colored, and abound in red and yellow ochre. Immediately on the banks of the creek trap rocks may be traced in a direction N. 50° E. At the mill, near the village, beds of highly inclined silicious rocks occur, that resemble gray wacke, and belong probably to the palæozoic rocks. I could find no fossils in them, notwithstanding that I made diligent search for them. Similar rocks occur in North Carolina, not far from the line; but I am not aware that any organic remains have been discovered in them.

In South Carolina it is difficult to ascertain the relative position of these rocks, as nearly the whole of the region in which they occur is covered by beds of sand; and it is only on one or two streams, where the latter are removed, that they are seen at all.

At Mount Crogan the Tertiary deposits terminate, and we have again the usual argillaceous rocks, which occupy this part of the District till they are covered by the New Red sandstone, on Clay Creek.

I ascertained the curious fact that the air, in wells recently dug in the argillaceous rocks of this region, becomes so foul, that it becomes necessary to resort to artificial means of ventilation before the men can proceed with the work. I think it highly probable that this result is due to the absorption of oxygen by the clay slates. Humboldt has recorded a similar instance, where the air, in certain mines, became so deoxidised by this cause, as to be irrespirable.

In old wells it is quite common for carbonic acid to accumulate, but in wells in the progress of construction it is not easy to suppose such a cause, in this region, as the evolution of that gas.

At Slate-ford, on Lynch's Creek, the argillaceous rocks are again brought to the surface, by denudation; and between Fork Creek and Lynch's Creek they are seen reposing against the talco-micaceous rocks of the gold formation. It is here that the remarkable mine, known as Brewer's, occurs, which has been described at length in another place.

The strip of New Red sandstone that comes into the State, extends from the line a distance of five miles. It is composed of quartzose particles, cemented by red ferruginous clay, varying in color from a brick-red to yellowish gray. On clay Creek the solid ledges of the rock are found outcropping, which are quarried for building materials, and sometimes for grindstones. One of the most interesting features in the geology of this part of the District is found in the trap dykes, which may be traced for miles by the black streaks they have produced by the alteration of the sandstone.

ABBEVILLE.

From the manner in which the subjacent granite rocks of these Districts are laid bare, by the removal of the metamorphic slates, by denudation from their prominent and irregular points, it is obvious that their surface must be constantly increasing, in proportion to the destruction of the slates. It appears that the granitic foundation upon which the superincumbent rocks were deposited, was exceedingly uneven—so that the prominent points would first be reached by denudation, while the depressions would yet remain covered up.

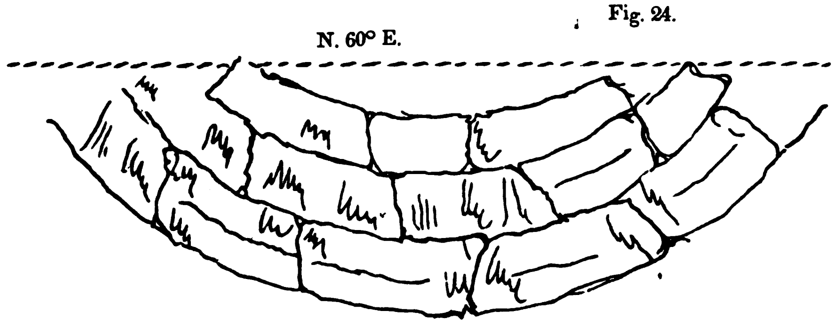
Numerous examples of true granite are found in Abbeville at distant localities: on the South between Hard-labor and Long-cane; on the South-east, along the Saluda, from the line to Swansey's Ferry. On the weathered surface of the rocks exposed here, a lively imagination could readily convert the effects of decomposition into foot-prints of various animals. Very similar to these are the horse and buffalo tracks pointed out to visitors of Table-rock. These impressions are altogether due to the unequal disintegration and decomposition of the rock: every shower of rain dissolves or washes away the portions that have crumbled down, leaving these fancied tracks on the surface.

Granite is also found on the surface on Rocky River, and farther south, on Little River; around, and in the vicinity of the village, and again between the latter river and the North Fork of Calhoun's Creek. There are but few localities, however, where the granite appears at all conspicuous; and it is so associated with gneiss, (both much decomposed,) that it is difficult, if not impossible, to separate them.

The trap of Abbeville is well developed in the centre of the western side of the District, between Little River and the Savannah. No locality in the State offers so good an opportunity for observing all the characteristic features of this rock, as is presented at Calhoun's Mills, on Little River. A few hundred yards above the mill a space of some extent is laid bare by the overflowings of the river; and here a series of rocks composed of trap, porphyry, sienite, and eurite, all finely exposed, may be seen.

A remarkable structure is presented by the trap at this place: the rock is divided by concentric joints, which are crossed by others, that are nearly, but not quite coincident with the radii of the curved surface. The cut, Fig. 24, represents a horizontal section of this rock.

Fig. 24.



At other places the trap appears in its more common form of globular masses, coated with a rusty loking shell. The texture of these rocks varies between that of fine, compact basalt and coarse greenstone.

The tract so generally known as the "Flat-woods" of Abbeville, and to which this locality belongs, differs principally from the trap lands of Chester, in being more broken and undulating, and hence better drained. Indeed the term "Flat-woods" is descriptive of but a small portion of this region. It is drained by Little River and its branches. The water, like that of the springs and wells of Chester, is charged with lime and iron; and on Mr. Norwood's plantation there is a spring containing lime, magnesia, iron and sulphur, which, in a more favorable position, would, no doubt be a place of resort. Chalybeate springs are not uncommon.

The outline of this remarkable region is very irregular; and even in its very midst other rocks are found associated with the trap; the whole tract will, however, be included by a line drawn from Russell's Creek to Little River, at the mouth of Anderson's Creek; crossing, towards the West, Calhoun's Creek and its tributaries; re-crossing Little River, at Davis's bridge, and thence to the mouth of Rocky River, on the Savannah. This, I suppose, is, next to Chester, in extent, as a locality of trap rock.

Near the village a good opportunity occurs of studying the crystalline and basaltic rocks. The Court House stands upon granite, against which the metamorphic rocks are seen reposing to the North and South. A fine sienite, resembling the Quincy granite, is found here; and although no quarry has been opened in it, the masses on the surface give evidence of its great extent. Greenstone and hornblende rock are also found alternating with these rocks. Some remarkable dykes of Eurite are also found near the village; and a few miles to the North-west they contain garnets.

A curious variety of trap occurs here, that I have not observed elsewhere in the State. Its surface appears pitted, as if indented by a stone-cutter's tool. This seems to be the result of a concretionary structure, or perhaps a tendency to crystallization: at all events, the small spheroids fall out, leaving the surface of the rock thus singularly marked. In the eastern corner of the District, between Barrattsville and Cambridge, trap abounds, and I have already mentioned that the village of Cambridge stands upon a series of trap and porphyritic rocks.

Near White Hall, on Hard-labor Creek, there are several localities. Between the head waters of Wilson's Creek and Long-cane, and again near the Double-bridges, on Rocky River, trap dykes come to the surface.

The gneiss of Abbeville is also well developed; it may be seen in the beds of the rivers and creeks, particularly in the northern part of the District, where we find the western extremity of those thick strata that extend across the State, and give rise to the principal falls in the rivers.—One of the most southern exposures of the outcropping edges of this rock I saw on Long-cane, at Morton's mill. The bands of black mica contrasting strongly with the feldspar, the folds and contortions of the laminæ of this rock give it a very ornamental appearance.

The falls at Ware's mill, on the Saluda, are produced by the obstruction presented by the gneiss, as it crosses the Saluda. It occurs again on Rocky and Little River. So slight is the covering of slates in the northern portion of the District, that they are cut through down to the gneiss by every considerable stream.

Mica and talcose slates occupy a considerable part of the surface of the District. After passing the ridge between Hard-labor Creek and Reedy-branch, we meet with a series of these slates, which extends nearly to the village, and through which Long-cane and its numerous tributary branches find an easy passage to the Savannah.

Between McCord's Creek and the Flat-woods, a strip of mica slates covers the surface, having Parson's Mountain in the centre.

This little knob is one of those elevated spots due to the comparative durability of the materials of which they are composed, and to which I have elsewhere alluded, as marking the comparative amount of denudation suffered by the surrounding strata. The direction of the crest of the mountain corresponds with the strike of the rocks, and on its very summit may be traced the ruins of an enormous stratum of quartz rock. In the north-eastern part of the District, particularly around Lowndesville, mica slate occurs, which passes gradually into a rock from which the mica has disappeared, and which is there used for the manufacture of whetstones. There are other patches of these slates distributed over Abbeville, but they present little to entitle them to special notice, and the localities mentioned will be sufficient as examples of the occurrence of these rocks in the District.

In describing the gold formation of the State, I have mentioned the gold-bearing rocks on Hard-labor Creek, and in the vicinity of Parson's Mountain. At both of these localities gold has been found: at the former in a deposit, and at the latter both in a deposit and vein. Near Lowndesville there are numerous veins so much like those of the gold formation that they are well calculated to mislead, for they contain not a particle of the precious metal.

Fragments of magnetic iron ore are found near the village, and brown hematite on McCord's Mountain. Bog iron ore is found near the Saluda, on Gen. Gilham's land.

There are some interesting mineral localities in the District. Near the Court House a dyke of Eurite furnishes, by its disintegration, kaolin of great purity. There are several beds of soap-stone of excellent quality. One locality occurs south-east of the village, and but a short distance from it, near a little saw-mill. I observed another bed on Cane-creek, on the road to White Hall.—Between Rocky River and the Savannah, fine crystals of amethystine quartz. Beryl, rose quartz, schorl, and garnets are also among the minerals of the District.

Besides the mineral springs now known, there are some others that deserve notice: one near Parson's Mountain, which is within a short ride of the village. In the north-west corner of the District Murray's spring occurs; and although not so well charged with mineral ingredients as those in the Flat-woods, nevertheless this place has many advantages, as regards locality and health.

On the Saluda, near Pinson's Ford, Dr. Jones pointed out to me a spring highly charged with salts of lime and iron. This is also a pleasant locality and is situated in a healthy region.

Laurens District.

The granite of this District is not extensive. It occurs most abundantly towards the South, on the Saluda and Little River; and in the north-east, on a ridge between Duncan's Creek and the Enoree.

Several considerable dykes of trap come to the surface, but do not, in general, occupy any great space. On the hill, near the limestone locality, on the Saluda, large globular masses of this rock strew the surface, and extend down its side into the valley. Between Boyd's mill and Garlington's, and east and west, it may be seen covering the surface with its hard black fragments, for a breadth of fifty feet. These fragments, as they present good forms for building, would make excellent fences. In the north-western corner of the District trap rocks may be traced from the Enoree, across Durban's Creek, to Young's P. O. The dyke that occurs here is not wide, but it is quite conspicuous when compared with the grey surface of the gneiss, which is the prevailing rock.—The course of the dyke is N. 15° E.

The gneiss formation of Laurens is well marked, and may be observed along the Enoree, at numerous picturesque cascades, formed by the upturned edges of this rock. At Gordon's mills the falls are about 30 or 40 feet in a distance of 200 yards; and a few miles higher, at the Mountain Shoals, there is a fall of 70 feet, in about the same distance. At this place the rock is much contorted, and seems to be a continuation of the stratum described as occurring on Long-cane, in Abbeville. This is an exceedingly beautiful spot. Standing on one of the little islets, at the foot of the falls, and looking upwards, the river is seen as if emerging from a noble arcade of green foliage—now foaming and sparkling in the sunshine, as it dances over the broken edges of the rock, and again hiding itself in the deep shadows of the vine-clad trees. Above the mill the rock forms a natural dam across the stream, so perfect as to present the appearance of a work of art. This is a circumstance of common occurrence on many of the rivers and creeks in the part of the State where they flow over the outcrop of the gneiss.

At Van Patton's Shoals, near the north-west corner of the District, the river falls 55 feet in about 100 yards. So very even is the edge of the rock at this place that a single plank, bolted to it, forms a sufficient dam for the mills on each side. A little below the falls the alternating strata are of different degrees of hardness, and as the softer are disintegrated and washed away, the others are left projecting from the bank in huge tablets. Towards the top of the shoals the rock loses its stratified structure, and passes into granite.

It is impossible to examine the localities on this beautiful stream, without being struck with the great facilities it affords, at small expense, for manufacturing establishments.

From this place to Laurensville a ridge extends, which, with the exception of a few alternating strips of hornblende slate, has gneiss for its underlying rock. In all that part of Laurens drained by Reaburn's Creek, Reedy River and the Saluda, it is finely exposed at numerous localities.

Hornblende slate also occupies an important place among the rocks of the District. The soils derived from it are every where prized, and known as mulatto soils, from their peculiar color. At Swansey's Ferry it is seen overlying the gneiss, which comes to the surface a short distance above. A wide band, composed of this rock, extends from Boyd's mills to a point within five miles of the village. I also traced it at intervals between Reaburn's Creek and Sandy-ford, on the Enoree. A portion of the strata contains sulphuret of iron, in abundance, which gives rise to some excellent chalybeate and sulphur springs. One of these occurs within a mile of Reaburn's Creek, and is known as Cheek's Spring; and not far from the road, between Sandy-ford, on Enoree, and the village, another is found, which is strongly sulphuretted water. There are doubtless others, which I did not see, but these are highly worthy of the attention of the Medical Faculty of the District.

Some fine beds of soapstone are known to exist in this range of hornblende slates. Other localities of the latter rock occur on Durban's Creek and in other parts of the District; but the localities I have enumerated will suffice as examples.

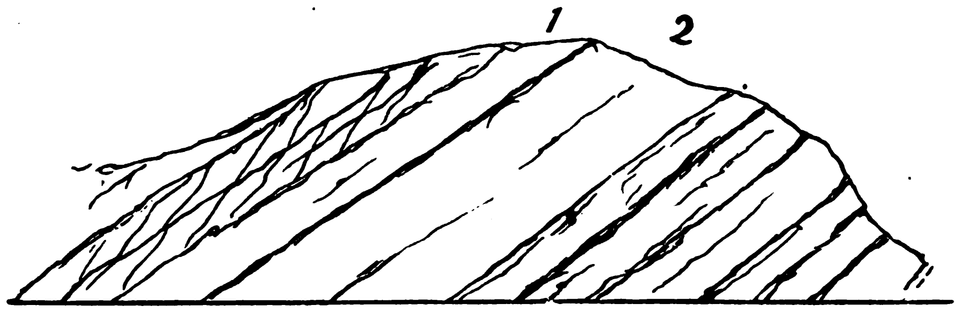
But by far the most interesting rock in the District is the limestone of the Saluda and Reaburn's Creek. About one half mile below Ware's mill, on the Saluda, and at the head of navigation, this rock is seen cropping out between beds of gneiss, which may be seen above and below it, on a little stream which enters the river at this place.

I was informed that Dr. Waits is the discoverer of this locality. The strike of the rock is N. 30° East, and the thickest part of it is fifteen to twenty feet: only a portion of the stratum, however, is seen for a distance of eighty yards, and it was difficult to arrive at the precise thickness. The rock is white, crystalline, and some of it is sufficiently fine to make a good marble. Two miles distant from this place it is laid bare again by the denudation of the surface, on the banks of a little stream, in heavy ledges; but no excavations having been made it was impossible to ascertain its thickness. A short distance beyond this on 'Squire Waits's plantation, it is found again in several places. Wherever it has been uncovered it exhibits unequivocal evidences of the wasting action of water, to which it was once subjected. It passes into the underlying gneiss at some of these localities; and as the latter rock is nearly of the same color, it will always require some care to distinguish the two, when the limestone is to be converted into lime by burning.

I have hopes that some handsome slabs for ornamental purposes may be procured here, for I found the rock colored by streaks of chlorite and groups of crystals of actinolite. No quarry has as yet been opened at any of these localities, notwithstanding the decided advantages they possess, in their vicinity to the river.

This stratum is exposed again, on a branch of Reaburn's Creek, in a position highly advantageous for examination. It is associated with soapstone, and passes, as at the other localities, into gneiss. About ten feet of the middle of the bed is good limestone; but on each side of this it requires care in the selection of the rock for burning. That this care was not always bestowed I had abundant evidence, in the lime burned at this place. A few hundred yards distant another opening has been made, and an excellent blue limestone procured; but it was covered with a thick bed of earth, which added materially to the cost of quarrying. On the opposite side of the Creek the beds immediately underlying these, come to the surface; but the lime is so impure as to be worthless in an economical point of view. It shows, however, the manner in which the lime-rock was formed, and leaves no doubt as to its sedimentary origin; for here, and every where else in the State, the rock is stratified. Fig. 25 will give a correct view of the position of the limestone at this locality.

Fig. 25.



1.—Soapstone. 2.—Limestone.

I have no doubt that when lime is used extensively in this and the adjoining Districts, numerous localities will be discovered along the strike of this stratum. Simple as the fact is, that the rocks of the State have a general direction or strike of about N. 20° to 30° E. it seems to have occurred to but few persons to apply it to the tracing out of beds of lime rock, or other useful mineral.

Lime has been burned here to some extent, in a kiln alike unfavorable to the quality of the lime produced, and to the economy of the operation. I shall point out elsewhere the defects of the kilns of the State, and give approved plans for such structures.

Union District.

The state of the rocks, in Union, renders it peculiarly difficult to point out their precise limits.

Granite and gneiss being essentially composed of the same minerals, it is only where stratification can be observed, that they can be distinguished. Gneiss, however, is the prevailing rock of the District.

Granite may be found near the village, and to the South, on the ridge between Tinker's Creek and Fair Forest, much decomposed. On the road to Glenn's Springs it may also be observed, in the deep ravines washed in it by the rains. Granite is also found in the numerous picturesque hills that border the valley of the Pacolet. On the North, between Gelkey's Creek and Thicketty, localities of this rock are not uncommon.

At Meansville a sienitic granite occurs, which deserves notice, as one of the gold-bearing rocks of the State. It may be examined on the road, near the top of the hill, between the mill and the village. The feldspar of this rock is white, and although it contains hornblende at this and other localities, yet it passes into common granite with black mica. I have, in another place, mentioned the occurrence of this rock at the mine above Grindal's Shoals, as well as at the Nott mine, on Fair Forest.

The Trap Rocks of the District occupy the greatest continuous area on Tyger River, about nine miles south-west of Union Court House, and above Bobo's Ford. This tract is known as the "Meadow-woods," and is three or four miles square. After crossing the river an interesting series of porphyritic dykes may be seen on the ascent of the hill, composed of feldspar, with blue crystals embedded. The outer edge of this extensive tract presents the usual indications of the presence of trap rocks—the dark brown and yellowish soil, together with the rough and rounded black masses scattered over the surface, apparently without any connection with the underlying rock.

The level portions of the land, as usual, are covered with "black-jack," and are not cultivated.

On Frenchman's and Paget's Creeks dykes of considerable extent occur. Two miles south of the village, and between the latter and Buffalo Creek, several dykes cross the road; and between Rocky and Beaverdam Creeks, others are seen, which extend nearly to Grindall Shoals. In the vicinity of the village these rocks may be traced for miles in extent—often marking the surface, like the ruins of an enormous wall.

The Gneiss of Union assumes the coarse, feldspathic character of the thick gneissoid rocks of the upper Districts of the State, where it becomes porphyritic, having oblong crystals of feldspar embedded.

It seems almost useless to enumerate all the localities examined of this rock, for it can be seen at all the shoals and falls on the rivers, and no where to better advantage than on the Pacolet. It is often interstratified with hornblende slate, of which there are numerous prominent localities in the District. Between Hamilton's and Greenshaw's Ford, on Tyger; on the right bank of Sugar Creek; on Thicketty Creek, and near Smith's Ford, the fissile and outcropping edges of this rock may be seen.

Around Meansville, and between it and the gold mines, hornblende slates are sufficiently extensive to give character to the soil.

The Mica and Talcose Slates of the District are scarcely separable. Gelkey's Mountain is the most noted locality, and that has been already described. It is in the slates on the flanks of this mountain that the most valuable beds of iron in the State are found. South of the mountain these slates extend to Smith's Ford, and on the North, to People's Creek, where they are associated with the talcose slates, containing the magnetic ores. The quartz rock, which forms the back-bone of the mountain, and which, at other localities, is interstratified with the talcose slates, as it extends into the District, becomes quite arenaceous, and makes an excellent fire-stone, which is used at the iron works at Cherokee Ford. The sand from this rock is sufficiently free from iron and other impurities to be fit for the manufacture of glass.

Many of the hills on both sides of Pacolet are covered with mica slates, which gives them a rounded outline.

The gold Mines on Fair Forest, in the north-west corner of the District, are situated in a group of these slates, which are interstratified with hornblende slates.

Beds of soapstone are not uncommon in the District, and are generally found in the hornblende. Near Glenn's Springs this mineral is found passing into asbestos, and is used as a substitute for slate-pencils, a purpose for which it seems to answer admirably.

Besides Glenn's Springs, which are so well known and so deservedly popular, there are others, not far distant, which, flowing through hornblende slates, the water is strongly chalybeate, and, somewhat sulphuretted; it also contains lime. These springs are situated in a little valley near the gold mines, but are not much known or frequented, although they would form an admirable adjunct to the water of Glenn's Springs, in which salts of lime are the predominant ingredients.

Chester District.

In the geology of Chester granite is not very conspicuous; nevertheless there are some remarkable localities scattered over the District. Between Tinker's Creek and the Canal, on the West, and on the eastern side of the District, a wild and picturesque locality of this rock may be seen, on the Catawba. Towards the South long narrow ridges of granite are seen, like white stripes, among the trap rocks. Price's Mountain is deserving of notice, as being the most elevated mass of granite in the State; and on the North-east localities of true granite are abundant.

Trap Rocks.—It is to these rocks, which are finely developed, that the characteristic features of the District are mainly due. I had frequently heard of the "Black-jack lands" of Chester, but I could get no definite information as to their character, excepting that they consisted of plains, having a peculiar soil, and being covered with "black-jack." It is a little remarkable that the three great trap regions of the State should have been distinguished by names that convey no correct idea of the rocks or even the land. In the "Flat-woods" of Abbeville there are some level tracts, but the greater part of the surface is undulating, and often broken; while the "Meadow-woods" of Union include not an acre of any thing approaching a meadow. The trap of Chester is, indeed, covered with "black-jack," but that tree loves a moist, cold soil, and is therefore only so far characteristic.

It was with no small degree of pleasure and surprise that I discovered that the underlying rock of these lands was trap. For the most part the country between Rocky and Fishing Creeks is comparatively a plain, but slightly broken or undulating, and consequently but badly drained. Masses of globular trap cover the surface in places, but generally the surface of the rock is covered with soil—the result of its own disintegration.

From every little channel and ravine magnetic oxide of iron is washed out, in the form of black sand, and often, one would suppose, in sufficient quantity to be of some economic value as an ore of iron. The rounded masses on the surface that generally indicate the presence of trap rocks, have been described as true transported boulders. Their rough, unpolished surfaces, however, will always be sufficient to distinguish them.

In wet weather the roads over this plain are almost impassible, from the stiff, tenaceous mud, formed by the soil. I was informed that at no very distant period this tract resembled a prairie, with but a few scattered post-oaks, the stumps of which may yet be seen among the thick growth of "black-jacks" that covers the surface.

These rocks are not confined to the space included between the branches of the creeks mentioned above, but extend towards the South-west, on the waters of Sandy River. They are here more or less mixed with feldspathic rocks, which gives the soil a lighter color. This portion of the District is also more undulating and even broken.

This mixture of trap, eurite, and feldspathic porphyry, I found in many places on the outer edge of the main body of the trap, and is always indicated by patches of yellowish soil, containing fragments of compact feldspar.

I am inclined to think that the true character and value of the greater part of the trap lands of Chester have been concealed by the "black-jacks" which have taken possession of them, to the exclusion of almost every other tree; and not being considered indicative of a fertile or promising soil, the tract of land under consideration has never received the attention it deserves. So far, however, as my observation goes, this tree must be considered as indicating, with far more certainty, the relations of soils to moisture, than to fertility. The disintegration and decomposition of trap rocks always produce a stiff sub-soil, impervious to water, and hence favorable to the growth of "black-jack."

A bed of soap-stone is found a few miles from the village, on Sandy River, which has been worked to a limited extent.

Near Hopewell a series of rounded hills of coarse, crystalline granite extends over a distance of two or three miles. A strip of mica slate is also found here. This rock, which is not very abundant in the District, may be seen on the eastern side of the District, on the plantation of Col. Pride, where it passes into gneiss, which is highly fissile, and splits readily into tablets suitable for flagging stones.

Near the Canal hornblende rock and sienite have been excavated in the construction of that work.

Near Fishing Creek fine specimens of brown jasper are found, and large manganesian garnets occur in a vein of quartz. Another locality of this mineral, I was informed by Dr. Douglass, is known to occur near Hopewell Church.

There are two mineral springs on the creek, the waters of which are charged with iron and muriate of lime. Indeed the lime of the trap rocks has very generally imparted itself to the water of the wells in the District, as may be perceived in the village and elsewhere.

The knolls of granite interspersed through the trap, frequently on the same plantation, often present a choice between the two, as sites for dwellings. Every thing else being equal, of course the granite should be chosen, on account of the purer water that it would furnish.

Lancaster District.

The *Granite* of this District is laid bare by the Catawba River from Peay's Ferry to Landsford, in a series of rapids having a fall of 200 feet in 10 miles, where this rock may be examined to great advantage.

Gneiss and Hornblende Slates cover the surface towards the West, a few miles from the river; and the eastern side of the District is occupied by the micaceous and talcose slates of the gold formation, which cover nearly one half its entire area.

A more distinct view of the geological character of the District will be presented by the examination of the rocks, as they present themselves in a continuous section north and south, than by examining them in the order of their relative geological position.

Commencing with the section north of Bellair, we find the micaceous rocks overlaid by a belt of talco-micaceous slates, six or eight miles wide, consisting of a soft, whitish rock, containing much silicious matter, which gives it a rough touch on the disintegrated surface; but at a short distance below it becomes exceedingly hard and tough. There are several interesting gold mines in these slates, which have not yet been worked beyond a depth of forty feet—probably because of the fact just stated: the exceeding hardness of the rock that encloses the auriferous veins.

We find along the ridges the usual phenomena accompanying the elevations among these slates, thick veins of compact quartz, which have no connection with the gold-bearing veins: they are quite different—being generally composed of hornstone, that becomes, by disintegration, arenaceous quartz.

On the Catawba, at Turkey Point, a fine section of the rocks of this formation may be seen at a bluff which was once the site of an Indian village. Crystals of iron pyrites pervade the rock at this locality. From this the rock crosses the river, and may be seen on the York side, on the plantation of Mr. Sitgreaves, thinning out towards the granite ridge in the lower part of that District.

Farther South gneiss and hornblende crop out from under the slates just described, and at the other extremity are cut off by a bed of sienitic granite. The rocks of an interesting settlement on Waxhaw Creek are trap and hornblende slate. Half a mile south of the creek a band of talcose slates crosses the road. Ridges of gneiss occupy the distance between this and the slate-hill, near the village, where a trap dyke occurs. After passing the village we again enter that portion of the gold formation which is drained by the tributary streams of Lynch's Creek, on the West, and which covers so large a part of the District.

The slates of this region present every gradation between mica and talcose slate, and are quite variously colored, white, red, and green. Strike N. 10° to 60° E. and the dip varies between 30° and 70° towards the N. W.

Although the rocks of this formation are spread over so large a space, yet the productive veins are confined to a narrow belt, extending from the village to the N. E. corner of the District. One distinctive character marks the mines of Lancaster, namely, the almost entire absence of true veins, and the occurrence of the gold in beds, that in many cases require some skill to distinguish them from the ordinary slates.

The gold, too, is rarely found in a gangue of common quartz; but universally occurs in hornstone, or else in the slate itself. Wherever the slates are at all arenaceous or rough to the touch, they invariably become hard below the surface, and it is only where the slates are entirely talcose that they remain soft even to a short depth—facts highly interesting to those who would engage in mining speculations; for rocks that at the surface appear soft, and yield readily to the pick, thirty or forty feet lower become so hard as to require the force of gun-powder at every step; and besides this, the difficulty of grinding is increased in a greater degree.

The quartz veins that are found on the ridges, in the vicinity of the mines, contain not a particle of gold.

But I have, in the preceding pages, already described the gold region of Lancaster. Besides gold, other minerals occur in the District, that may, at some future period, have some economic value. I observed indication of the existence of iron ore in a thick bed near Blackman's mine, which has never been examined below the surface.

The pyritous slate thrown out of the mines yields, on disintegration, a considerable amount of sulphate of iron, or copperas. This salt is easily extracted by the simple process of lixiviation. At Hale's mine it occurs in great abundance. In the talcose slates there are numerous localities.

I examined the trap dykes of the gold formation, with some care, in order to determine whether or not they had exerted any influence on them; but, although many of the mines are intersected by dykes, I could find no alteration produced in the gold-bearing portions, notwithstanding that they have, in many cases, been worked on both sides of the dykes.

The granite of Lancaster is best exposed in the south-western corner, along the Catawba, where the superincumbent slates have been removed by denudation.

York District.

Yorkville stands upon a granitic ridge, which presents favorable opportunities for the study of the granite of the District. This ridge, which extends towards King's Mountain, is composed of a crystalline granite with white feldspar and black mica. Huge rounded masses are left standing above the surface, which are often, as elsewhere, mistaken for boulders. Similar appearances are presented by the granite in the south-eastern corner of the District. Between this point and the village an unbroken ridge exhibits granite overlaid by gneiss, and cut by trap dykes of considerable extent. A series of these dykes may be traced from the intersection of the Chesterville and Herron Ferry road and the York road, almost to the village. Near the 13-mile post one is found, which occupies a considerable space. Strange to say, it was cultivated, exhausted, and turned out, as waste. No where is the alternation of trap and granite more conspicuous than along this section. The dark brown soils of the trap contrasting with the light gray of the granite.

The south and south-eastern part of York is more broken, and presents many interesting geological sections.

At Smith's Ford hornblende slates occupy a considerable space on both sides of the river. On the left bank, or York side, it reposes against the granite exposed on the hill side. The gold mines of this locality are highly interesting, as showing the connection between the auriferous veins and the underlying granite. At one place a vein of quartz, containing gold, is seen passing from the granite through the superincumbent slates; at another a similar vein intersects hornblende rock.

The ridge along the banks of the river continues much broken towards Cherokee Ford. On Guion Moore Creek the slates are intersected by large veins of milky quartz, some of which are auriferous, and at one time gave great promise of productiveness, but I believe have hitherto disappointed the owners. Veins very similar to these were once explored on Allison's Creek, but are now abandoned. They deserve notice as being among the few places in the State where indications of copper occur. Sulphate of copper, the result of the decomposition of copper pyrites, is found in small quantities lining the fissures in the quartz.

On Bullock's Creek trap rocks, consisting of greenstone and porphyry, cover a large space, and on both sides of Turkey Creek trap and sienite strew the surface.

Between the head waters of Allison's Creek, and Smith's Ford—the north-eastern portion of the District—mica and talcose slate cover the entire region, which, taken together, is one of the most interesting portions of the State.

If we commence our examination of this part of York about five miles south-east of King's Mountain, we shall find a good opportunity of studying the mica slates in a picturesque little mountain, known as Henry's Knob. This is not, as I have elsewhere shown, a mountain composed of rocks pushed up into their present position, above the surface, but one whose elevation is entirely due to the wasting and washing away of the surrounding country—the mountain itself remaining, being protected by a stratum of hard, indestructible quartz rock, which extends its whole length, like a huge back-bone. Planes of stratification are visible, and on the weathered surface crystals of iron pyrites and cyanite may be seen; being in every respect similar to the cap-rock of Ruff's Mountain, in Lexington.

Throughout its entire length it is broken, by seams and bedding planes, into numerous tabular masses, which remain piled up, higher and higher, till we reach the summit of the mountain.—The angular and rugged aspect of the rocks composing this little knob, causes it to contrast strikingly with the other mountain masses of the State, which are generally more remarkable for their rounded and softened character.

From the base of the knob a sparkling stream issues, which I find marked on the District map, "Mineral Spring." I fancy, however, that the medicinal properties attributed to it are chiefly due to exercise, pure air, and the beauty of the place.

Between the knob and Dickson's Meeting House indications of beds of iron are quite abundant. Ascending King's Mountain towards the pass, the talcose and mica slates, curiously contorted, are finely exposed on top of the ridge, which slopes away gradually towards the Battle-ground, whilst the crest of the mountain is seen on the right, on the North Carolina side, with its gibbous outline sharply defined against the sky. So gentle is the ascent towards the peak of the mountain on the west, that it is not before we find ourselves on the brink of the fearful abyss below, that we can be assured of our great elevation. The escarpment on the North Carolina side consists of an enormous tablet of quartz rock, reared up on end, apparently as a buttress to the mountain. The strike is N. 30° E. and dip nearly vertical. It is evidently stratified, differing from the other rocks with which it is associated only in the predominance of quartz and absence of talc or mica, yet both of these minerals can be readily detected in it. Traces of this rock may be found in numerous places between this and Gelkey's Mountain, in Spartanburg. Following the ridge into South Carolina, we find the quartz rock passing insensibly into mica slate, containing more or less talc, and splitting readily, and consequently quarried to a limited extent. On the Battle Ground a rude stone furnishes, at the same time, a specimen of the rocks of the mountain, and marks the spot where the brave fellows fell, who fought and died here.

Farther down, towards Clarke's Fork, this rock becomes more talcose, and is used for tablets for graves, to some extent. Good whetstones are found here, and at Crawford's mill fine specimens of jasper and striped agate occur.

Parallel with the King's Mountain range, and between King's Creek and Buffalo Creek, the mica and talcose slates are found, in a narrow belt, extending from the North Carolina line to Cherokee Ford. The mica slates that compose the ridge near the river, are a prolongation of the King's Mountain range, and are finely exposed near the iron works, in a gorge through which Dear Little Creek flows.

From the bed of the stream to the top of the hill, thick, somewhat contorted beds of this rock are exposed. Crossing the river, it forms the shoals and the islands known as the "Ninety-nine Islands." Near the furnace the river is divided by an island composed of quartz rock, which rises up in bold masses at its northern extremity. Along the northern flank of this ridge beds of iron ore are found at intervals, nearly throughout its entire extent. These have already been described under the head of the ores of the State.

The next strata in the section towards the North include the limestone beds, which seem to occupy the line of a slight anticlinal axis—probably one of those flexures common in these slates.

About a quarter of a mile from the North Carolina line the lime-rock first makes its appearance, on the land of Mr. Ettres, where the bed is exposed to a depth of twenty feet. A small kiln is in operation at this place, and about 1500 bushels of lime are burned annually, and sold at eighteen cents a bushel, on the spot. The capacity of the kiln is about 250 bushels, and requires ten or twelve cords of wood for a charge. Strike of the rocks N. 30° E. dip N. W.

Wisenant's bed is near this, and can be traced 100 yards across the stratum. Lime is burned here also, in a kiln of 300 bushels' capacity, requiring about eleven cords of wood. About two miles from this is Hardin's locality, which I examined across the outcrop 150 yards.

South of this there are two parallel strata on which several other localities are known. Among these are the beds on the land of Hollander and Bird; one on the land of the Hon. W. C. Black, and another the property of the King's Mountain Iron Manufacturing Company. The latter is a fine exposure: the stratum is nearly vertical, and exhibits evident marks of the denuding action of water.

These localities are confined to the bottoms of valleys, which follow the strike of the rocks, are drained by the branches of King's Creek, and, like all the depressions in this region, are the result of denudation. The lime-rock presents less resistance to abrasion and chemical action than the associated rocks, and hence have suffered more from these agencies, and, in the lapse of time, have been reduced to their present level. At some of the quarries mentioned the rock requires some attention in selecting it for burning, as it is often rendered impure by admixture with the talcose and other rocks with which it is interstratified. This remark, however, applies only to a few localities, for generally the beds are free from all impurities, and the lime manufactured from them of excellent quality.

This rock appears again on Broad River, a few hundred yards from the bed of magnetic ore, on

Black Rock Creek. It is, however, much mixed with the slates—at least where I saw it. Beyond the lime-rock, and reclining against the rocks in which it occurs, we have another stratum of mica slate containing beds of iron ore, corresponding with those on the South side of the gray ore beds. It is in these slates that the Hardin bank, already described, occurs. The strike of the beds containing this ore is N. 50° E. and the dip N. W. 45°. On the roof, or hanging side of the bed, a coarse, feldspathic rock occurs, with a thin mica slate between it and the ore. It is from this source that the white porcelain clay, scattered on the surface, near the mine, is derived.

The talcose rocks of York differ in some important particulars from those of the other Districts. They are, in general, less contorted, contain less silicious matter, and frequently pass into common soapstone; hence the many fine quarries of this rock known in the District, where excellent tablets and flags are procured, of any dimensions.

I examined this region in company with A. Hardin, Esq. to whose local knowledge I was much indebted. On Carroll's muster-ground we had the pleasure of finding indication of a bed of peroxide of manganese, near the brow of the hill; but as no opening was made we had no means of ascertaining either the value or extent of the bed. There are other points along the flank of the mountain where similar indications occur, but they are not so decided as at this point.

Traditions of lead mines, which furnished abundance of that metal, to persons in the secret, during the Revolution, are quite common in the upper part of the District. I examined several places which were pointed out to me by persons who received the information from those who were certain that the lead occurred somewhere in the vicinity. I am far from thinking lightly of all popular opinions upon such subjects, and I invariably examined all such localities, for the satisfaction of my friends, who could not always see how I could tell what was not there, without visiting the spot. I need not say that I found no indications of lead at any of these places. The Indians, from whom these traditions were often handed down, were but poor geologists, and frequently made very unfortunate locations of this and other metals.

Spartanburg District.

A coarse feldspathic gneiss is the characteristic rock of Spartanburg, south and south-east of the village. True granite is found in the vicinity of the Court House, in the lower part of the slate, on Tyger River; but these exposures are of limited extent, compared with the other rocks. Here, as in all the upper Districts, gneiss is seen on the rivers, where the slates have been removed.—The rocks forming the bed of Pacolet from Hurricane Shoals to Easterwood Shoals are gneiss, which may also be seen on the banks, in wide shelving sheets. Between Glenn's Springs and the village the Fair Forest has scooped out a channel, at the base of a hill, in this rock, forming a wild and picturesque little view. Gneiss is also well exposed at the surface, at the quiet and pretty spot called Cedar Springs, where a bold stream of pure water issues from a fissure in this rock. East and west of the village hornblende slate alternates with gneiss, as may be seen along the road to the iron works on Pacolet. The same may be seen on Thicketty.

Immediately underlying the mica slates of the northern part of the District, beds of very fissile hornblende slates are seen outcropping, and may be traced into Greenville, a little South of Dantzler's.

The talcose rocks of Spartanburg are found principally between Cherokee Ford and People's Creek, and have already been described, in connection with the magnetic iron ores of the District.

Next to gneiss, the mica slates occupy the most prominent place. Nearly the whole of the region drained by the branches of Pacolet and Tyger is covered with these rocks. They are coarse and silicious, contain lenticular particles of quartz, closely invested with mica, which remain upon the surface when the rock is broken down by disintegration—giving it a dry and meagre appearance.

The topography of these mica slate hills is very different from that presented by those Districts where feldspathic and hornblendic rocks abound. Instead of the rugged, broken and washed surface, intersected by ravines, we have a series of gently rounded hills.

Near the Cowpens Furnace a quarry was opened, which exhibits the character of this rock below the surface. It is highly charged with iron pyrites, and along the strike of this stratum some mineral springs have their source, which contain both sulphur and iron. Of this character are the springs at the furnace, one near Pacolet, and another at Ellis's Ferry, near the line; and a short distance beyond, Wilson's springs rise from this rock.

Graphite, or, as it is commonly called, black lead, is found in the slates here. It has been used at the furnace, and when selected with care is of good quality.

But the most valuable product of these slates are the beds of iron that abound in them, nearly throughout their entire extent, even as low down as the head of Furguson's Creek, towards the Enoree. This ore is brown hematite, of excellent quality; it is found distributed in the slates, in irregular beds of very variable thickness; but which have been no where explored to any depth. The Cowpens Furnace, and those on Pacolet, procure ore exclusively from this formation.

The limestone of Spartanburg occurs in the north-eastern part of the District. The principal exposure occurs at Limestone Springs, where the bed cannot be less than 100 feet in thickness, although it rises but little above the surface.

It is, at one extremity of the bed exposed here, a blue, compact rock, presenting distinct marks of stratification; and at the other, it passes into a white, crystalline marble, occasionally clouded and marked with gray and reddish bands—forming, altogether, a handsome stone for ornamental purposes. It is found at other localities between this and the river, which have been elsewhere described.

The strike of the bed is N. 30° E. and dip 30° S. E. It is associated with the strata containing the flexible quartz rock.

Lime has been burned here more extensively than any where else in the State; it is of excellent quality, notwithstanding the disadvantage of badly constructed kilns. A few miles distant, and in the opposite direction, this stratum is again laid bare, on the plantation of Dr. Overton Lewis; and on the adjoining lands of Mr. Watkins, there are promising localities. It would be very difficult, without more time and aid than I had at my disposal, to determine the extent of this rock; yet I cannot doubt that it will be found sufficient to supply a very large demand.

Below Thompson's Ferry limestone was said to be found, but I could only trace this report to some porcelain clay, taken from a well in the vicinity. A spring said to be impregnated with lime, was mentioned in evidence of the presence of this rock; but that is not an unusual circumstance, even where no limestone exists. Most rocks contain lime, though not as a carbonate in that form which is dissolved by the water of springs. Such is the case with many of the springs in Abbeville and Chester; and even the lime contained in the water of Glenn's Springs is not derived from limestone, but from other rocks over which it flows.

The group of rocks containing the magnetic ore of iron, the red and brown hematites, the limestone and flexible quartz rocks, I need scarcely say, are a continuation of the same group found in York District.

It is impossible not to be struck with this beautiful association of rocks. Here we have iron ore of nearly every species, and of the very best quality, lying side by side with limestone, for fluxing; quartz rock, for fire-stone; and beds of excellent fire-clay are not uncommon in the very neighborhood of the iron works. And all occurring on the banks of a noble stream, capable of furnishing abundant water power.

The gold mines of the District have been described in their proper connection, and need not be mentioned here.

Greenville District.

The gneissoid rocks, which, in the lower Districts, are principally seen upon the rivers, and at other localities where the superincumbent slates are washed away, are here fully developed, and a corresponding change in the topography of the country is equally well marked. Instead of the low and rounded hills of those Districts, we have here long, and comparatively level ridges, but little cut up by the lesser streams. Of this character is nearly all that portion of the District south of the village. Large naked surfaces of this rock, studded with crystals of feldspar, are quite common on all the streams; and notwithstanding the abundance of the feldspar, it is not equally subject to disintegration with the rocks lower down. The thick beds have the appearance of true granite, but where they are thinner the stratification can readily be distinguished. The rocks of Greenville have, in general, a strike of about N. 30° E. and dip towards the S. E. 25° to 40°. East of the village a very short distance, a slight undulation has produced an anticlinal axis, and the strata are accordingly found dipping towards the North-west, and this is continued for about a distance of seven miles. The gneiss is then covered by mica slates, which continue on the surface till they meet a coarse, crystalline granite, towards the Enoree. On the opposite side of the District, and toward the Saluda, gneiss is every where seen outcropping on the sides of the hills, whose tops are often capped with mica slates; hence it often happens that these little hills are covered with a meagre and scanty soil, while the surrounding country presents one of considerable fertility. Beds of porcelain clay are found wherever the feldspathic gneiss is disposed to disintegration.

Although the gneiss of Greenville is pretty uniform in its general character, yet it is subject to variations that produce important changes in the quality and appearance of the soils derived from it.

Hornblende slates occupy no inconsiderable portion of the District. Commencing about ten miles north of the Court House; on the head waters of Enoree; between S. Tyger and the Saluda, these rocks, interstratified with gneiss, may be traced for some distance upwards, towards the mountains.

The *Mica Slates* of Greenville occupy that part of the District between the head waters of Tyger and the base of the mountains. It presents the usual groups of rounded knobs, so characteristic of these slates. I have said that patches of these rocks are often found capping the hills in other parts of the District. Paris Mountain is a remarkable example of this sort. For some miles around the mountain mica slate is the prevailing rock, and the mountain itself owes its elevation to the indestructible nature of this rock, which contains beds that are more silicious than usual. It is another of those monuments that are scattered over the State, as if to mark the progress of denudation. It has the same strike and dip of the rocks with which it is surrounded, showing that it was elevated at the same time, and by the same force. And it now stands above the surrounding surface, because the latter has been wasted and depressed by agencies that are still ceaselessly doing their silent work.

East of the mountain there is a mineral spring, known as Chick's. It is at a pleasant distance from the village, and a place of considerable resort. Salts of lime and magnesia are the predominant ingredients in the water.

In the general view of the geology of the State, I have described the structure of the Saluda Mountains, and it need not be repeated here.

Greenville will ever possess attractions in its healthful climate and the beauty of its mountain scenery. But those who pass through the gap with post haste, know little of the magnificent scenes that they are passing to the right and left. A few of the prominent points are indeed known and visited, but in the deep recesses of the mountains there are scenes of surpassing beauty that are but seldom seen.

One featute in these mountains cannot fail to strke the traveller, particularly if he has, as is common, associated in his mind rocks and sterility: it is the rich luxuriance of every growth—tree and herb. No stunted plants mark his upward progress, but all is full of life and vigor.

Not only are good crops raised in the valleys, but on the mountain sides, and even on their very summits, where one would expect nothing but a naked rock.

Anderson and Pickens.

Anderson presents little in its geology to distinguish it from the adjoining portion of Greenville. Gneiss is the prevailing rock, and gives rise to long, unbroken ridges. Sometimes it is quite fissile, and then passes into mica slate. Towards the lower part of the District it is frequently intersected by veins of coarse feldspathic crystalline granite. Rocky River presents numerous localities where this rock may be seen.

Although gneiss is not very abundant in Pickens, at least below the mountains, there are localities enough to show that it exists at no great distance below the surface. West of Pickens Court House, on Little River, this rock is seen crossing the stream: it is underlaid by slaty beds, which disintegrate, and allow the superincumbent beds to fall down in huge blocks. In the bed of the river the surface of the rock is perforated by pot-holes, that are sometimes seven or eight feet in depth. The water, at this point, is confined to a narrow bed, and as the outcrop of the rock extends across the entire stream, it forms an excellent mill site. About a mile from this, near the muster ground, a broad sheet of gneiss occupies the surface. Eight miles south of the Court House, on the Greenville road, a remarkable locality of slaty gneiss is known, which furnishes very superior flagging stones. On Stump-house mountain this rock is seen, as well as in Chauga valley. On Chatuga, near Whetstone Creek, ledges cross the river, in a direction north and south.

The gneiss of the mountains, as I have elsewhere shown, is found capping the entire range. It appears, indeed, like an enormous weight, placed upon the underlying more fissile rocks, to keep them in place.

On Cheochee Creek the gneiss is remarkable for its large, lenticular crystals of feldspar. A fine opportunity is presented, in Jocasse Valley, for the study of the geological structure of the mountains of the State; and if a section be traced from thence along the Estatoe Mountains, to Table-rock, very correct ideas may be formed of these spurs of the Blue Ridge.

A very interesting formation, composed, for the most part, of hornblende slates, alternating with gneiss, is found along the base of the mountains, forming a band several miles wide, and extending nearly, without interruption, from Table-rock to Little River. Another extensive patch of these rocks may be seen between Pendleton village and West Union; they are also well developed around Pickens Court House.

The warm brown color of the soils derived from these rocks will enable any one to detect these localities, even where the rocks do not appear upon the surface.

Between Chauga and Pulham's Ferry other interesting exposures occur. A bed of crystalline hornblende rock occurs, which, from its great weight and peculiar color, was taken for iron ore.

Not far from this locality a fine stratum of chloritic slate is seen, passing into soapstone. Strike N. 20° E. and standing nearly vertical. Soapstone is found very constantly associated with hornblende slates, wherever the latter occurs in the District.

The mica slates of Pickens occupy the north-west corner, or that portion drained by the waters of Chauga.

One would suppose, from a glance at the map of Pickens, that this portion, and indeed nearly the whole of the District, was covered by rugged mountains. This is, nevertheless, far from the truth. The surface is indeed undulating, but below the mountains proper there are but few hill sides so steep as to be inaccessible to the plough. I mention this, because I recollect my surprise when I reached Pendleton, at finding the mountains barely in view above the yet distant horizon. Persons who, like myself, derived their knowledge from the topographical delineations on the map, would conclude that the country was too rugged and broken for cultivation, when, in truth, it is not more so than Union and the adjoining Districts.

It is in the mica slates that the limestone of Pickens is found.

On Chauga Creek this rock is found in the narrow part of the stream; but many years having elapsed since any opening was made, I was unable to come to any conclusion as to the extent of the bed. A rude kiln was erected here and a few charges seem to have been burned in it. I found a bed of impure limestone below the kiln, and extending across the stream. Fragments of a better quality are, however, scattered over the surface in the vicinity, that indicate a better bed, which was doubtless used in the kiln, and is now concealed beneath the loose materials that have fallen down from the steep banks of the creek.

Another bed occurs on Brasstown Creek, a stream which flows along the strike of the rocks, and empties into the Tugaloo, at Pulaski. This bed, which is found about nine miles from the mouth of the creek, is twenty feet thick. Strike N. 30° E. dip 45°. In a country covered by dense forests, and where the surface is strewed with the ruins of the rocks from the hill sides, it is plainly impossible, in the absence of excavations, to present any thing like a correct estimate of the extent of beds so situated. I can therefore only direct the attention of those interested to the subject.

Before I had any knowledge of this locality, I pointed out the old Indian boundary line, as the direction in which lime would be found. I had arrived at this conclusion while tracing the strike of the limestone on the Georgia side of the river; and the Brasstown bed does not deviate more widely from that line than was to be expected from difference of level. It is exposed again on the Blue Ridge, and I have not the slightest doubt that when the bed is explored, it will be traced to numerous other localities.

The bed on the Georgia side is on the immediate bank of the Tugaloo. Strike N. 15° E. dip 45° S. About twenty feet of it is quite pure; the rest is more or less mixed with the rock in which it occurs. This stratum is exposed higher up, on Panther Creek, where it is burned to some extent.

Beds of iron ore, which have been worked, are found in the slates between Wilson's Ferry and Pendleton; and at another locality, between Oolenoe and Table-rock.

About six and a half miles south of Pickens Court House, on the road to Pendleton, traces of manganese are found, which seem to result from the decomposition of manganesian garnets. Still stronger indications of this mineral are found near Town Creek, on the road between Pendleton and Table-rock.

Brasstown Creek flows through a narrow valley in the mica slates. A few miles from its mouth it crosses some strata less destructible than the rest, over which it tumbles, forming two pretty cascades in the distance of half a mile. To the right of this, some bold ledges of the same are found outcropping on the sides of the valley, and are highly charged with iron pyrites, which, by spontaneous decomposition, forms sulphate of iron, or copperas. This salt is found, in the state of efflorescence, on the surface of the rock, and among the fragments, where they are protected from the rains. Did the price of this useful substance warrant it, a considerable quantity could be obtained here. At present it is collected and used in domestic dying.

The gold of the District is, as yet, confined to deposit mines, and some of these rank among the best in the State, both in richness and extent. A vast amount of work has been performed in the deposits of Cherokee Valley. But it is extremely difficult to collect any reliable statistics on the subject, on account of the desultory manner in which the business is pursued.

From the angular character of the fragments composing the deposit, on Keowee, the property of Col. Calhoun, one might well expect that the vein, the original source of the gold, was not far off; yet no vein has been discovered.

At the base of the Estatoe Mountains there is a chalybeate spring, at Barton's, which is a pleasant spot from which to visit Table-rock, on the one hand, and Jocasse Valley and its beautiful water-fall, on the other.

CHAPTER VI.

Upper Secondary, or Cretaceous, System.—Tertiary Series.—Eocene.—Buhrstone Formation.—Calcareous Beds of the Charleston Basin.—On the Santee.—On Cooper River.—On Ashley.—On Edisto.—On the Savannah.—Recapitulation.

With the exception of a few unimportant beds, that occur on Thompson's Creek, in Chesterfield, which I have referred, with doubt, to the lower Silurian rocks, and a limited patch of New Red sandstone which is found on Clay Creek, in the same District, there is a wide gap in the geological series of South Carolina, extending from the metamorphic rocks to the Upper Secondary, or Cretaceous, formation. Unfortunately, among the missing rocks, we find the Carboniferous system, with its coal measures.

Whether the latter ever existed in the State, or not, it is now not easy to determine, but it is quite certain that not a vestige of the carboniferous rocks is to be found at present. There is nothing absolutely impossible in the supposition that these rocks may be covered and hidden from view by the Cretaceous and Tertiary beds; nevertheless it is exceedingly improbable: for along the Atlantic coast, between this State and New Jersey, these beds are frequently removed by denudation, and are found to rest, almost invariably, on the granite or metamorphic rocks, which is precisely the position they occupy in South Carolina; nor has there been a trace of the carboniferous rocks found in this connection throughout the entire distance.

The newer formations, particularly the Tertiary, are finely developed in the State; and to these attention will now be directed.

Cretaceous Formation.

The Cretaceous formation of the United States, although deriving its name from the chalk found in contemporaneous formations in Europe, does not any where contain beds of true chalk, but is composed of beds of clay, quartzose sand, calcareous matter, or marl, and green sand, variously interstratified.

The most interesting of these is the green sand, which, in New Jersey, where it has been long used as a manure, is called marl. It is composed of grains that are, sometimes at least, concretionary, and in size generally resembling ordinary gunpowder—the color green, inclining to black. It may be crushed by the finger-nail, and leaves a bright green streak, which is a simple and reliable test for this substance.

Its distribution in our rocks is very remarkable. In New Jersey and Delaware, where it occurs extensively, it is characteristic of the Cretaceous formation. In Maryland and Virginia this formation has not yet been recognised, and the green sand is found in the Tertiary, extending, in the latter State, as high as the Miocene beds. This is also the case at Martha's Vineyard, in Massachusetts, where Prof. Hitchcock has determined the existence of the Tertiary formation. In North Carolina, although the Cretaceous strata resemble in color and external appearance the Eocene green sand beds of Virginia, yet that mineral is very rare as an ingredient of those strata—at least where I have examined them, at Wilmington, and other localities higher up the Cape Fear.

In South Carolina I have not found a grain of green sand in the Cretaceous formation, and yet a bed of green sand, three or four feet in thickness, is found in the Eocene of the Santee River, and large grains, disseminated through some of the superincumbent calcareous beds.

It seems, then, that the quantity of green sand in the Cretaceous beds of the Atlantic coast becomes less and less towards the South, until it disappears altogether from them, in South Carolina.

The chemical composition of this mineral, it seems to me, leaves but little doubt as to its identity with those compounds known as *clauconite*, *green earth*, &c.

The following table presents the composition of green sand, from different localities in the United States, and of the green earth of Europe.

	Martha's Vineyard.*	New Jersey.†	Germany.‡	Scotland.§
Silica	56.700	48.45	46.1	48.16
Alumina	13.320	6.30	5.5	16.85
Protox. of Iron	20.100	24.31	19.6	19.00
Potash	——	12.01	5.3	6.56
Magnesia	1.176	——	3.8	2.91
Lime	1.624	trace	——	2.67
Water	7.000	8.40	8.9	2.35
Quartz	——	——	11.5	——
	99.920	99.47	100.7	98.50

The green earth of Europe is found occupying cavities in trap rocks; and if our green sand, as there is every reason to suppose, be identical with it, we may safely refer its origin to the vast series of trap dykes found along the Atlantic slope, from New Jersey to the Coosa River, in Alabama.

The debris of these rocks, washed down into the Cretaceous and Tertiary seas, would be quite sufficient to furnish the green sand of these formations—to say nothing of the probability of eruptions of trap in the seas of those periods.

The beds of green sand, of Virginia, present unequivocal evidence of their origin in the ruins of the older rocks, for near their upper verge they abound in fragments of limpid, smoky, and even rose quartz, sometimes rounded, but more frequently angular.

The Cretaceous formation of South Carolina is a continuation of the beds so finely exposed on the Cape Fear River, in North Carolina; it is seen again on a creek about half-way between Wilmington and Horry District. It dips beneath the sands of the coast, and is covered by Tertiary beds. In the District just named, however, this covering is so slight as to be removed by the waves, and cretaceous fossils are washed up on the beach. I found, at this place, which is a few miles south of the mouth of Little River, numerous valves of *Exogyra costata;* and this is the

*Dr. L. S. Dana. †Rogers. ‡Berthier. §Thomson.

most eastern locality of the cretaceous rocks in the State. From this it rises gradually towards the North-west, till it attains its greatest elevation, at Mar's Bluff, on the Peedee, which is about 150 feet above tide. Right and left of the river it is covered by the Tertiary formation, yet it seems to be at no great depth below the surface, for it is exposed near Darlington Court House and on Black Creek. A line drawn from the Court House, south, to the mouth of Sparrow Swamp, on Lynch's Creek, and thence to Black River, below King's Tree, will mark the western boundary of this formation, in South Carolina. It now sinks beneath the Tertiary of the Santee and is not seen again.

At Buck's Saw-mills, on the Waccamaw River, nine miles below Conwayboro, is the lowest point, in Horry, where it is seen. Here some bands of silicious, slaty rocks are found, at low water, that must be referred to this formation, although I found no fossils in them. On the banks of the lake, at Conwayboro, beds of indurated calcareous clay occur; and on the opposite bank of the river, on Mr. Wilson's land, similar beds are found, which correspond in position and mineral character with certain cretaceous beds.

At Harper's Landing, a few miles higher, on the river, they rise above the surface of the ordinary state of the river, eight or ten feet; they are composed of a grayish, sandy clay, but slightly calcareous, containing *Exogyra costata*. These beds are overlaid by a stratum of upper Tertiary marl, abounding in fossils. The fine section at this place is one mile and a half in length.

At Waller's it is seen again, but rising above the river only two or three feet, showing a considerable amount of undulation in the surface. On Tilley's lake, at Nixon's, it occupies the same position, and is elevated about the same height above the river. At both of these places *Exogyra costata* is the only fossil present.

Other localities occur as high up the river as Royal's Landing, but they present nothing to distinguish them from these. They are every where overlaid by Pliocene beds.

The lowest point on the Peedee where the Cretaceous rocks are exposed, is at Yahany Ferry. At low water beds similar to those on the Waccamaw are seen here. About ten miles higher up the river, at Petersfield, a bluff four or five feet in height is composed of dark gray beds of sand and clay, with white, irregular fragments of marl; the mass, however, is but slightly calcareous.

Britton's Ferry, still higher, exhibits a fine section, ten feet in height. About seven feet of the upper portion of it is composed of a mixture of sand and clay, approaching loam, with very finely comminuted shells interspersed throughout the mass. These beds, although quite dark when wet, become light gray or ash color, when dry. Underlying this, and immediately on the brink of the river, is an indurated bed, which Mr. Ruffin has called marl stone. It is about three feet thick, and much more calcareous than the superincumbent bed, which is washed away three or four feet, leaving this standing out, and forming a convenient terrace from which the section may be examined. I found here *Exogyra costata*, *Gryphæa mutabilis*, *Anomia argentea*, *and Cucullæa vulgaris*.

Composition of the Beds.

	Upper Stratum.	Marl Stone.
Carbonate of Lime	29.30	55.00
Silica	40.00	30.25
Alumina and Ox. Iron	30.50	13.60
	——99.80	——98.85

Towards the top the upper stratum becomes less calcareous, and is charged with sulphate of iron. These beds may be traced, at intervals, nearly to the preceding locality.

At Port's Ferry the same beds occur, and are composed of precisely the same materials. The ledge of marl stone is about four feet thick, presenting, on the upper side, an even surface, but below it is much water-worn and shelving. In addition to the fossils at Britton's, I found here, in the marl stone, very perfect casts of *ammonites placenta*, *Mor*. for the first time in the State.

The stratum above the marl stone contains soft concretionary nodules of lime, like those I observed at Petersfield. The beds now show a very decided dip, wherever they are sufficiently stratified to render it observable. So long as the thick upper beds alone appeared above the surface, it was difficult to observe it; but the ledge of marl stone, which is exposed at low-water, makes it quite evident. For instance, at Britton's Ferry it was, when I observed it, on a level with the river; at Port's Ferry it was two or three feet above it; and at Williams's Bluff, above this, the bed below the marl stone comes fairly into view. Of course, in making these observations, the direction of the river must not be lost sight of; for where a bend coincides with the strike, the rock will appear horizontal, and it is only where the direction of the stream is at right angles with the strike, that the dip can be correctly determined.

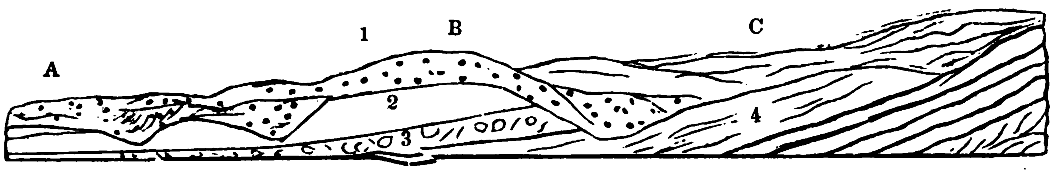
The last mentioned bluff presents an exceedingly interesting section. The alternating beds of marl and marl stone are seen gently emerging from the water. Above the marl stone is a white stratum, very rich in calcareous matter, and this is succeeded by irregular masses of calcareous rock, filled with the common cretaceous fossils, *Exogyra costata* and *Ammonites*.

Similar alternations of hard and soft strata occur at Gibson's Bluff. The marl, however, which is of greater thickness, is capped with a bed of compact limestone, the weathered surface of which is paved with fossils, composed of crystallized carbonate of lime. I identified, among these, *Plagiostoma dumosum?* well preserved *Venilia Conradi, and Crassatella*—species undetermined.—These, with other fossils, occur here in horizontal layers, and are detached from the matrix with difficulty, for this limestone is equally hard and compact with that of the older fossilliferous rocks.

At Giles's Bluff, on the land of Col. Davis, the calcareous beds attain their greatest height, which is about 20 feet above the river. The section, however, differs little from those just examined, for it shows the usual alternation of hard and soft beds, containing nearly the same fossils. The formation at this point, namely, between Gibson's and Giles's Bluff, has its maximum of calcareous matter, and for the simple reason that the middle beds are most exposed, that is, those in which the indurated beds occur. The upper part of the soft marl is generally poorer in lime than the bottom of the same bed, perhaps because much of it has been removed by the percolation of water. The bed underlying the marl stone is also poor.

Now it is the upper part of the marl that is exposed below Britton's Ferry; and it is the lower beds—those below the marl stone—that come to the surface higher up on Lynch's Creek. The following section, (Fig. 26,) will make this plain.

Fig. 26.



Section from Britton's Ferry to Mar's Bluff.

A.—Britton's Ferry. B.—Giles's Bluff. C.—Birch's Ferry. D.—Mar's Bluff. 1.—Tertiary Beds. 2.—Marl, overlying marl stone. 3.—Marl stone. 4.—Beds underlying the marl stone. 5.—Shale. 6.—Sand.

The next exposure, on the banks of the river, is at Birch's Ferry, where a fine section, 200 yards in length, and 15 to 20 feet in height, is laid bare. The fossilliferous bed of marl stone, (3, Fig. 26) has disappeared. The stratum immediately below it forms the greater part of the bluff, and the black shale makes its appearance, for the first time, as a distinct and well characterised stratum. It is seen, at the southern extremity of the section, emerging with a gentle dip from the water. I found here *Ostrea cretacea* pretty common, and *Belemnites Americanus*, in most astonishing abundance. The lower part of the perpendicular bluff is only accessible by means of a boat; but when the ledge of shale is reached one can then examine that part of the section with ease. The bed overlying the shale, which I have already said constitutes the greater part of the bluff, is a soft, dark gray marl, and, for the first ten feet, is filled with *Belemnites*, which project from it in every direction. It looks as if some persons had amused themselves by driving as many as possible into the face of the bluff. Hundreds have fallen down and are strewed along the edge of the water.

This is certainly the most extraordinary locality of this fossil in the United States, or perhaps in any country. I looked in vain for any other remains of the *Cephalopod*, that must have existed on this spot in such vast numbers.

The substance that I have denominated shale is a black, laminated clay, quite smooth and unctious to the touch, but is seldom so hard as not to yield to the knife. There is a black mud, which is found in the marshes and other places in Charleston harbor. It is called "pluff mud," and when dry it resembles this shale more nearly than any substance that I have seen.

A half mile west of the river the marl stone stratum outcrops, on the road side, near Leggett's mill-branch. It contains but few fossils, and among them I found *Anomia argentaria* and *Belemnites;* and this is the only place, besides Birch's Ferry, that I have found this fossil.

At Gordon's old mill the shale occurs, and is overlaid by masses of silicified shells. I identified, among these, *Cardita planicosta* and *Turretilla Mortoni*, two characteristic Eocene fossils—showing the existence of this formation on the Peedee.

The calcareous beds of the Cretaceous formation extend a short distance above the mouth of Jeffrey's Creek, and after that the shale alone is found in the river bluffs. It continues to rise, and the underlying sandy beds make their appearance.

The noted locality, Mar's Bluff, is made up of these beds, in the following order, beginning at the base: Blackish clay and sand, five feet, overlaid by beds of sand, showing oblique lamination; these are succeeded by heavy beds of shale, almost unmixed, which are capped by alternating bands of shale and sand.

At Greenwood, a short distance higher up the river, the sand becomes a solid sandstone, which is found alternating with clay.

I made diligent search for fossils, at this place, yet, notwithstanding the apparently favorable circumstances presented by thick beds, evidently deposited in tranquil water, a single species alone rewarded me for my trouble, and that was *Hamulus onyx*, a fossil which had previously been found on Lynch's Creek, by Dr. Blanding.

On the river the shale now gives place to the underlying beds of sand, which become blended with the Tertiary beds of sand, clay, and gravel, that cover the surface and overlap the metamorphic rocks above, and cover the whole of Marlborough.

There are few sections more instructive than those presented by the Cretaceous beds of the Peedee. It is true that fossil species are not numerous, and, with a few exceptions, the shells occur only in the form of casts, but every fragment is characteristic. The gentle dip of the strata, seldom exceeding an angle of 10°, marks the quiet manner of their elevation. In proceeding upwards, the superincumbent strata disappear at the surface, giving place to those below, as they successively emerge from the water.

The upper surface is very uneven, and at intervals between the bluffs the formation is removed, by denudation, altogether; the beds, however, preserve their relative position, and the depressions on the surface are often filled with Tertiary beds—to be described in another place. The uniformity of mineral character of the formation is very remarkable. The sections on the river extend over a space of sixty to eighty miles, and yet three or four well marked strata characterise the whole. First, beds of dark gray, and generally soft marl, varying somewhat in the amount of lime and silicious matter; next a stratum of hard lime or marl stone, much richer than the preceding, in calcareous matter, and very uniform in external appearance; and lastly the shale, which contains no lime, and which can be mistaken for no other rock in the State. It often contains iron pyrites, which gives rise to the sulphates found efflorescing on the surface.

Mr. Ruffin, who examined all these localities with care, pointed out the interesting fact, that every one of them occurs upon the right bank of the river. He noticed that this was also the case on the Savannah, and rightly concluded that an effect so general could only be the result of some common cause. I think that this phenomena is not confined to these rivers, nor to South Carolina, but may be seen in those to the East and West; but I shall take up this subject in another place.

It is quite evident that the Cretaceous formation underlies the whole country between the Little Peedee and Lynch's Creek, for I found a fine bed exposed at Hodge's mill, about eight miles above Gallivant's Ferry, on the former river. This is by far the richest bed in fossils that I have seen; but they were in a chalky state, and the marl being quite soft, it was impossible to preserve them.

On Willow Creek the formation is exposed for miles; and on Jeffrey's Creek the shale comes to the surface in numerous places.

Between Mar's Bluff and Darlington Court House, I observed it, on Black Creek, where it is covered by sand, and at other points along the road. Near the village it underlies the Tertiary beds, and is exposed in thick fissile beds, at Col. Ervin's marl pit.

Directly south of the Court House the Secondary rocks are exposed, on Sparrow Swamp, near its junction with Lynch's Creek. This locality is found near the point where the corners of Marion, Williamsburg, Sumter, and Darlington Districts meet. It is the oldest, and was almost the only locality known in the State, of this formation, before Mr. Ruffin's discoveries. It is known to Geologists as Effingham's Mills, and was first made known by Dr. Blanding. It forms the banks of the stream, to the height of four or five feet, and extends across the swamp at the mill. The bed is composed principally of a poor, silicious marl, with irregular bands of marl stone running through it. The most common of all Cretaceous fossils, *Exogyra costata*, abounds here. I also found *Trigónia thoracica*, and another undescribed species.

It is highly probable that the channel of the creek, like that of the Peedee, is cut in this formation, for it may be traced some miles lower down. It appears again as the creek approaches the river, and at its mouth it rises into beds of considerable thickness.

West of this, on Lynch's Lake, it also occurs; and I received, from the Hon. G. C. Cooper, specimens from the Black Mingo, near Indian Town, which prove the existence of the fossilliferous marl stone at that place. Among them were *Ammonites placenta*, with the nacreous portion of the shell beautifully preserved; and a fragment of a shark's tooth, of the genus *Carcharodon.*

Mr. Ruffin examined other localities on Black River, below King's Tree, that I did not, for want of time, visit.

The same inequality of surface is presented on Lynch's Creek that was observed on the Peedee, and the depressions are, in like manner, filled with beds of Tertiary marl—showing that the Cretaceous formation formed the bottom of the Tertiary sea, during the deposition of these beds.

The unequal distribution of carbonate of lime in the softer marl and marl stone, is not an uncommon circumstance; for when beds are porous, and consequently permeable to water, they are subject to lose a portion of their lime, which is dissolved and carried away. The water holding the lime in solution is, however, often arrested by meeting with less porous strata, and the result is, frequently, the formation of a hard, calcareous bed; so that marl stone is often formed at the expense of the lime of the superincumbent strata.

Ten specimens of marl, analysed by Mr. Ruffin, from various sections of the Peedee beds, gave an average of 34 per cent. of carbonate of lime; and eight specimens of marl stone presented an average of 75 per cent. Near the upper surface of the beds it is often observed that very little lime is present, and that hollow moulds of the exterior of the shells remain, which are coated with oxide of iron. This generally happens where sulphuret of iron is present: it generates sulphuric acid, which acts as a solvent of the lime; or else it forms sulphate of iron, which is decomposed by the lime, leaving behind incrustations of oxide of iron.

The cretaceous fossils of the State, so far as they are known, are comprised in the following very short list.

Carcharodon,	sp?	near megalodon.
Lamna,	sp?	
Belemnites Americanus,	Mor.	
Ammonites placenta	Dekay.	
Turritella vertebroides,	Mor.	
Natica petrosa,	"	
Ostrea cretacea,	"	
Exogyra costota,	Say.	
Plagiostoma dumosum?	Mor.	

Pectunculus hamula	Mor.
Anomia argentaria	"
Cucullæa ovata.	
Trigonia thoracica,	Mort.
" crenulata.	
Cardium altum.	
" sp?	
Crassatella vadosa,	Mor.
Hamulus onyx,	"

Tertiary Series.

Pursuing our investigations upwards, we next come to a group of rocks, presenting altogether a different aspect from those we have just examined. The dark beds of marl and marl stone of the latter are replaced by thick strata of white limestone, and beds of highly calcareous marl, that remind one of chalk. So totally unlike in mineral composition, are the Cretaceous and Tertiary rocks of South Carolina, that even in the absence of organic remains, they cannot, in general, be confounded with each other for an instant.

I stated, in another place, that green sand was a prominent constituent of the Lower Tertiary of Maryland and Virginia. In the green sand strata of the latter State there is frequently not a trace of lime, and when it is present it rarely exceeds 25 to 30 per cent. These are, however, interstratified with calcareous beds; but even in these the lime seldom amounts to 60 per cent.

It is not before we reach North Carolina that we find beds at all approaching in mineral character those of South Carolina. Above Rocky Point, on Dr. McRee's plantation, white limestone and marl occur, abunding in corals, and in all respects similar to the Eutaw beds, in this State.

Marl Bluff, about thirteen miles from Wilmington, on N. E. Cape Fear, is another locality where a white calcareous bed is found, made up of the comminuted shells of *Echinoderms*. These and the beds at Wilmington are good examples of the great calcareous deposits of the Tertiary of South Carolina.

We have, in the accumulations going on along our coast, at the present time, analogies that enable us to understand the cause of the difference in the amount of calcareous matter in contemporaneous beds, at distant localities. There is not more difference in this respect, between the Virginia and South Carolina strata, than there is between the deposits forming at this moment on the coast of Virginia and on that of Florida. I saw, in the cabinet of Prof. Gibbes, of Charleston, specimens of calcarereous mud, brought from Key West, by Dr. Wurdeman, which so closely resembled the Cooper River marls, that it was difficult to distinguish the two. This mud is accumulated in great quantities in the vicinity of coral reefs, and is from thence distributed along the shore. The shells of molluscs are buried in it, in vast numbers, and in time it may present the counterpart of our rich shell marl. Farther north the coast deposits consist of mud, sand, and comminuted shells, which also serve as the burying ground of numerous molluscs, that leave behind their well preserved exuviæ, and present us with types of a former state of things.

The physical changes that could have so completely affected the mineral contents of two formations deposited on the same spot, and superimposed, the one upon the other, as are the Cretaceous and Tertiary rocks, must have been very great, to say nothing of the almost total extinction of animal life, which took place at the close of the Cretaceous period.

The Tertiary rocks of South Carolina are composed of beds of loose sand, clay, gravel, and sandstone, together with strata of limestone of great thickness, and beds of soft or pulverulent marl.

A line drawn from the mouth of Stevens's Creek, on the Savannah, north of Hamburg, crossing the Saluda and Broad rivers, near their junction; the Wateree, at the Canal; Lynch's Creek, at Evans's Ferry, and Thompson's Creek, at the point where it enters the State, in Chesterfield District, will mark, with sufficient accuracy, their upper boundary. Wherever the rivers, in their downward course, enter this boundary, they wash away the more yielding Tertiary rocks, and expose the metamorphic, and very frequently the granitic rocks; and hence it is that at these points, in ascending the rivers, we meet with the first falls. And this is true along the whole Atlantic slope—the boundary of the Tertiary, coinciding with the first, or lowermost, falls on the rivers; and for the obvious reason that the Tertiary rocks do not offer sufficient resistance to the force of the streams to produce obstructions.

Nothing can be better marked than this boundary: a line of outcropping, sandy strata extends along the entire distance, overlapping the clay slates, or granite, and producing a striking change in the topography, and even in the botanical character of the country. The long-leaved pine, (*Pinus palustris*,) finds here the line that limits its distance from the coast; nor does it venture beyond it, excepting where a sandy, granitic ridge meets this line, and tempts it to proceed a few miles beyond.

It is interesting to find so conspicuous a plant as this noble pine marking, throughout its entire range, with such accuracy, the boundary of a geological formation.

Among the under-growth characteristic of this region, the scrub oak, (*Quercus catesbei*,) is prominent. The rare *Ceratiola* is confined to a very narrow belt here, together with several showy species of *Baptisia*. The brown grass, (*Andropogon*,) which takes possession of barren wastes higher up, is here replaced by the genus *Aristida*, which is the natural grass of the open pine woods. In short the Flora of the upper verge of the Tertiary is as distinct from that of the rest of the State as are the two geological systems that meet there, from each other.

Eocene.

We have seen that the Cretaceous formation sinks under the Santee River, forming a depression of great depth, which is filled with calcareous and other rocks, and which I have named the Charleston Basin. The calcareous rocks are those which Mr. Ruffin called the Carolina Bed, on account of their great development in the State. They are seen outcropping, at intervals, along the right bank of the Santee, as high up as Stout's Creek, about ten miles below the junction of the Congaree and Wateree rivers; again, in the vicinity of Orangeburg Court House; on Rocky Swamp, S. Edisto; on the head waters of the Salketchie; on Tinker's, and down the Savannah, below the Lower Three Runs. The marl of these beds is also said to exist on Ashepoo River, and if so, this is the most western point in the State where it occurs. Underlying these vast deposits of calcareous matter, are beds of clay, sand, gravel, &c. which, together with the Carolina Bed, constitute the Eocene formation of the State.

These underlying beds are best examined along the upper edge of the formation, where they are cut through by the rivers and streams. On the Savannah a good section occurs, at Silver Bluff, below the mouth of Hollow Creek; it is composed of beds of sand, and blue tenacious clay. I examined this locality with care, because it is one of those mentioned by Bartram, as Cretaceous, for he says that he found *ammonites* here. I found a bed of lignite a few miles up the creek, which is doubtless what he saw and described. Its dark color, so much like that of other Cretaceous beds of the State, deceived him.

A bed of white clay underlies the lignite, which is three feet thick, very compact, and containing iron pyrites. In portions of the bed the structure of the wood no longer remains, it being reduced to a jet black homogeneous mass. The superincumbent bed is twelve feet thick, and is composed of sand and gravel. There are indications of this bed on other parts of the creek, but I could find no fossils in it, and from the identity of the mineral character of the associated strata, I must refer it to the Eocene of this region.

At the ferry, below Augusta, a section of considerable height occupies the left bank of the river. It is made up of beds of clay and sand, the latter obliquely stratified, and presenting evidence of deposition from water violently agitated. Nearly all the sections among these beds present very striking proofs of having been deposited during alternating periods of repose and violence, for the sand and gravel are thrown up obliquely to the general planes of stratification, in a manner such as one may see on the coast, after a storm. These beds are followed by others, composed of clay, deposited in horizontal planes, evidently fine, sedimentary matter, once held in suspension, and thrown down in still water. Porcelain clay, or *kaolin*, mixed with grains of quartz, and scales of mica, the ruins of granitic rocks, form a large part of this bluff, and to these it owes its white color.

At Hamburg, some high red cliffs, overlooking the town, belong to this formation. In the vicinity, a locality, known as the "Chalk Hills," was pointed out to me, by Dr. Wray, of Augusta. The name of these hills is derived from the very fine beds of porcelain clay found there, which are overlaid by red loam and sand. The surface is very much broken and washed into ravines by the rains, and the alternating red and snow-white beds give the place a picturesque appearance.

Among the beds of white clay I found crystals of hornblende, showing their origin to be the sienite, of which there is none found nearer than Abbeville. The whole of these beds are obviously the remains of the granitic rocks, brought from above—the kaolin being derived from those abounding in feldspar. It appears also that the kaolin of many of these beds had been separated from the original granite, before their transportation hither, for I found interspersed rounded pieces of kaolin, evidently formed by the breaking up of previously existing beds.

Nearly the whole of this region, known as the "Sand-hills," is underlaid by beds of this mineral, frequently of unsurpassed purity. Those near Hamburg are ten to fifteen feet in thickness.

Similar deposits occur between Aikin and Graniteville, but of far greater extent, the beds being, in many cases, sixty feet thick. They are, however, intermixed with bright red and yellow clays.

For a mile in extent these beds may be traced in the ravines on the surface. The overlying sands are often washed away, and leave a series of bald, round and snow-white hills, relieved by an occasional stunted pine, or a clump of kalmias—often producing a pretty little picture amid the monotony of pine woods scenery.

Occasionally a level spot occurs where the impervious sub-soil of porcelain clay retains the rain-water, producing a verdant spot, interspersed with plants that love wet places, which contrasts pleasantly with the surrounding parched and scanty herbage. Beds of pure quartzose sand are also found here among these hills, that would answer well for the manufacture of glass.

On Horse Creek I examined a very remarkable sand stone, which is not uncommon among the strata under consideration. It consists entirely of the ruins of granite, consolidated into a pretty hard rock. The quartz, feldspar, and mica are there, and it requires a close examination to satisfy one that it is neither granite nor gneiss, in which the feldspar has barely lost its lustre. It is soon seen, however, that the latter mineral is not disposed, throughout the mass, in crystalline grains, as is the case in granitic rocks, but that it is the cement, keeping the whole together. It is not, in fact, feldspar, but that mineral deprived of nearly all its potash.

This rock varies much in its structure, and is coarse or fine grained, as quartz or porcelain clay abounds in it. In some beds the quartz and mica are disposed in laminæ, and it then resembles gneiss. In almost every case round pieces of the kaolin will be found scattered through it, which will always be sufficient to distinguish it from the older rocks, in the absence of organic remains.

Of the beds of loose sand of this formation fine sections are seen on the "Inclined Plane," at Aikin: they are composed of sand, colored clays, kaolin, with water-worn fragments of the latter interspersed.

The next stratum, superimposed on these, is uncovered on a little stream about one half mile west of Aiken. It is a yellowish white, silicious rock, comparatively light. It yields readily to any cutting implement when first taken from the quarry, but becomes much harder by exposure. It is disposed in very regular beds, evidently deposited from still water, and indicating a period of repose that succeeded the deposition of the preceding beds, which present, in the manner in which they are thrown up, evidence of strong currents, and otherwise agitated waters. This bed, which is not more than four feet thick at this place, is very variable in its structure and appearance: sometimes appearing as a laminated silicious clay, at other localities it is quite hard, breaks with a conchoidal fracture, and resembles *menilite*. Another variety is light and porous, and so closely resembling the infusorial earth of Virginia, that I incautiously referred it to that substance, and thus misled Mr. Ruffin. This curious stratum I traced, at distant localities, nearly encircling the boundary of the calcareous beds of the Charleston Basin.

On the hill side, and overlying this, the northern edge of a bed composed of silicified shells, cemented together, and resembling buhr millstone, is found. The fossils at this locality are neither numerous nor well preserved, but I recognised, among them, *Fusus papillatus*, *Ostrea longirostris*, and *O. Alabamiensis*—well known Eocene fossils.

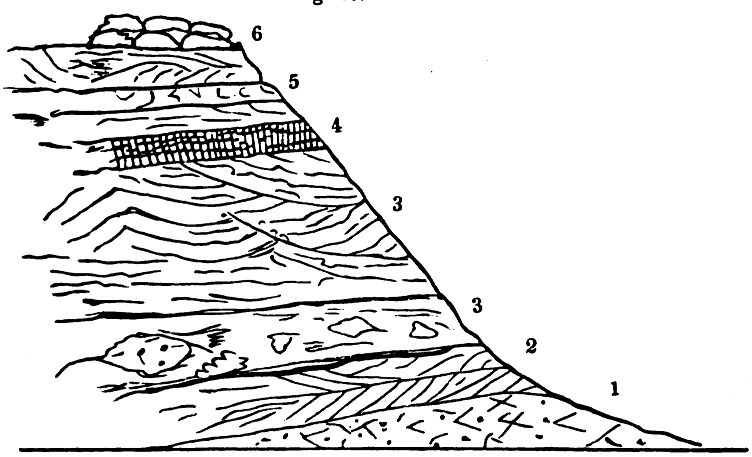
A few miles south of Aiken, on Cedar Creek, one of the branches of Upper Three Runs, this rock is again exposed in beds of considerable thickness. On each side of the little valley, on the farm of M. Caradeaux, thick ledges of silicified shells are seen outcropping, and as they are underlaid by sandy beds, which are often washed away, the rocks tumble down and strew the surface. The shells having left their hollow casts only, which gives the rock a cellular structure that fits it admirably for mill-stones. The casts are sometimes filled with silica, in the form of curiously interlaced filiments, that resemble a spider's web, spread over the surface. The cavities in the rock have a vitreous appearance, as if it had undergone a partial fusion, and brown and striped jaspers are quite common in the mass. The lower part consists of a bed of *Ostrea longirostris*, in the form of casts, perforated by boring shells, which have left behind them casts, with the tubes and all beautifully preserved. It is remarkable that when these rocks are decomposed, the substance left resembles silicate of alumina or porcelain clay. Indeed the passage of this substance into the silicified rock, may be distinctly traced. Among the fossils casts of corals are conspicuous, and I found what I suppose to be the ***Palmula***, of Lea.

This is undoubtedly the most extensive locality of buhr-millstone in the State. Taken together, the beds exceed thirty feet in thickness.

Superimposed upon this, there is generally a stratum of fine sand, which overspreads almost the entire surface across the State, north of the calcareous beds of the Charleston Basin. On the crest of the sand-hills of this region there are often irregular beds of oxide of iron and sand, as I have already mentioned, when describing the denudation of Chesterfield District. In the vicinity of Aiken the seare conspicuous, as well as on the hills between that place and Graniteville. The beds are from three to six feet in thickness, but it was not before I reached Orangeburg that I discovered any fossils in them. There I had the pleasure of finding beautifully distinct casts of *Cardita planicosta*, and in great numbers. This group of rocks, which constitutes, in South Carolina, as I shall presently show, the lowest beds of the Eocene, may be conveniently included under the name of Buhr-stone formation.

The following section, from Aiken, down the "plane," to Horse Creek, will place the relative position of these in a clear light.

Fig. 27.



1.—Granite, on Horse Creek. 2.—Beds of sand-stone and grit. 3.—Beds of sand, gravel, colored clays, &c. showing false bedding. 4.—Silicious clay bed. 5.—Silicified shells. 6.—Beds of sand and iron ore.

A peculiar feature in the topography of this sand-hill region is the number of circular depressions that are scattered over the surface. They are not deep and conical, like "lime-sinks," but flat and shallow, at first sight reminding one of a circular race-course. They are numerous in Barnwell District, and may be seen between the Court House and Aiken; some filled with water and others dry. Between Orangeburg and Rocky Swamp, on the Edisto, there are several—some of them many acres in extent, quite level, and having the edges somewhat raised above the ordinary surface. They have quite an artificial appearance, and it was not before I had examined the ponds, above Vaucluse, on Horse Creek, that I was enabled to make them out.

At the latter place the ponds are situated at a considerable elevation above the valley of the creek, having under-ground vents opening on the sides of the hills, in the form of what are called "boiling springs," that is, springs that bubble up with some force. No inconsiderable amount of fine sand is thrown out by these springs, and conveyed downwards by the streams.

Now it is obvious that so long as a pond supplies more water, derived either from rains or springs, than these vents can carry off, it will remain permanent; and, on the other hand, when the vents, from any cause, become too great, or will discharge more than the supply, that the ponds must be drained. Should these under-ground drains afterwards become choked, or by any means stopped, the ponds would again be filled; and such alternations as this I have seen in Barnwell—where roads once passed through dry hollows, that are now permanent ponds; and the stumps of pine trees, standing in the water, show that they had long been dry.

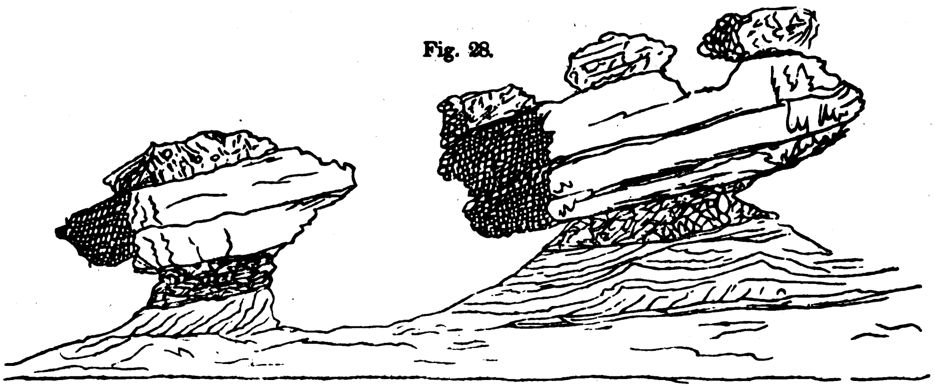
Other examples were pointed out to me of ponds of considerable extent that were known for years with water, but becoming dry, now present the depressions of which I have spoken. The circular form of these depressions is easily accounted for. Any sheet of water, in so incoherent a soil as that covering the surface of this region, however irregular its outline, would soon become circular, because the projecting irregularities would be washed away. Neither is it difficult to understand why the depth should be so slight, and the form not conical, like lime-sinks. The sandy surface, when completely saturated with water, becomes almost semi-fluid, and as sand is removed by the drain, of course this semi-fluid mass flows in towards the centre, and, by extending the circumference, prevents any material change in depth. And after the pond has become dry, this tendency towards the lower points still continues until the surface becomes nearly level. Of course the clearing and cultivation of the land are constantly affecting these accumulations of water.

It will be seen that Aiken, including a few miles around the village, presents peculiar facilities for the study of the Buhr-stone formation of the State. From the summit to Horse Creek, the perpendicular height is 200 feet, and in this thickness we have all the members of the Buhr-stone formation.

The granite ridge that extends across to Columbia is covered by beds of white sand. Where these are removed, on the hill-sides, the underlying red loam is exposed, which forms a better soil. On the ridge, above the head waters of Edisto, the surface is level, as far as Lexington, and in summer the deep sands make travelling exceedingly laborious.

From Aiken to South Edisto the country sinks gently, but the ridge between the two rivers is elevated, and is an uninterrupted pine barren; the beds of sand, however, are not so deep, and the red loam and mottled clays come more frequently to the surface. Towards the head springs of Lightwood Creek the white Eocene grit and sandstone are left upon the tops of the ridges, in thick ledges, interstratified with beds of sand and porcelain clay. These ledges are ten or twelve feet in thickness, and, from the unequal resistance they present to destructive atmospheric agencies, they are worn into singular forms. The lower beds are often loose sand, which is constantly subject to waste—the undermined superincumbent beds of rocks fall down and cover the surface with their ruins. Fig. 28 is an example of the forms given to these rocks by unequal disintegration.

Fig. 28.



The next locality of this rock to be examined, occurs at the head of Congaree Creek, where it outcrops in the form of beds varying in thickness from three to forty feet, and interstratified with loose sand and white clay, which only differ from the hard rock in not being cemented into a solid mass. Many grotesque forms are presented by the rocks at this interesting locality, and are due to the cause explained above.

When the hard stratum rests upon one of sand or clay, portions are often left standing, like an enormous fungus. One of the most remarkable of these is called Buncombe's Table, and is said to commemorate a person of that name, of Revolutionary memory. One of the most remarkable beds here is one of mottled clay, quite indurated, and in some parts of the bed sufficiently hard to take a good polish. The bed is unfortunately much broken by fissures, otherwise this would be an exceedingly ornamental rock.

This is the first locality at which I discovered fossils in the sandstone. They occur in the upper part of the bed, but are so comminuted as to render it impossible to determine more, with certainty, than their Eocene type.

At the "Rock House" is another noted locality, where this rock has been quarried for architectural purposes; and it was here that all that was formerly used in Columbia was procured. The outcrop is half a mile in length, and a section of 100 feet in height may be examined at this spot. About eight or ten feet of this is solid; the rest is loose sand, clay, mica, &c. presenting beautiful examples of false bedding. Fine porcelain clay is seen in beds in the sand, and indurated, or converted into semi-opal in the rock. The sandstone is seen in all stages of disintegration, and presents every degree of fineness, from coarse quartzose grit to hard white clay. The debris that covers the surface has very much the appearance of pulverized granite.

Three quarters of a mile south of this I found impressions of leaves of Decotyledonous plants, silicified wood, and fragments of bones, in about three feet of the upper part of the rock. Some remarkable beds of porcelain clay are found on the sides of the valley; the clay is colored by oxide of iron, and presents every shade, from a light buff to deep yellow.

Whenever the porcelain clays of the State come into use, the pure white deposits of Congaree Creek will hold a prominent place.

Second Creek exposes, on its banks, a fine section, where it passes over the outcrop of the sandstone. The first three feet, in the descending order, is composed of silicified shells, passing into sandstone, five feet thick, the whole resting upon a bed of sand and gravel, nine feet. The surface of the sandstone contains embedded fragments of bones.

Among the shells I recognised *Cardita planicosta*, *Pectunctulus pulvinatus*, and *Cytherea, sp?* but the whole seem thrown together in confusion, and not a single valve is found in juxtaposition with its fellow.

These localities are highly interesting, as placing beyond doubt the relative position of the silicified shells and sandstone.

Between Congaree Creek and Lexington Court House, on Red Branch Creek, vast beds of variegated clays are exposed, in the ravines, on the southern slope of the hills, which are protected from further denudation by horizontal beds of iron ore and ferruginous sandstone. The ore is good, but does not occur in sufficient quantity to be of any economic value. Congaree Creek is the most eastern point to which I have traced the sandstone of the Eocene.

The spring branches, and even streams of considerable size, sink into the sands of this region, and are lost, or re-appear at distant points, in the form of springs; and to this fact is due the almost entire absence of swamps, and the consequent healthfulness of the sand-hills of the State.

Near one of the head streams of Congaree Creek the silicious clay bed may be seen, cropping out on a hill 80 or 100 feet high—it is four feet thick, and rests, as at Aiken, on beds of kaolin, sand, and gravel, and is covered by ferruginous sandstone.

There is a quarry opened in the bed, at this place, which has furnished materials for chimneys for the surrounding country. For this purpose this indurated clay is admirably adapted, for it may be sawed into blocks, and fashioned with the axe into its proper shape, and it resists disintegration well. Add to this, that its extreme lightness renders the carriage and subsequent handling comparatively easy.

The next remarkable locality of silicified shells, towards the northern boundary of the Buhr-stone formation, is found on Beaver Creek, not far from its junction with the Congaree, and at Mr. Oliver's mill. The bed of silicious clay, which is ten feet thick, at this place, is quite dark, and when wet, almost black. It is laminated and quite hard, and breaks with a conchoidal fracture. It contains much iron pyrites, and a spring that issues from it is highly chalybeate. It is, as usual, associated with silicified shells of Eocene species.

A short distance west of this is another instructive exposure, near a little mill, on Ball Creek. Here the bed of laminated hard clay, is twenty feet thick; and, like that at the last locality, it breaks with a conchoidal fracture.

At Col. Rumph's, a few miles east of Oliver's, I examined a fine section, composed, towards the bottom, of beds of quartzose sand, porcelain clay, &c. This is overlaid by the bed of silicious clay, which is thirty feet thick; and above this, a bed of iron ore, already mentioned, containing very perfect casts of *Cardita planicosta*, which must have existed in vast numbers, for some of the masses of iron ore are completely filled with them.

The bold hills of this locality show the great thickness of the Buhr-stone formation of the northern part of Orangeburg District. The distance below Columbia is about eighteen miles, and this is the highest point on the Congaree where any organic remains of the Eocene are found.

Around Totness the silicified shells are found in a bed sufficiently hard to be used for building purposes, and about a mile farther south, at Butler's mill, the clay stratum makes its appearance, on the side of a hill, about fifty feet above the level of the mill pond. It is underlaid by the mottled clays and sand, and above it is a band of iron ore.

The upper sandy stratum that covers the upper part of the District now thins out as we descend towards McCord's Ferry, and the yellowish and red loamy beds of the Buhr-stone formation appear at the surface, and form a wide and well marked belt, that extends across the country. The peculiar ochrey color of the subsoil of this belt is so different from that of all the others of the State, that it enabled me to identify the formation to which it belongs, on the Peedee, before I had seen any fossils or other evidence of its existence there.

Crossing the Congaree and Wateree, near their confluence, I was not a little surprised, on emerging from the low grounds of the latter river, to find the first rocks in view, on the brow of the hill, to be the silicified shells and associated bed of clay. I had now traced these beds from Barnwell to Sumter, a distance of one hundred miles, and it was curious to find them here retaining all their characteristic features and relative position. The buhr-stone has fallen down from the hill, and large blocks are scattered on the road side: the fossils are so much broken and so firmly cemented, that I could not identify a single species. The bed of silicious clay is laid bare on the brow of the hill, for a considerable distance, and fragments from the outcropping edge strew the surface. Mr. Ruffin examined this stratum in several places, in Sumter, and was also struck with the uniformity of its appearance. It underlies the sand-hills of the District in heavy beds, and has received the name of "Fuller's earth." Casts of fossils are found in it, but they are few and small, and I only made out among them *Pecten Lyelli.* Beyond this, towards the East, it is not again seen, although the associated bed of silicified shells is found on the Peedee. I first observed the sienna-colored loam and sand of the buhr-stone, about sixteen miles north of the mouth of Lynch's Creek, and at Gordon's old mill I found masses of that rock, containing *Cardita planicosta*, and *Turritelli Mortoni.* Above Mar's Bluff there are also silicified shells that I refer to this formation.

Mr. Ruffin observed other beds of buhr-stone, on Black River, below King's Tree, but states that the shells were very imperfect, and that they were, in some cases, still undergoing the process of petrifaction, for he found some of them having a part of the calcareous matter left.

A similar phenomenon may be seen at Stroman's, on Rocky Swamp, Orangeburg, where I found *Cardita planicosta*, with a portion of the shell composed of chalky carbonate of lime, and the rest silicious. What was most remarkable, was the apparent preservation of the ligament of the hinge. The smooth outer surface was complete, and when broken, it presented the fibrous structure peculiar to that part of shells. It was, however, carbonate of lime that had assumed that form. I had, on another occasion, seen, in Virginia, the large muscle of *Ostrea compressirostra* replaced by the same substance, which preserved the appearance and structure of the real muscle.

That the removal of the lime, not only of the shells, but of the marl, is constantly in progress, there are numerous examples throughout the marl region of the State.

There are some beds from which every particle of lime has been removed, leaving a white, porous substance, that cannot, from external characters alone, be distinguished from the richest marl. Of this character are the beds overlying the marl, at Winnamaker's, in Orangeburg, and at another locality, not far distant, on the Columbia road. At both of these places numerous casts of *Lutraria petrosa*, and other Eocene fossils, are found, but not an atom of carbonate of lime, either in the casts or the white beds which enclose them.

In the village of Orangeburg there are similar beds, abounding in casts of *Cardita planicosta:* portions of these beds are rich in carbonate of lime, and others quite poor, or nearly destitute of lime. The removal of the lime is easily understood: nothing more is necessary, indeed, than the percolation of water holding in solution carbonic acid. Water thus charged, passing constantly through a bed of marl, would leave only such portions as were insoluble, namely the silicious matter and alumina—precisely what is left in the beds just mentioned. The effect would, of course, be heightened by the presence of salts of iron, which are decomposed by carbonate of lime.

But it is rather more difficult to account for the complete replacement of substances by other matter.

When wood is enclosed in beds of clay or marl of the Cretaceous and Tertiary periods, it is generally converted into lignite, but when found embedded in sand, the wood is replaced by silica, and assumes the form of silicified wood.

In like manner, the shells enclosed in marl or clay are never silicified, while all the beds of buhrstone, which are nothing but masses of shells, are associated with sandy strata.

To those who have not examined the matter closely, it may appear that the lime of the shells was first dissolved out, and their hollow moulds filled by the infiltration of silica, held in solution. A little reflection, however, would satisfy any one that this was not the process; for it would be obviously impossible, in loose sand, for any such perfect moulds to exist; for the moment the lime was removed the sand would pour into the hollows left. Besides, the internal cast of the shell would fall down, there being nothing to support it, and the mould be spoiled. We are obliged, then, to suppose that the process went on slowly, and that the lime was replaced by silica, particle by particle; that is, that when an atom of lime was removed one of silica took its place, and this was continued until all the lime was removed and its place taken by the silica; for in no other way can we account for the preservation of the most minute striæ on the shells, together with every spine, process, or other characteristic mark. The solution of the silica offers no difficulty—hot water will dissolve silica largely, with the help of an alkali.

Now as these beds are along the upper verge of the Tertiary and overlap the metamorphic rocks, it is not a very wild supposition, that the waters of the Tertiary sea may, at one time, have been heated, and thus facilitated the solution of the silica.

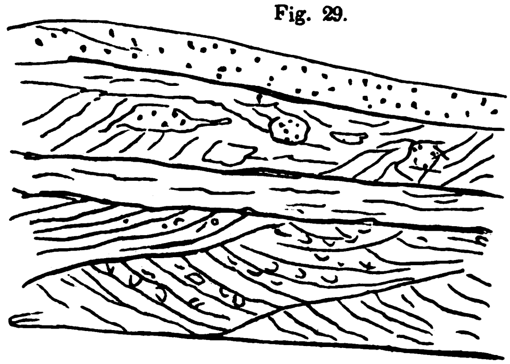
At an interesting locality, at Lang Syne, in Orangeburg District, to be hereafter described, I found, in the interior of the claw of a fossil crab, some fluid silica. At first it resembled thin, transparent jelly, but on exposure to the air it changed color, becoming milky, and finally became hard, and presented the external appearance of pearl-stone.

Mr. Ruffin pointed out the fact that the buhr-stone lies just at the verge of the calcareous beds of the Charleston Basin; and it is now known that no Eocene marl is found north of it. Now we can only account for this, by supposing that the Buhr-stone formation underlies the calcareous beds, and that where the latter thin out at the surface, the former makes its appearance. Had the buhrstone been superimposed upon the calcareous beds, it is scarcely possible that marl would not be found beyond the area circumscribed by the buhr-stone; for the rivers and streams cut through these formations near their junction, at numerous points, and expose sections of great depth in which not a particle of lime has been found.

It was these considerations that led me to doubt Mr. Lyell's conclusion,* in regard to the relative position of these beds; and to satisfy myself, and settle a fact of practical importance, I set myself to examine carefully, across the State, every point where the two formations approach each other. Commencing below Fort Motte, where the rail-road passes round the bluff, to cross the Congaree, in Orangeburg District, there is a section brought to view, composed of the sand and colored clays, very similar to that already seen higher up the river, near the mouth of Beaver Creek. The height of this section cannot be less than 150 feet. The road from the ferry leaves this bluff to the right, but passes over the beds at an easy angle, up the hill to Lang Syne, the plantation of D. J. M'Cord, Esq. where two or three enormous ravines have very fortunately been excavated by the rains, and expose to view exceedingly interesting sections of the upper beds of the Buhr-stone formation.

The depth of the principal ravine is about fifty feet, and the beds of which the sides are composed are the following.

Fig. 29.



1.—Soil and loam. 2.—Colored clays, sand, and fragments of buhr-stone. 3.—Red and yellow sand, nodules, and irregular masses of cemented white sand, and silicified shells. 4.—Clay, two to five feet thick, containing, on the surface and lower portions, fossil shells. 5.—Sand and comminuted silicified shells, with strong lines of oblique, or false, bedding.

The lower portion presents evident marks of violence during the deposition of the materials of which it is composed. The shells that are mixed with the sand are thrown up into diagonal and slightly curved lines. On the surface of the sand, where it joins the clay, fossils are quite numerous, although much broken; among them I found *Cardita Blandingi*, *Pecten membranosus*, *Turritella Mortoni*, and *Endopachys Maclurii*.

The period of repose which followed the deposition of the lower beds, is well marked by the bed of laminated clay, the surface of the bedding planes of which are studded with shells that lived and died on the spot. Among these are *Ostrea Alabamiensis*, *Ostrea Sellæformis*, and *Cytherea McCordia*, Ruffin. One layer of the clay, towards the bottom of the bed, is perforated by a *Pholas*,

* I desire to restrict this observation to South Carolina, and to what I have seen. Mr. Lyell found the buhr-stone overlying the calcareous rocks, in Georgia.

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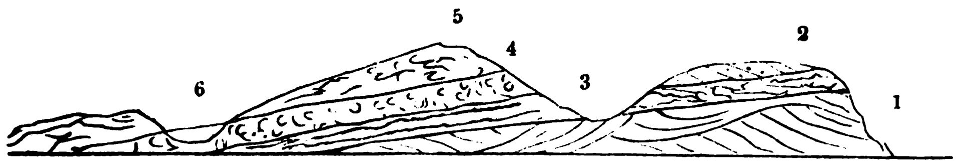
which existed here in considerable numbers. The *Pholas* burrows perpendicularly into the mud and sand in shallow water, along the coast, and the shells at this locality occupy precisely the same position: they are found standing vertically in the clay, which was once soft mud—showing that they lived and died where we find them.

Bands of iron ore are found overlying the clay at the bottom of the ravine, associated with a thin seam of rich yellow ochre. In another ravine pieces of silicified wood are found, and impressions of leaves, in a purplish clay.

The whole of this rests on a bed of dark colored sand and clay, in which I found, at Gates's quarry, casts of *Turretella Mortoni* and *Cardita planicosta.*

The sub-soil of this region consists of the yellowish loam to which I have alluded, as extending from the Congaree to the Court House. At Warley's store, a few miles distant, the bed of silicious clay, containing Eocene fossils, is seen distinctly, overlaid by the green sand of Stout's Creek, which thins out on the side of the hill at this place. Now this green sand underlies the calcareous beds of Cave Hall and Half-way Swamp, and hence the Buhr-stone formation passes under these beds. Fig. 30 represents a section from Lang Syne to Stout's Creek.

Fig. 30.



1.—Beds exposed at the bluff near the Congaree. 2.—Lang Syne. 3.—Silicious beds, with fossils. 4.—Green sand. 5.—Warley's store. 6.—Stout's creek.

Proceeding towards the Court House, accompanied by Dr. Barratt, who rendered me very important assistance in all my explorations here, we found, on the road, near the head branches of Half-way Swamp, thick beds of sand, containing water-worn nodules of marl, and a log of silicified wood, of considerable size. Immediately beneath this is a bed of yellow, tenacious clay, with partings of fine sand and scales of mica. Between the laminæ of the clay we found very distinct impressions of the leaves of the oak, beech, and willow, with their most minute veins preserved. This and the locality already described, are the only ones known where fossil vegetable remains have been found in the Eocene of the United States, with the exception of silicified wood and lignite, which are every where abundant.

The next locality to be examined occurs at Belle Broughton, Mr. Darby's place, on Half-way Swamp. Here a ledge of the clay bed, about fifteen feet in thickness, is laid bare, on the banks of the creek, near Stewart's old mill. Following it down stream, to its junction with the marl and green sand, which rises above the surface gradually from Hale's mill, a point from which I had traced it on a former occasion, we had, after a laborious search, the pleasure of seeing the green sand and marl overlying the bed of silicious clay. This is by far the most satisfactory locality for observing the juxtaposition of the Buhr-stone formation and calcareous beds. For the green sand is well developed, and is overlaid by thick strata of marl. The green sand is seen thinning out, on the road, towards the foot of the hill. It seems, at this point, to be associated with beds of sand, and, as usual in such cases, every particle of carbonate of lime is removed, although a few hundred yards lower, it is mixed with calcareous particles, in considerable quantity.

Gates's quarry, in this neighborhood, is a noted locality of buhr-stone, where the rock has been procured for economical purposes. The buhr-stone is about four feet thick, rests upon a stratum of sand and clay, and although the fossils are very numerous, it is not easy to make them out: I found, however, *Cardita planicosta* and *Crassatella alæformis*, pretty well characterised. A bed of dark colored sand underlies the whole, and is exposed in the bed of a small stream below the quarry.

Following the outcrop of the calcareous rocks to Cawcaw Swamp, about three miles from Orangeburg Court House, we found the finest locality in the State, of the Buhr-stone formation, so far, at least, as its fossils are concerned. As high up the swamp as Pooser's silicified shells are found; but they occur at Legare's mill in greatest abundance and perfection. They are embedded in red loam, which is enclosed in whitish clay, at an excavation made near the mill-pond. The red loam in which the fossils are embedded presents the appearance of having been rolled, very much as we have seen balls and cylinders of clay moved backwards and forwards by the waves, on the coast, and attaching to themselves whole and comminuted shells.

The section at the mill, in the descending order, is as follows: Eight feet, sandy, whitish loam and clay, containing masses of red loam with fossils; two feet, greenish clay; four feet, white silicious clay, containing casts of *Cardita planicosta* and *Lutraria lapidosa.* When the excavations are washed by rains the fossils are detached from their matrix, and may be collected in great numbers. On the road side, where the swamp is crossed, red loam is again exposed, and here also a vast number of well preserved fossils may be collected. From these two localitities on Cawcaw Swamp, nearly all the fossils in the appended list were procured.

The red and yellow loam appears at the surface, nearly all the way, but the junction of the buhr-stone with the marl, in the village, is not seen.

The formation is again exposed on S. Edisto. On Goodman's Swamp a bed of quartzose rock is quarried, for mill-stones; and on Dean's Swamp the buhr-stone shows itself, at some height above the swamp. Near the mill, on the road, lower down, it is again laid bare, and shells and casts are found, composed of quartz that is almost transparent.

The buhr-stone rises fifteen feet above the surface, at Stroman's mill, on Rocky Swamp. The section at this place is nearly the counterpart of Gates's quarry. It consists of five feet of buhr-stone, underlaid by three feet of fine, deep-yellow sand, which rests upon a bed eight feet thick, composed of red clay and silicified shells. The strike of the bed, at this place, is N. 20° E. and the dip about 15°. Below the surface there is a thick stratum of clay, containing pieces of wad, or impure oxide of manganese. At the mouth of the swamp a thick bed of white, silicified shells occurs: the shells have all the appearance of being carbonate of lime, although they contain not a particle of that substance. The common Eocene fossils abound in it.

At Tyler's Landing, on the Edisto, about one mile below Willow Swamp, the silicious clay bed is found on the left bank of the river, cropping out in thick layers; and a little higher up the swamp, near the bridge, the buhr-stone is seen crossing the road. A portion of the bed is converted into red and brown jasper.

The locality below Tyler's landing is but three or four miles from Johnson's, or Binnaker's bridge, which is the upper edge of the marl, on the S. Edisto.

The bed of silicious clay is also found in Beaufort District, on Huspa Creek. It is hard, and of a dark gray color, and in every respect resembles menilite. On the surface it becomes white, the result of partial decomposition.

I found no fossil shells here. The superincumbent bed consists of sand, smooth pebbles of quartz, and water-worn nodules of white marl. The only organic remains that I discovered in this bed were some sharks' teeth.

The locality is altogether a curious one: the bed of the creek, at low water, is covered with this remarkable rock, apparently having no connection with the loose, incoherent materials with which it is associated, and yet, even in the absence of the evidence of organic remains, its physical characters are so well marked that it must be referred to the Buhr-stone formation.

Beds of pebbles and sand, with sharks' teeth, are found at other localities in the District. A bed of green sand was also said to occur here; and if I am right in referring the Huspa rock to the Buhr-stone formation, there is nothing against this; on the contrary, it is the position for it. But after a very careful examination of the localities around Pocotaligo and Huspa Creek, with the advantage of every facility and assistance, politely afforded me by Walter Blake, Esq. I was unable to find any indications of such deposit. I did, indeed, see sand that was green, but it was not *the* green sand.

I have been, perhaps, tediously minute, in describing and pointing out localities of that part of this formation which borders on the calcareous rocks; but it was because I deemed the determination of the fact, as to its precise position, one of great practical value; and I think that I have now placed the matter at rest. Indeed had I not absolutely traced the Buhr-stone formation immediately under these beds, I would have been satisfied that that was its true position, after having seen beds two hundred feet in thickness, on the Congaree, as low down as McCord's ferry, containing Eocene fossils, which it was impossible could have thinned out so suddenly as to overlie the marl on Stout's Creek.

It must be borne in mind that I include under the name of Buhr-stone formation, those beds described in the section at Aiken, consisting of sand, porcelain and common clays, grit, and sandstone, as well as silicified shells, which, taken together, are 200 feet in thickness.

As to the bed of silicified shells, or buhr-stone, which has given name to the formation, I consider it as merely the upper edge of the marl, in which, from peculiar causes, silica has taken place of the lime. Every thing in the aspect of this rock and its associated beds of sand, indicates a sea beach: the sands are thrown up and mixed with comminuted and broken shells, whilst here and there a bed remains undisturbed; and the embedded fossils show, very clearly, its littoral character.

This rock, then, may rest upon the marl, at its upper verge, although I have not found it so in South Carolina, while the rest of the formation sinks beneath it.

The stratum that I have called, for want of a better name, the silicious clay bed, must not be confounded with one somewhat resembling it, that is sometimes found on the marl. There is no difficulty in distinguishing the two: the former is always more or less laminated, and is poor in organic remains. The bed of clay, associated with the marl, being deposited under similar circumstances, resembles the marl, both in structure and embedded fossils; hence it is not laminated, and is generally rich in fossil remains. It is, indeed, marl, from which the lime is removed. The fossils most abundant in it are casts of *Lutraria lapidosa* and *Cardita planicosta*.

Fossil Shells of Buhr-stone Formation.

Marine Gasteropoda.

Fissurella tenebrosa,	Con.	Fusus thoracicus,	Con.
Infundibulum trochiforme,	"	" limulus,	"
Crepidula lyrata,	"	" papellatus,	"
" dumosa,	"	" pulcher,	Lea.
" lævis,	T.	" decussatus,	"
Dentalium arciformis,	Con.	" robustus,	T.
Auricula Gibba,	T.	" crenulatus,	"
Natica striata,	Lea.	" spinosulus,	"
" œtites,	Con.	" minor,	Lea.
" limula,	"	Triton pyramidatum?	H. C. Lea.
Sigaretus bilix,	"	Monoceros armigeros,	Con.
Actæon pomilis,	"	" fusiformis,	Lea.
Scalaria venusta?	H. C. Lea.	" vetustus,	Con.
Meleagris antiquatus,	Con.	Melongena elevata,	"
Turretella carinata,	H. C. Lea.	Pyrula cancellata,	Lea.
" Mortoni,	Con.	" elegantissima,	"
" humerosa,	"	Mitra perexillis,	Con.
" gracilis,	H. C. Lea.	Aneillaria scamba,	"
Cerithium striatum,	Lea.	" staminea,	"
" cancellatum,	T.	" altile.	
Pleurotoma depygis,	Con.	Buccinum lineatum,	T.
" monilifera,	Lea.	Cypræa semen,	"
" subulata,	T.	Terebra costata,	Lea.
Cancellaria alveata,	Con.	" venusta;	"
		Voluta Sayana,	"
		Oliva gracilis	Lea.
		Conus saurileus.	Con.

Lamellibranchiata.

Teredo.		Cardium Nicolleti,	Con.
Pholas Roperiana,	T.	Cardita planicosta,	Lam.
Mactra pretænuis,	Con.	" alticosta,	Con.
Lutraria lapidosa,	"	" Blandingi,	"
Crassatella alæformis,	"	" bilineata,	T.
" protexta,	"	Cucullæa depressa,	"
Corbula nasuta,	"	Arca rhomboidella,	Lea.

Corbula oniscus,	Con.	Pectunculus stamineus,	Con.
Tellina papyria,	"	Lithodomus politus,	T.
" Ravenelli,	"	Nucula bella,	Con.
Lucina pandata,	"	Ostrea sellœformis,	"
symmetrica,	"	" Georgiana,	"
Cytherea æquorea.	"	" Camera,	T.
" McCordia,	Ruffin.	Perna silicea,	"
" ovata,	Rogers.		

Crustacea.

Crabs' claws.

Cirripedia.

Balanus humilis, Con.

Polyparia.

Three or four species of corals, undetermined.

Plants.—Exogens.

Silicified wood.	Quercus, the leaves.
Lignite.	Fagus, "
	Salix.

From this list we obtain the following numerical proportion of species.

Gasteropoda,	53 species,	or 64 per cent.
Lamellibranchiata,	30 "	36 " "
	—	
	83 species.	

The predominance of Gasteropods among these fossils indicates the littoral character of the formation. The Auriculæ are land shells, living on marshes and other places that are occasionally overflowed by the tide, and the existence of even a single species is interesting in this connection. Of the Lamellibranchiata nearly all the genera are living on the coast, at this moment. So that the whole group, taken with the remains of plants found in the formation, makes the inference a fair one, that the buhr-stone was deposited on the coast of the Eocene sea.

Calcareous Strata of the Charleston Basin.

A line joining the points indicated, in the preceding pages, as the localities of the buhr-stone proper, will give, with sufficient accuracy, the boundary, towards the North, of these strata.

Commencing at the Upper Three Runs, and tracing a line thence to Lemon Swamp, we cross S. Edisto one mile above Johnson's bridge, and Rocky Swamp at Stroman's mill. Turning east from this, the line will cross N. Edisto, at the mouth of Limestone Creek and Cawcaw Swamp, a few miles higher; passing the head of Lime-hill Creek, the line continues to Stewart's mill, on Four-hole Swamp, and crosses to Stout's Creek; after which it follows the windings of the Santee, to Mayzick's Ferry.

On the West the line may be drawn from the mouth of Lower Three Runs to the Ashepoo, and thence to the Ocean.

Between these points there are wide gaps that must be filled by future exploration; nor must it be supposed that the upper verge of marl and limestone will be confined to the line that I have indicated; on the contrary, the true outline will doubtless be more undulating—now extending beyond, and again falling short of it.

This irregular area, occupied by the calcareous strata of the Charleston Basin, is, in length, about seventy-five miles, and sixty miles wide.

Section on the Santee.—The lowest point on the river, at which the marl of this section makes its appearance, is at Mazyck's Ferry; and although it is not seen, at that point, above the surface of the water, yet there is every reason to suppose that at no great distance from the bank it occurs above the level of the river, covered and hidden, it is true, by superincumbent newer beds. For some distance inland from the river the surface is much broken by lime sinks—depressions that are due to the solution and washing away of the lime, producing thereby caverns, and finally causing the surface to fall in. Now it is obvious that the lime must be elevated above the river, in order to allow the springs an outlet, otherwise the lime could not be washed away.

Marl, mixed with green sand, is found in the bed of Wambaw Creek, but not near the surface. The next point at which I observed it is Watahaun Creek, at Dr. Tidyman's, where a white marl stone outcrops on the right bank, in large, irregular masses. This little creek is a branch of the river that has cut across one of those bends so common in southern rivers. The course of the creek is so much shorter (because more direct) than that of the river, that its velocity contrasts curiously with the sluggish progress of the latter.

Proceeding upwards, the next exposure occurs at McDowell's, where green sand, mixed with soft rich marl is found, forming a thick bed, rising a little above the water level, and extending towards the bed of the river. About a mile below the mouth of Echaw Creek, this bed is seen again at Moore's. Near the church, in the bed of the creek, and where the swamp meets the high land, white marl stone is found outcropping in thick ledges, of considerable hardness. The surface of the country, between Mazyck's Ferry and Echaw, is far more irregular and broken than one would expect, from its position or geological character, and presents a striking contrast to the almost unbroken plain on the left bank of the river, which extends to Georgetown.

The next locality of importance that I examined is at Gourdin's Ferry: here the green sand, which was depressed to the surface of the water, at McDowell's, is raised above it six feet. The height of the section, a short distance below the ferry, is fifteen feet; the upper four feet is a compact, white marl stone, that is much worn on the surface and exposed edges. The fossils being so completely blended in the mass, it is difficult to develope them.

This passes into a conglomerate of calcareous pebbles and rounded fragments of indurated green sand, containing numerous sharks' teeth, and reminded me of a similar bed, at Wilmington, N. C. This dips down stream till it disappears beneath the surface.

Next below is the bed of green sand, mixed with marl, five feet thick. This rests upon a thick bed of dark grey, hard marl, altogether different from any seen on the river; and it might have been troublesome to determine its true position, had I not found in it casts of that most cosmopolite of all Eocene fossils, *Cardita planicosta.* The length of this section is nearly a mile. The bank of the river, at this point, is high and level, and was once the site of a village, built by the early settlers. Inland this plain is broken down, and a swamp occurs, along the margin of which a white pulverulent marl is found outcropping, as may be seen at Col. Palmer's.

On the opposite side of the river, on Dr. Gourdin's land, the compact, white bed is found, alternating with soft beds of marl. The fossils at this locality are chiefly in the state of casts, and among them I was able to identify a large, undescribed *arca*, which I found at Wilmington, on another occasion.

A few miles from this, and on the way to Georgetown, marl is again exposed to view. It was soft, and had been used on the land to some extent. The most prominent fossil at this locality is *Graphæa mutabilis*, which has attained a greater size here than elsewhere in the State.

Returning to the right bank of the river, the soft marl may be examined to advantage, on the plantation of Dr. J. S. Palmer. Above this, the immediate margin of the river is occupied by swamps, and of course these beds are no longer exposed—having been removed, by denudation, at least as low as the bottom of the swamps.

To continue the examination of the Santee beds, which I consider the lowest of the calcareous portion of the Eocene, we must now turn west, to where they are again laid bare by the head waters of Cooper. At Mr. R. Mazyck's the green sand is visible. We are indebted to Mr. Ruffin for a knowledge of this interesting locality, and for having first pointed out its Eocene character. He found *Gryphæa mutabilis*, which is very abundant, and *Scutella crustuloides*. On my first visit to this place I added to these *Terebratula Harlani*, Var. B. well characterised; *Scutella Lyelli*, Pecten perplanus, and casts of *Cardita planicosta*, and *Plagiostoma gregale*. The green sand stratum is about four feet thick, much indurated towards the lower part, where fossil shells are most abundant. It was during the excavation of this bed, for agricultural purposes, that Mr. Mazyck discovered the jaw and teeth of *Zeuglodon*, accurate and beautiful figures of which have been published by Dr. R. W. Gibbes, of Columbia.

These remains were accompanied by *Lima concentrica* and casts of *Nautilis Alabamiensis*, and a very perfect portion of the jaw of *Cœlorynchus*,* now in the cabinet of Dr. Ravenel, of Charleston.

Below this remarkable deposit is a stratum of white marl, abounding in corals, which may be designated the coralline bed of the Charleston Basin. From the nature of the surface, it does not appear, at this place, in natural sections, but it has been explored, for agricultural purposes, sufficiently to afford opportunities for examination.

At Dr. Cain's I found *O. Panda* and other Eocene fossils; and the Doctor very liberally presented me with a perfect tooth of Zeuglodon, from this marl. So that this is the lowest stratum in S. Carolina in which the remains of that extraordinary animal are found.

The excavations at Pooshee, and the rare chance of a field covered with marl, afforded a good opportunity of studying this bed. Assisted by Mr. Henry Ravenel, I made a very interesting collection at this locality, among which were *Nautilus auriculata*, T., *O. Panda*, *O. Sellæformis*, and an *Ostrea*, resembling the genus *Malleus*; three species of terebratula; *Plagiostoma gregale*; *Echinus infulatus*, and numerous species of coral.

At Deveaux's old mill we found *Cardita planicosta* and *O. Sellæformis*.

* This fossil, so much like Belemnites, was first found by Mr. Ruffin, many years since, in the Eocene of James River. It has puzzled every one who has seen it, until I had the pleasure of learning, from Prof. Agassiz, its true affinities. Cœlorynchus rectus, Ag. appears among the fishes of the London clay.

On the banks of the Santee Canal I found specimens of the large oyster, (*O. Caroliniensis*, Con.) referred to so frequently by Geologists, since the time it was first noticed by Mr. Finch. It is undoubtedly a variety of *Ostrea compressirostra*, and identical with one found in the oldest Eocene beds of James River, Va. differing from the common type of that fossil only in being much more ponderous. So far from its being found in a continuous bed, extending across the State, into Georgia, as has sometimes been stated, this is the only locality at which I have met with it. It appears to have been confounded with *O. Georgiana*, found in Barnwell, and in Georgia, at Shell Bluff. At the rocks the marl is laid bare in several places, and is mixed with green sand. *Ostrea sellæformis* and *O. Panda* are found at all these localities.

Proceeding north, the next important exposure occurs at Eutaw, where the coralline beds are finely characterised. The marl seems to be a mass of comminuted coral, slightly cemented by calcareous matter, and rising above the surface in rugged irregular ledges. A bold spring rises here, or rather, a subterranean stream has been brought to light by the falling in and removal of a portion of the natural tunnel through which it flowed. This is a spot of considerable elevation, and as the formation is exposed, at intervals, to the river, it shows its great thickness.

Below Eutaw, on the Santee, strata, forming high bluffs, again make their appearance. *Ostrea sellæformis*, which Mr. Ruffin had noticed was a rare fossil below this, here is found in great numbers, and seems to have attained its full size.

At Vance's a noble section of six miles in length is washed by the river. It consists of layers of marl stone of various hardness, and contains a prominent bed of *O. Sellæformis*. At the highest point it is thirty feet, and when I saw it, it presented a picturesque object for so level a country. Towards the water line the bluff was ornamented with a dense fringe of gray fibrous roots that extended down its face, whilst above it was ornamented with a gay zone, composed of such showy shrubs as the Hydrangea, Itea, and Philadelphus, in full bloom. In many places the bluff was sufficiently overhanging to admit our canoe, and afford a shelter from the rain. A little below the landing a mass had fallen, and an eddy produced by it in the current, by which the formation of a strip of low land was favored; and although the latter has not advanced into the river above fifteen feet, yet trees, two feet in diameter, are found growing on it. Besides *O. Sellæformis*, there is, about half way up the section, a bed three feet in thickness, consisting of casts of fossils. Owing to a bend in the river, which carries it along the strike of the strata, persons who have seen these rocks, at this point, have erroneously represented them as horizontal.

Between the river and Mr. Simmons's house, a soft white marl is found in the ravines, and on the hill sides. I saw here, for the first time, casts of *Lutraria lapidosa*, together with *O. sellæformis*, *Pecten calvatus*, casts of *Cardita planicosta*, and a large Pyrula, identical with one found at Wilmington. The surface here is much broken by lime sinks, and some of them are of very recent date.

Proceeding up the river, I found, on the adjoining plantation, fragments of *Cœlorhynchus* and *Lutraria lapidosa*. Between this point and Pinckney's mill there appears to be an old bluff, which once constituted the river bank, but is now removed many yards from it. At Felder's the thick oyster bed of Vance's Ferry is quite conspicuous, and at Pinckney's, where the marl is forty feet thick, the overlying white beds, containing Lutraria, are seen.

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At Felder's I observed an old lime-kiln, excavated in the marl, in which lime was once burned. The section exposed here is an interesting one. There are many others on the river, at this place, but I had no means of examining them.

At Hale's mill a good exposure is presented, where the relative position of the beds seen lower down, is well exhibited. The upper bed of soft marl is about ten feet thick, in which *Terebratula lachryma* is quite-abundant. The lower bed is mixed with irregular grains of green sand, of larger size than I have seen elsewhere: they are quite smooth and even polished on the surface. The upper part of this bed is rich in fossils, of which the most numerous is *O. Sellæformis*, (young.) *Cardium nicolleti*, *Cypræa lapidosa*, *Nautilus Alabamiensis* are also found intermingled with them.

At Cave Hall a good opportunity is presented for the further examination of these beds. The cave at this place is another instance of the exposure of a subterranean stream, by the falling in of the roof of the passage which it had worked through the calcareous rocks. The little stream, after leaving the cave, which is quite a spacious one, passes down a ravine, towards the river, and exposes, on each side, thick strata of marl.

The mixture of green sand and marl is seen in a bed of considerable thickness, forming the sides of the cave, and characterised by the fossils found at Hale's mill. The roof of the cave is composed of marl stone, containing but little green sand.

On Stout's Creek the calcareous beds disappear, and the green sand is seen along the banks and in the bed of the stream, and below Warley's store it thins out over the buhr-stone, on the hill side.

Higher up, on Half-way Swamp, both the green sand and superincumbent calcareous beds occur. Commencing at Heatly Hall, some fine sections may be examined, where fifteen or twenty feet of white marl is found overlying a bed of green sand and marl, twenty or thirty feet in thickness. The fossilliferous portion of the latter contains fossils identical with those at Hale's. Sharks' teeth, in a fine state of preservation, are found at this locality; and I obtained a single process of the snout of a *Pristis*.

Proceeding along the edge of the swamp, these beds may be traced to Belle Broughton, Mr. Darby's plantation. An excavation having been made here for a lime-kiln, a good opportunity was afforded for examining a section composed of marl, marl stone, and green sand. The marl stone, though in some instances quite hard, is not compact, like that at Gourdin's Ferry. The most common fossil is *O. Sellæformis*. One or two species of crab were found here, and corals are not uncommon. At the base of the hill, and bordering the swamp, the green sand was traced, rising gradually, nearly to the old mill, where the marl disappears, and the green sand passes below the silicious clay bed. To place the relative position of these two beyond doubt, we bored through the green sand to the clay.

West of this I saw marl, containing scattered grains of green sand, on Lime-hill Creek, a branch of Four Hole Swamp. The surface is not sufficiently broken to exhibit more than the upper bed of white marl, which is exposed along the stream for a considerable distance. Full grown specimens of *O. Sellæformis* are pretty abundant at this locality; and from what I saw myself, and from the information collected by Mr. Ruffin, I infer that this bed is underlaid by one of green sand.

The next exposures towards the West occur on Caweaw Swamp. At Pooser's the marl is seen in the low ground, near the swamp, and a short distance above silicified shells are found. At Wannamaker's the marl was excavated for lime burning, and is overlaid by a bed of clay, containing casts of *Lutraria lapidosa*, *Cardita planicosta*, and *Turretella Mortoni*. This bed of clay is very remarkable: it is exceedingly light and porous; and it seems as if this character was the result of the solution and removal of the lime which it once contained in the form of minute particles. I have seen hornstone, in the carboniferous limestone, assume the same appearance, from a similar cause.

That the whole of this region is underlaid by marl there can be no doubt, for, besides lime sinks and other indications, it is laid bare in a canal, near the village, where I found perfect casts of *Cardita planicosta*. The bed containing *Lutraria lapidosa* is found extending over a considerable space. It may be seen on the Columbia road, above the village, and again near Mr. McMaster's, and at Poplar Springs, on the opposite side of the Edisto. On Limestone Creek I saw some indications of the green sand bed, presented in irregular, indurated masses, mixed with clay. Below this the whole is covered up by more recent beds of sand and loam.

I have already mentioned the upper edge of the marl, at Stroman's, on S. Edisto, in which I found *C. planicosta*, partly silicified. Associated with these is a fine, compact marl stone, very rich in carbonate of lime.

A mile or two above Binnaker's bridge a poor marl occurs, forming a perpendicular bluff on the right bank of the river. The marl at the N. W. verge of the Charleston Basin differs very materially from the Santee marls and marl stone, in the amount of carbonate of lime: the latter are every where exceedingly rich, whilst in the former clay and silica abound, and in some of the strata barely a trace of lime is found. This is the case with some of those on the Salkehatchie, near Brockton's Ford, in Barnwell, where I saw sand carried out on the land, for marl, which had not a particle of marl in it, although it contained sharks' teeth, and other indications of marl.

At a camp ground, near this place, I found some casts of shells, fishes' teeth, and palatal bones of *Diodon*, which, together with some water-worn pieces of marl, were taken from a well. I searched this place diligently without finding any marl. Near the river a silicious rock occurs, containing a few fossils.

Col. Graham pointed out to me a very interesting locality, on Lemon Swamp, where a rich white marl, with green sand above it, is found. Issuing from the marl are numerous clear and deep springs; but I could find no fossils. North of Barnwell Court House, about seven miles, on Buck Creek, I found a silicious marl, on the land of Mr. J. M. Whaley. It occurs at the bottom of a steep hill, near the stream. Marl is said to be exposed in several places, near the Court House; but I had no opportunity for further examination.

On Tinker's Creek there are several localities at which I found Eocene fossils, and among them the large *Ostrea Georgiana*, so abundant at Shell Bluff. Other exposures occur on the Lower Three Runs, but I was unable to find any marl on the river bluffs. The characteristic fossil on the Savannah, and its tributaries, is *O. Georgiana*.

The noted locality, Shell Bluff,* is on the right bank of the Savannah, and on the Georgia side:

* For a particular description of this bluff see Mr. Ruffin's Report.

it is a perpendicular escarpment, seventy or eighty feet in height, composed of beds of marl, of various thickness, and differing much in the amount of carbonate of lime present in them. The bluff extends inland some distance, where it is no longer washed by the river. *O. Sellæformis* and *O. Georgiana* are the most prominent fossils.

At Griffin's Landing, a few miles lower down the river, *O. Georgiana* is found projecting, in great numbers, from the horizontal surface of the marl, where it is washed by the river—the hinge invariably downwards; forcibly reminding one of the beds of the long variety of *O. Virginiana*, found along the shores of Charleston harbor. Had the stratum in which the fossils are embedded, been black, instead of white, the resemblance to a recent oyster bed would be complete.

Fragments of jasper, chalcedony, and agate, scattered over the surface, above the Lower Three Runs, give evidence of the existence of the buhr-stone, although I did not find it in place, below the bridge on Upper Three Runs, where it shows itself in heavy beds of silicious sandstone, containing fragments of shells.

Mr. Ruffin noticed the numerous indications of denudation presented on the western side of the District. On the last mentioned stream thick beds of gravel, containing rolled pieces of marl stone, occur, similar to those already mentioned, on the Salkehatchie and on Huspa Creek, in Beaufort. The remains of fishes in these beds, prove that they have been accumulated during the Tertiary period.

The section indicated as extending along the Santee from Mazyck's Ferry to Stout's Creek, is about seventy-five miles in length. It was right to expect much diversity in the fossils distributed over so great an extent, and it was curious to observe the different groups as they made their appearance, one after the other.

Of all the Eocene fossils of South Carolina, *Gryphæa mutabilis* and *Cardita planicosta* are the most persistent, as they extend from the buhr-stone to the upper beds of the Santee, and the former is even found on the Ashley. *O. Sellæformis* and *O. Panda* first appear in the coralline bed at Pooshee; and *Nautilus Alabamiensis*, in the green sand at Mr. R. Mazyck's, with *Scutella Lyelli*, *Terebratula Harlani;* and here, too, the first cetacean is found, which has continued to exist up to the time of the deposition of the Ashley. *O. Compressirostra* is found on the Santee Canal alone.

Fossils of the Santee Beds.

Cetacea.

Zeuglodon,
lower maxilla, teeth and vertebræ.

Sauria.

Teeth, (undetermined.)

Fishes.

Carcharodon,	Diodon,
Lamna,	Pycnodus,
Oxyrhina,	Cœlorhyncus,
Otodus,	Pristis.

Cephalopoda.

Rhyncolites,
Nautilus Alabamiensis,
" auriculata.

Pteropoda.

Terebratula Harlani,
" lachryma,
" Wilmingtonensis?
" abnormis,
" striata.

Gasteropoda.

Scalaria amplicosta.
Pyrula ponderosa,
Trochus acutus.
Cypræa lapidosa.
" hemispherica,
Conus gyratus,
" obtusus.
Buccinum? spissus.

Lamellibranchiata.

Solen,
Pholadomya Marylandiea? Con.
Lutraria lapidosa,
Cardium Nicolleti,
Cardita planicosta,
" turgida,
Arca obliqua,
Nucula,
Chama,
Lima concentrica.

Pecten membranosus,
" calvatus,
perplanus,
Plagiostoma gregale,
Ostrea sellæformis,
" panda,
" compressirostra,
" Georgiana,
Gryphæa mutabilis,
Avicula.

Crustacea.

Carapace and claws of several genera.

Cirripedia.

Anatifa.
(Back valves of this genus are common in the coralline beds at Pooshee.)

Echinoderma.

Echinus infulatus,
" the spines,
Scutella Lyelli,
Var " pileus sinensis,
" crustuloides,
(Other genera not determined.)

*Polyparia.**

Ocellaria ramosa,
Flabellum cuneiforme,
Endopachys Maclurii,
Cladocora recrescens,
Tubulipora proboscidea,
Idmonea maxillaris,
" commiscens,
Lichenopora,
Farcimia,
Vincularia,
Hippothoa tuberculum,
Eschara petiolus,
" incumbeus,
" linea,
" viminea,
Lunulites distans,
" contiqua.

* This beautiful addition to our Tertiary Fauna is one of the many debts American Geologists owe to Mr. Lyell's visit. I have not been so fortunate as to identify all the corals collected by him in South Carolina, but I have inserted Mr. Lonsdale's list in full, from the Quar. Jour. Geol. Soc. the only instance in which I have deviated from a rule with which I set out—to insert no fossil that I had not seen.

This list presents a very different result from that obtained from the fossils of the buhr-stone, for besides the introduction of the classes Cephalopoda and Pteropoda, there is a great numerical falling off in the Gasteropods; and yet the occurrence of oysters in all these beds, and of corals in some of them, would indicate a sea of no great depth at the time of their deposition.

The following are the numerical proportions of the classes.

Cephalopoda	3	species, or	6 per cent.
Pteropoda	5	"	11 " "
Gasteropoda	8	"	18 " "
Lamellibranchiata . . .	20	"	50 " "
	36 species.		

Eocene Beds of the Ashley and Cooper Rivers.

Next in order above the Santee beds, are those exposed to view on the banks of the Ashley and Cooper, and their tributaries.

The marl of these beds, particularly towards their southern extremity, differs, both in external appearance and embedded fossils, from that of the Santee beds. In general, the structure of the marl is loose and granular, and the color dark gray, sometimes approaching olive—the latter is particularly the case with the Ashley marl, when recently taken from below the surface. This dark color is frequently due to minute particles of carbonaceous matter dissemminated through the mass. It will be seen that the most remarkable feature connected with the organic forms entombed in these beds, is the vast number of the remains of fishes that they include, and hence the very notable amount of phosphate of lime in the marl.

Mr. Ruffin has shown that these beds underlie the city of Charleston, by identifying the specimens taken from an Artesian well,* (attempted in the city, in 1824,) with the Ashley marl. He also showed that this marl forms the bottom of Charleston harbor, specimens often being brought up by the anchors of vessels and the tackle of fishermen.

From fossils picked up on Beresford Creek, between Cooper and Wandoo, I infer that marl must be found on its banks; but the lowest point at which I observed Eocene beds is near Bonneau's Ferry, on the eastern branch of Cooper. At Dr. Prioleau's mill, marl is exposed to a considerable extent, just below the dam, on the sides and bottom of the race.

It is again laid bare, at low water, below Strawberry Ferry, on the left bank of the river, and a short distance above, on the plantation of J. Harleston, Esq. in a fine natural section, which was once the river bank, but is now removed from it by the extent of a rice plantation. The marl is yellowish and pulverulent, and presents no marks of stratification.

I found here, embedded in the face of the bluff, nodules rather whiter than the rest, containing an amount of chloride of sodium, or common salt, quite perceptible to the taste. I did not visit

* Since this was written I had an opportunity of examining the borings from the wells at present in progress, in the city and at Fort Sumter. The marl brought up has the dark or grey color characteristic of that of the Ashley, and like that, it abounds in those beautiful little forms, Polythalamia and Foraminifera. I had the pleasure of finding, through the politeness of Capt. Bowman, that the green sand had been reached, at a depth of nearly 300 feet, at Fort Sumter, confirming the conclusion I had arrived at, from observations made elsewhere, on the dip of the beds of the Charleston Basin.

this interesting locality after having observed this, and cannot, therefore, say whether or not these nodules had absorbed salt from the spray of the brackish water of the river, or it existed in them, as an original constituent of the marl. If they extend into the bluff, beyond the surface, the latter, of course, must have been the case.

Fossils are quite rare in all the lower exposures on the Cooper, and I only identified here *Balanus peregrinus*, *Pecten calvatus*, *P. membranosus*, and *Anomia jugosa*, and some teeth of *Lamna*.

The bluff at Mepkin is a continuation of this, although some portions are wanting at intermediate points. The upper surface of the marl, on Cooper, is quite undulating: sometimes it rises into sections twenty or thirty feet in height, and then sinks to the level of the water, or disappears altogether. The Mepkin bluff is from ten to fifteen feet above tide, and has the same fossils as the section at Strawberry Ferry. Near the mill, the marl is overlaid by a bed of sand and gravel, mixed with calcareous pebbles, and containing fragments of bones and teeth of fishes—all transported from a distance; and in all respects resembling a bed found on the land of Dr. Barker, near Mulberry. Through this latter deposit a ditch has been cut, in which I collected numerous teeth of the genera *Lamna*, *Oxyrhina*, and *Otodus*.

On the opposite side of the river from Mepkin, the marl is found very near the surface, over a wide extent. At Point Comfort some excavations have been made, in a rich white marl; and on the plantation of Col. Ferguson, a long canal has been excavated in the same bed. Still farther from the river, near Monk's Corner, it is again exposed, somewhat altered in its appearance and mineral character. On the road a bed appears, which has lost the granular structure characteristic of the marls of this region. It resembles a white calcareous mud, such as would be deposited in the still waters of a lagoon. A bed very similar to this occurs on the plantation of Dr. Barker; and these are the only deposits in which I have observed any thing like stratification: every where else the entire substance of the beds appears to have once existed in the form of an immense pulpy, calcareous mass, and then to have assumed its present granular structure, by concretion. Even the few fossils embedded in it are not disposed in layers, that would indicate what was formerly the surface, but are scattered throughout the mass.

On the Santee, on the contrary, where the marl itself is not stratified, there is frequently a bed of oyster shells, or a fossilliferous stratum of some sort, to enable us to determine the mode of deposition.

It was stated that the Santee beds, at least in the form of bluffs, are principally confined to the left bank of the river: on the Cooper they are pretty equally distributed. While Mepkin is on the left, Mulberry and Steep Bluff are both on the right. The latter presents a fine section, extending from the river a considerable distance. I found here *Pecten calvatus*, *P. membranosus*, *Scutella crustuloides*, *Conus gyratus*, and one or two species of coral.

On my way up the river I saw a canal cut in the marl, and at Lewisfield the same portion of the formation is finely exposed, frequently without any superincumbent beds of sand or loam. From this point upwards fossils become more abundant, and *Gryphæa mutabilis* makes its appearance in great numbers at Mr. Mayzick's, on a bald hill side; a very fine *Scalaria* also occurs at this interesting locality.

Steep Bluff, a little higher up, is another noted section. It is at the southern extremity of the

Santee Canal, on Biggin Creek. The marl here appears identical with that of the Ashley, particularly towards the bottom of the bluff, and in the bed of the creek. I found here a cast of *Artemis*, the same as one found on the Ashley. Above this the Ashley and Cooper beds are lost in what I have already described as the coralline beds of the Charleston Basin. Among the large fossils *Scutella Lyelli* becomes conspicuous, and *O. Sellæformis* quite abundant, to the right and left of the canal.

An extensive excavation, made on the plantation of Dr. Holmes, gave me a better opportunity of examining below the surface of the marl than I had had hitherto. I obtained here the first cetaceous bones that I had seen in the Eocene; and the Doctor very politely presented me with some fine and well preserved teeth of *Carcharodon*.

A little to the north of this, at Mr. Gaillaird's, I saw other beds exposed. And to the right of the public road, I visited, in company with Dr. Gibbes, of Columbia, an exceedingly interesting locality. We found here the ruins of a dwelling of considerable size, said to have been erected by Sir John Colleton. Of the house itself little more remained than the dilapidated foundation, but there was an out-house, or office, in a pretty good state of preservation. It is evident that the walls were of stone, and at first sight I was reminded of Portland stone, which I supposed had been imported, in those early times—as I had seen, in Maryland and Virginia, stone steps and window-sills, that had been brought from Europe by the first colonists.

The stone was well dressed and coursed, the window-jambs well cut; and within the building, the fire-place was decorated with a tasteful mantel, handsomely moulded, with angles quite sharp, and all composed of the same stone. Even where the wall was exposed to the weather, the marks of the tools were as well defined as if they had been impressed but yesterday. While examining these things I discovered some minute Eocene fossils; and on closer examination I found that this building material was nothing more or less than marl, and the quarry, in the vicinity, from which it was taken, we were not long in finding. The blocks had evidently been split out, and sawed, or shaped with the axe, into proper form. The rock is not marlstone, but the ordinary compact, granular and yellowish marl, found in numerous places on the river.

Seeing how well this material resists the disintegrating effects of atmospheric agencies, in many of the bluffs along the river, such as the high and perpendicular escarpment on the creek, near the Rectory, which is even perforated with caves, it is not surprising that it should have suggested itself as a building material, and it is only strange that the experiment should have ended here.

Ashley Beds.—In ascending the Ashley, from Charleston, marl is first seen at Bee's Ferry, on both sides of the river, below high-water level. Both here and elsewhere, on the river, it is exceedingly uniform in structure and external appearance, with the exception of about two or three feet of the surface, which is composed of irregular and water-worn fragments of marl stone, embedded in clay, and containing numerous fossils, in the state of casts. These fragments are scattered over the surface, so as, in some places, to offer obstruction to the cultivation of the land. On the Rev. Dr. Hanckel's plantation I had a good opportunity of examining these fragments; and at Drayton Hall they have been gathered from the lawn and thrown into heaps. At first sight I was disposed to refer the beds containing these fragments to a formation different from the underlying marl, but I have since found that nearly all the fossils are common to both, and that these fragments are only the surface of the marl torn up, and thus scattered. That their dispersion took place at a comparatively recent period, is evident from the fact that they are found, in St. Thomas's Parish, resting on the Post Pliocene; and they also occur on John's Island, which must be referred to the same period. The recession of the waters of the ocean, at the time of the elevation of the Post Pliocene to its present level, would be quite sufficient, as a cause, to produce such a phenomenon as this.

I have more than once alluded to the removal, by solution, from calcareous rocks, of a portion or all of the lime. This has taken place, to a great extent, in the beds under consideration. In many instances there is little more left than the silica and alumina of the marl, with a trace of lime; and the latter ingredient rarely exceeds six per cent. At Castel's Landing a white, porous substance occurs in contact with the marl, from which every particle of lime has been removed.

Many of the fossils of the Ashley are found on the Cooper, and elsewhere, but, as a group, they are very distinct from those of every other bed in the State. Mr. Ruffin was struck with the absence of all the more common Eocene forms of Virginia, and even of the Santee, such as *O. sellæformis*, *C. planicosta*, &c. but the most remarkable feature in the Fauna of the period of the deposition of these beds was the vast number of cartilaginous fishes. It would seem as if, about the close of the Eocene period, these voracious monsters, conscious of their approaching end, had congregated here to die; and it is no exaggeration to say that more than a bushel of fishes' teeth have been collected at Bee's Ferry, within the last few years. I have visited the locality several times, and never without finding a large number of specimens. As the marl is washed away by the river and tides, the fossils are left exposed at low water, and in this way the locality appears almost inexhaustible, and well deserves the name of the "Fish Bed" of the Charleston Basin.

It was here, aided by the zeal and industry of my friend, Mr. Holmes, that I was enabled to enrich the Palæontology of the State with the materials now in the hands of Agassiz, for determination. Below the ferry we found three costal plates of a large Chelonia, that must have rivalled in size Chelonia Midas, of the coast. The free scutes prove it to have been a marine species. Fragments of this fossil are common in the marl, higher up the river, but I had not before an opportunity of seeing any considerable portion of the carapace.

Teeth of a fossil horse are not uncommon at the ferry; and I owe to the kindness of Capt. Bowman and Lieut. Kurtz, of Fort Johnson, several fragments of the teeth of a tapir, found in the sands, in the bottom of the river.

Where the land is low, as it is some distance back from the river, marl is exposed on the creeks, as at Springfield, and on the plantation of the Rev. Dr. Hanckel.

Ascending, the marl rises gradually, and at Mr. J. A. Ramsay's it is exposed on the banks. This is a noted locality for the remains of the *Manatus*. I saw in Mr. Ramsay's possession a rib nearly entire, and he presented me with a fine Ichthyodorulite of the genus *Ptychodus*, related to *P. spectabilis*, of the English chalk. In front of the house, and to the left of the road, the bed of marl stone is again exposed.

The marl now rises into a steep bluff, eight feet in height, on the land of P. Clements, Esq. Fragments of lignite are found here, embedded in the marl, and the remains of Chelonia are frequent. Beautiful specimens of the teeth of *Myliobatis* have been found at this interesting locality, with *Balanus peregrinus*, *Gryphæa mutabilis*, and *Anomia jugosa*. Every where, on the river, the marl is exceedingly homogenious in structure, and presents, in every respect, but little variation. The surface is very uneven, and while, at Castel's Bluff, it rises eight or ten feet above the water, a short distance up stream it sinks below its level. It may be traced along the bank of the river, at low water, beyond Magnolia and Drayton Hall.

Greer's Landing is noted as the Zeuglodon locality, and it has been a fruitful source of fossils, since first noticed by Mr. Ruffin. It is a long, low bluff, extending from the landing to Middleton Place. The remains of fishes and bones of cetacea are abundant, and it was here that the most perfect remains of the head of the Zeuglodon that has yet been discovered, was found. The individual to which this head belonged was small, compared with those from Alabama, or that found in the green sand at Mazyck's.

The first intimation of the existence of this strange cetacean, on the Ashley, I owe to Mr. F. S. Holmes, who sent me a portion of the upper jaw, with one perfect tooth in its proper socket; and although it differed in size, and in other respects, from all the specimens hitherto discovered, its Zeuglodon characteristics were quite evident, and, with the rest of the skull, (afterwards found by Prof. L. R. Gibbes,) added very materially to our knowledge of the true affinities of this cetacean. Other bones, and among them a perfect scapula and another skull, have since been found by Mr. Holmes. So that the Ashley bids fair to become as famous for mammalian remains as it is already for those of fishes.

The marl of these beds has been traced as high up as the sources of the river, without much deviation from its usual character, as seen lower down.

Fossils of the Ashley and Cooper.

Mammalia.

Equus,
 teeth.
Tapir,
 teeth.

Palæotheria,
 teeth.
Manatus,
 ribs.

Zeuglodon,
 head, otolithes,
 and vertebræ.

Reptilia.

Chelonia.

Pisces.—Detached teeth, Ichthyodorulites, and vertebræ.

Pristis,	1 species.	Galeocerdo,	6 species.
Ptychodus,	1 "	Hemipristis,	2 "
Myliobatis,	5 "	Glyphis,	1 "
Carcharodon,	10 "	Otodus,	4 "
Corax,	4 "	Oxyrhina,	9 "
		Lamna,	9 "
		Cœlorhynchus.*	

* This is different from the Santee species. It was discovered and presented to me by the Rev. Dr. Hanckel.

Cephalopoda.

Nautilus Alabamensis.

Gasteropoda.

Scalaria amplicosta,
Trochus giganteus,
" like T. agglutinans,
Pyrula—a cast,
Cancellaria, "
Voluta, "
Conus gyratus.

Cirripedia.

Balanus peregrinus,
" calceolus,
" digitus.

Lamellibranchiata.

Venus crassus,
Astarte? erosus,
" proximus,
Cardium,
Cardita dubia,
Lucina—a cast,
" "
Mytillus, "
Gryphæa mutabilis,
Anomia jugosa,*
Panopæa elongata,
Pecten calvatus.

Corals.

Montevaltia?

Of the Ashley fossil shells, *Nautilus Alabamensis*, *Scalaria amplicosta*, and *Conus gyratus* alonea, re common to the Ashley and Santee beds. *Gryphæa mutabilis*, *Anomia jugosa*, the species of *Scalaria*, and the *Balani*, retain their calcareous coverings—the rest are all in the state of casts, but so perfect are those of the bivalves, in the upper marl stone, that impressions taken, in plaster, from the external casts, by my friend, Mr. Holmes, were almost as characteristic as the original shells.

Venus crassus bears so strong a resemblance to the Miocene species, *V. Lyrata*, Con. that it was not without hesitation that I separated them. *Cardita dubia* can scarcely be distinguished from a species found in the Miocene of Pamunkey, Va. *V. proxima* is like *V. cortinaria;* in a word, any one acquainted with our fossils would be struck with the Miocene aspect of these; and had I not found them associated with *Gryphæa mutabilis*, *Pecten calvatus*, *Conus gyratus* and *Panopæa elongata*, I would not have ventured to place them here.

Between the Gasteropoda and the Lamellibranchiata, numerically, there is not much difference; but the existence of the remains of terrestrial mammalia shows that the Ashley beds were deposited at no great distance from land.

Some of the fossils of the S. Carolina Eocene have a wide range. Those found in the contemporaneous beds of Maryland are the following.

Turretella Mortoni,	Crassatella alæformis,
" humerosa,	Ostrea compressirostra,
Cardita planicosta,	Panopæa elongata.
" Blandingi,	

And the following are found in the Eocene of Virginia.

Infundibulum trochiformis,	Cardium Nicolleti,*

*This fossil was brought from Missouri by the lamented Nicollet. I next found it in the Eocene of the Pamunkey, Va. and again in South Carolina.

Turretelli Mortoni,
" humerosa,
Monoceros armigeros,
Ancillaria altile,
Voluta Sayana,
Cardita planicosta,
" Blandingi,
Cytherea ovata,
Lutraria lapidosa,
Ostrea compressirostra,
" sellæformis,
Panopæa elongata.

The number of species common to the buhr-stone and to the Eocene of Claiborne, Ala. is quite remarkable. They are comprised in the following list.

Gasteropoda.

Fissurella tenebrosa,
Infundibulum trochiformis,
Crepeduda lyrata,
" dumosa,
Dentalium arciformis,
Natica striata,
" ætiles,
" limula,
Sigaretus bilix,
Acteon pomilis,
Scalaria venusta,
Meleagris antiquatus,
Turritella carinata,
" Mortoni,
" humorosa,
" gracilis,
Cerithium striatum,
Pleurotoma depygis,
" monelifera,
Cancellaria alveata,
Fusus thoracicus,
" limulus,
" papillalus,
" pulcher,
" decussatus,
" minor,
Triton pyramidatum,
Monoceros armigeros,
" fusiformis,
" vetustus,
Melongena alveata,
Pyrula cancellata,
" elegantissima,
Mitra perexilis,
Ancillaria scamba,
" staminea,
" altile,
Terebra costata,
" venusta,
Voluta Sayana,
Oliva gracilis,
Conus sauridens.

Lamellibranchiata.

Mactra prætenuis,
Lutraria lapidosa,
Crassatella protexta,
Corbula nassuta,
" oniscus,
Lellina papyria,
Lucina pandata,
" symmetrica,
Cardita planicosta,
" altecosta,
" Blandingi,
Arca rhomboidella,
Pecjunculus stamineus,
Nucula bella,
Ostrea sellæformis,
Cytherea equorea.

It is obvious, from this list of silicified shells, that the Buhr-stone formation of South Carolina is the equivalent of the great fossilliferous bed at Claiborne, and not of the overlying red loam, as Mr. Lyell suggests.

The organic forms common to the calcareous beds of the Charleston Basin and the "Orbitoidal" limestone of Alabama, are not numerous: they are as follows.

Zeuglodon.

Nautilus Alabamensis,	O. Sellæformis,
Pecten perplanus,	" panda,
" calvatus,	Scutella Lyelli.

There are other fossils mentioned as common to these beds, but I have not found them in South Carolina.

Fossils common to the Cretaceous and Eocene Formations.

It has already been stated that, mineralogically, a great difference exists between the Eocene of South Carolina and the contemporaneous beds of Virginia and Maryland. This difference consists in the great amount of carbonate of lime present in the formation towards the South. The white limestone and marls of South Carolina present a striking contrast with the gray or greenish marls of Virginia and Maryland. The nearest approach, in mineral character, to the Southern marls, was found at Timber Creek, New Jersey. The fossils of South Carolina were but little known: the few that were collected had scarcely any representatives in the better known beds of the States before mentioned, and the calcareous strata of the South were referred to the upper part of the Cretaceous formation—not more, I apprehend, because of identity of organic remains, than that they differed from known Eocene forms. At all events the beds in question were pronounced Upper Cretaceous, or beds that were supposed to be intermediate between the two formations—the Eocene and Cretaceous—and to contain fossils common to both.

It was thus that Mr. Lyell found things here on his visit. He passed over the entire length of the Tertiary formation of South Carolina, and traced its upper verge for a considerable distance towards the Savannah, and although he collected fossils with a degree of industry and care that those only who have gone over the same ground after him can understand, yet, owing to the few artificial excavations that then existed, he did not find a single true Cretaceous fossil. The result was that the so called Upper Cretaceous fossils were referred to the Eocene, together with the beds that enclose them.

Whoever looks at the list of fossils that I have presented from this formation, will, I am sure, refer the whole to our Eocene; nevertheless, there are among them a few Cretaceous fossils.

I am not a little surprised that *Gryphæa mutabilis*,* Mort. should have escaped notice, for it is met with in all the beds. It is quite a variable fossil, like most of its congeners: it is a large fossil, in the Cretaceous beds of Delaware and North Carolina; on the Santee it is pretty large, but becomes quite small in the Ashley beds.

* This fossil is sometimes referred to O. vesicularis and O. Nilsoni, of Europe, but this does not affect the question as to its distribution.

In the Cretaceous formation of Alabama it presents a like variation in size; yet it can scarcely be mistaken for any other, especially where several specimens are examined, for the characteristic radiating lines of the upper valve will be seen. I found this fossil near South Washington, N. C. with *Belemnites Americanus*, and it is identical with the ponderous variety on Santee.

In the green sand at Mazyck's I found several specimens of *Terebratula Harlani*, Mort. var. B. a cretaceous fossil of New Jersey, which Dr. Morton recognised at once.

Plagiostoma gregale, Mort. which is found at the same locality, is a Cretaceous fossil: it is found abundantly in the coralline bed at Pooshee. It is always attached to other fossils, but the squamous plates and striæ within, can always be observed. *Ostrea panda*, an undoubted Cretaceous fossil, is a very common Eocene form in South Carolina.

Mr. Lyell admits *O. cretacea*,* Mort. a well known Cretaceous fossil of South Carolina and Alabama, among the fossils common to the "Orbitoidal" limestone of St. Stephens.

In 1846 I happened to be in Wilmington, during the progress of an excavation in the conglomerate of that place, for the foundation of a distillery. The excavation was made on the side of the hill on which the city stands, and in the upper part of the conglomerate, where it was in contact with the Miocene. I found the surface perforated with lithodomous shells of Miocene species, showing that it was the bed of the Eocene ocean at the time that the latter formation was quietly deposited on it.

I was not a little surprised to find here a *Trigonia*, at least related to *T. thoracica*, Mort. if not identical with it, together with several well characterised casts of *Ammonites placenta*, Dekay, a fossil found in the Cretaceous beds of Delaware, and in those of the Peedee, South Carolina.

Seeing that this bed is a conglomerate, I set myself to examine the probability of these fossils being washed from the Cretaceous beds, higher up the river, upon which this rests. The conglomerate is composed, for the most part, of rolled calcareous pebbles, agreeing with the mass in which they are embedded, and it is well known that, lithologically, the cretaceous beds of North and South Carolina are entirely different, and hence I could not fail to detect any thing brought from that formation. The casts are composed of the white limestone; and the casts of Eocene fossils, with which they are associated, are so perfect that I was forced to the conclusion that the molluscs belonging to these shells lived and died where they are entombed.

I did not find here all the fossils that Mr. Lyell identified, but I recognised *Crassatella alta*, Con. an Eocene fossil of James River, Va. and of Claiborne. I have shown that this conglomerate is of the same age as the lower beds of the Santee, at Vance's Ferry, where several fossils, found with these casts, occur. We have, at least, then, the following species common to both formations.

Ammonites placenta, Dekay,	Gryphæa mutabilis, Mort.
Terebratula Harlani, Mort.	Ostrea panda, "
Plagiostoma gregale, "	Trigonia thoracica? "

Besides these, there are at least two species of *Echinoderms*, which I have not thought proper to insert, till Prof. Agassiz's revision of American Echinoderms is completed.

*Am. Jour. Sci. and Art, Sept. 1847.

Of the Pliocene of South Carolina.

Overlying the Eocene of Maryland and Virginia there are numerous isolated beds, consisting of sand, clay, and marl, which are every where richly fossilliferous. According to Mr. Conrad's latest determination* of the percentage of recent and extinct species of fossil shells in these, he finds, in 344 species, 49 that are now living, making the proportion a little over 14 per cent. Those who follow Mr. Lyell's classification, therefore, refer these beds to the Miocene period of the Tertiary. It will appear, from the investigations recorded in the following pages, that, in South Carolina, the percentage of recent species is far greater than this, and hence I have referred our beds to a newer division of the Tertiary—the Pliocene.

A glance at the map will show how irregularly these beds are scattered over the State. The finest exposures are found in the Eastern Districts, resting on the Cretaceous marls. In Darlington and Sumter the fossils are in a better state of preservation, and hence the deposits in these Districts have a more recent appearance, although, as it will appear, the organic remains are identical.

Mineralogically, the Pliocene beds of the State differ widely from the Miocene of Maryland and Virginia: in the latter State the amount of carbonate of lime in these beds, according to Mr. Ruffin's researches, does not average 40 per cent. whilst, in the South Carolina beds, the average is 70 per cent. It is, in this respect, even more uniform than the Eocene.

In Virginia it is not difficult to distinguish the Eocene and Miocene marls, by their mineral characters alone, but in South Carolina nothing but the evidence of organic remains will enable the Geologist to arrive at a reliable conclusion. The sections on the Waccamaw and Peedee show very clearly the depressions in the cretaceous rocks, in which the Pliocene beds are situated, and in a similar manner they are found resting on the Eocene on the Cooper, and elsewhere. In general, they are deposited on a plane that rises gently from the Atlantic, till it reaches its greatest elevation, in Darlington District. Although these deposits are confined to mere patches, that have been protected from denudation by the more elevated portions of the formations on which they repose, yet they may be traced, at short intervals, from Horry to Darlington, and from thence, by Lynch's Creek, to Sumter. Between the localities in the latter District and St. John's Berkley, where the next exposure occurs, there is a considerable gap. It next appears on Cooper River, at Mr. Carson's, and at the Grove, and still lower, on Goose Creek, which is the most southern point in the United States at which Miocene or Pliocene beds have been observed, unless it be a locality on the Edisto, which I have not seen, and only determined by some fossils in the possession of Dr. Joseph Johnson, of Charleston.

The best point to commence the examination of our Pliocene deposits is on Little River, a small stream, one prong of which rises in North Carolina. It empties into the Atlantic in the south-eastern corner of Horry District.

At the Timber Landing, below Capt. Randal's dwelling, and on the same side of the river, a bed is exposed, the upper surface of which is about the level of high-water. It is laid bare at low-water, in the sloping beach extending into the bed of the stream. A little higher it seems to thin

*Am. Jour. Sci. and Arts, 2d series, May, 1846.

out in a bed of blue clay, containing *Mactra lateralis* in great abundance; and is the only deposit in the State that reminded me of the Virginia Miocene. Resting upon the marl, is a bed of marsh mud, two or three feet thick, which is but an extension of the marshes on the shore, a few miles lower down. Superimposed upon this is a bed of incoherent sand, similar to the loose, moving sands along the coast, but now rendered permanent by the growth of plants, including large live-oaks. Immediately under the mud the marl is quite ferruginous, but lower it assumes a bluish tint. The calcareous portion is between eight and twelve feet in thickness.

I saw this bed exposed higher up the river, at Mr. Bessant's, where it occupies the bed of the stream, and still higher, some distance inland, at Mr. Vaught's, where it occurs six or eight feet below the surface.

At the mouth of the river I collected Pliocene and Cretaceous fossils, mingled together, as they were thrown up by the waves, on the shore—showing that these formations extend under the waters of the Atlantic. At Capt. Randal's the water is sufficiently salt to make it habitable to *Ostrea Virginiana*, *Fusus cinereus*, *Buccinum trivitatum*, B. *obsoletum*, and other littoral molluscs.

I collected, at these localities, the following fossils.

*Brachiopoda.**

Infundibulum depressum,	*Fusus cinereus.*
Crepidula fornicata,	*Pyrula carica,*
Natica duplicata,	*Oliva litterata.*
" Caroliniensis,	Conus adversarius,
Trochus philantropus,	*Columbella avara,*
Turritella alticosta,	*Marginella limatula,*
	Cypræa pediculus.†

Lamellibranchiata.

Pholas turgidus,	*Cytherea Sayana,*
Solecurtus caribæus,	*Artemis acetabulum,*
Myalina subovata,	Venus cribraria,
Mactra lateralis,	Carditamera arata,
Donax variabilis,	Pectunculus subovatus,
Astarte concentrica,	" 5—rugatus,
" radians,	Chama congregata,
	Ostrea Virginiana.

Making, in all, 28 species, of which 14, or about 50 per cent. are now living: eleven on the coast of South Carolina, one on the northern coast, and one belongs to the Fauna of the coast of Florida and the West Indies.

Between the Waccamaw and the coast the land consists of undulating sand-hills, not unlike those immediately on the coast. The marl is hid by these, nor is it seen until they are cut through by the river, although numerous lime-sinks indicate its presence below the surface. The lowest point on the river at which the Pliocene marl is seen, is at Grissett's Landing, a few miles above

* Those in *italics* are recent.

† I was not a little surprised to find this little W. Indian species among these fossils.

Conwayboro', where a thin band occurs over the cretaceous formation. On the opposite side of the river, higher up, at Porter's Landing, and at Harper's, it occurs in a bed twelve feet thick. The lower portion is indurated and the fossils not numerous; but I found here *Pecten eboreus*, very large, *Pholadomya abrupta*, and *Conus diluvianus*. In the upper portion of the bed, which is composed of comminuted shells and *Ostrea Virginiana*, (the long variety,) the valves of the greater part of the shells are displaced, yet *Panopæa reflexa* is frequently found buried in the marl, in the vertical position in which it lived and died—showing that these beds have not been disturbed since the time of their deposition. The superincumbent bed, at this place, consists of loose yellow sand, which constitutes the pine-woods land of this region.

The position of the beds in this section, which is over a mile in length, will appear from the following diagram.

30 to 40 feet.	Yellow sand, showing false stratification, and very undulating on the surface.
8 to 12 feet.	Yellow Pliocene marl.
8 feet.	Beds of the Cretaceous formation.

The next locality, ascending the river, is at Waller's. Here the marl rests upon the cretaceous rocks, which rise above the water only two feet. When I first saw this bed, with its numerous valves of the common long oyster of the mud flats of the southern coast, scattered through it towards the top, I supposed I had discovered a P. Pliocene deposit; but a little search corrected this impression, for I soon found *Venus Alveata*, *V. cribraria*, *Pectunculus subovatus*, *P. 5–rugatus*, and other characteristic fossils.

A short distance from this, one of the most interesting localities on the river occurs, on Tilly's Lake, at Nixon's. The mass of the bed at this place is made up of broken and comminuted shells, enclosing multitudes of beautifully preserved fossil shells. *Pyrula carica* and *Arca lienosa*, of immense size, are found at this place. I found projecting from the middle of the bed, a fragment of the jaw of *Cœlorhynchus*.

To the Geologist, examining the Tertiary formation of the South, it is of great importance to visit the localities where excavations are in progress; for the fossils are so destructible that they soon crumble, on exposure, in such a manner that a highly fossilliferous bed may present, on the surface of a natural section, little indication of the existence of the organic remains enclosed in the mass. Some marl had been excavated for economical purposes, a short time before my visit: so that I had an excellent opportunity for the study of the Waccamaw fossils. The marl is exposed on the river bank, for a distance of four hundred yards, and the strata, at the best exposure, stand thus—

30 feet.	Overlying loose sand and clay.
10 feet.	Marl.
2 feet.	Cretaceous formation, containing Exogyra costata.

At Royal's Ferry, on the left bank of the river, the marl is uncovered on the road leading to the water; it is yellow, somewhat sandy, and very rich in organic remains. I traced it in the low bluff, above and below the ferry, a distance of 300 yards, varying in height from five to eight feet. During a very hurried examination, I collected, immediately at the ferry, about thirty species of fossils, and among them, *Lucina Jamaicensis* and *Chama arcinella.*

Harris's Landing is the highest point on the river, at which I saw Pliocene marl; the bed is thin and overlaid by laminated beds of clay. On the opposite side of the river a white rich marl is exposed, just above the water line.

These are the most important localities that I examined on the river. That there are many others, no one can doubt, for these are all natural exposures, and a careful search, such as any one may make, will bring others, equally important, to light. Between the Marion road and the river there are several lime-sinks—certain indications of the presence of marl below the surface—but the country is flat and low, and the overlying beds are rarely cut through by the streams.

The following list comprises the fossils collected on the Waccamaw.

Gasteropoda.

Dispotæa costata,
" multilineata,
Infundibulum depressum,
Crepidula fornicata,
Natica duplicata,
Terebra unilineata,
Trochus philantropus,
Pleurotoma lunatum,
Voluta mutabilis,
Fasciolaria distans.
Buccinum vibex,
Conus adversarius,
Terebra dislocata,
Cassis Hodgii,
Pyrula carica,
Littorina irroratus,
Columbella avara,
Oliva litterata,
Cypræa Caroliniana.

Lamellibranchiata.

Pholadomya abrupta,
Panopæa reflexa,
Myalina subovata,
Mactra similis,
" *lateralis,*
" *congesta,*
Crassatella undulata,
Amphidesma subovata,
Tellina biplicata,
Lucina squamosa,
" *radians,*
" *Jamaicensis,*
" divaricata,
Ostrea Virginiana,
Loripes Americana,
Astarte concentrica,
" radians,
Cytherea Sayana,
Venus Mortoni,
" *mercenaria,*
" cribraria,
" alveata,
Cardium sublineatum,
Cardita granulata,
" perplana,
Arca lienosa,
Chama arcinella,
Ostrea disparilis.

Cirripedia.

Balanus proteus.

Echinoderma.

Scutella Caroliniensis.

The proportion of recent and extinct species stands thus—

Gasteropoda	19 species—	8 recent,	or 42	per cent.
Lamellebra	28 "	—13 "	" 45	" "
	—	—		
Total.	47	21 "	" 43	" "

From Conwayboro' to Galovant's Ferry, on Little Peedee, the country is a low, unbroken plain, occasionally relieved by a series of undulating sand-hills. The surface is covered with tufts of a species of *Aristida*, that furnishes a poor, harsh food for cattle, and, excepting on the sand-hills, where some oaks grow, the trees are magnificent long-leaved pines. Although I saw many lime-sinks, there are no natural sections, where observations may be made below the surface. On the right bank of the river, above the ferry, the surface is more broken, and the superincumbent beds are, in places, washed away.

About two or three miles from the ferry, and on the land of Mr. H. H. Harrelson, I found a bed of marl exposed, on a little stream, not far from the Marion road. It is about six feet in thickness, and is laid bare for a distance of one hundred yards. I found in it *Pecten eboreus*, *O. Virginiana*, and *O. disparilis*. There are other exposures not far distant, and I heard of localities in the neighborhood where this bed occurs, so near the surface as to be brought to light by fallen trees. Notwithstanding a diligent search made along Cat Fish Swamp and other parts of the District, this is the only point at which I found any Tertiary beds.

The black shale of the Cretaceous beds occurs in several places, along the road. I made a similar search, with the same result, in Marlboro, both on the Peedee and the Three Creeks. At the latter place I found the shale below the surface about fifteen feet.

The next locality to be examined is found on Giles's Bluff, on the land of Henry Davis, Esq.

I have, in another place, mentioned that the Pliocene of this locality is underlaid by the Cretaceous beds, which rise above the river to the height of twenty feet. The Pliocene marl is from eight to ten feet thick; the lower part is soft and of a light ash color, and contains fine specimens of *Pecten Mortoni*. This is overlaid by a bed of coarser structure, and of a more ferruginous color, and made up principally of calcareous casts of shells, among which *Chama congregata* is prominent. Casts of *Panopæa reflexa* are also found, in their usual natural position.

The lower and softer marl is frequently washed away, leaving the upper bed overhanging. A little below the principal bluff, the indurated bed is composed altogether of *Pectens*, lying together in every possible position, and often placed one within the other; yet many of the valves remain in juxtaposition.

Another locality, some distance from the river, is composed, in like manner, of *Pectens*, firmly cemented together. Dr. Harllee kindly presented me, from this locality, with the only specimen that I had seen in the State, of *Pecten septemnarius*. Mr. Ruffin also found here a *Pecten*, which, in his Report, is called *P. Peedeensis*.

Towards Godfrey's Ferry the bluff recedes from the river, or rather the river has encroached on the opposite bank, leaving the bluff with a narrow strip of low ground between it and the water. The upper bed is, here, pretty thick, and is perforated by openings, through which the surface water, from some distant point, finds a passage. This bed is seen again at Godfrey's Ferry, which is its southern limit on the Peedee.

Fossils are scarce in the lower, soft bed, where alone they can be extricated. I could only identify the following.

Fissurella redimicula,	Chama congregata,
Dispotæa ramosa,	" *arcinella,*
Oliva litterata,	Venus alveata,
Pyrula carica,	Artemis acetabulum,
Fusus quadricostus,	*Solecurtes caribæus,*
Panopæa reflexa,	*Lutraria canaliculata,*
Pecten Peedeensis,	*Cardium magnum,*
" Mortoni,	Modiola Ducateli,
" eboreus,	*Cardita tridentata.*
" septemnarius,	

At Witherspoon's Bluff, about two miles higher on the river, the Pliocene marl is seen rising from the water's edge, in a bed ten feet thick, the upper portion of which is more silicious than the rest. The only fossils found here are *Modiola Ducateli*, and *Panopæa reflexa.*

The position of these beds, as well as those on the Waccamaw, shows that they were deposited on the very uneven surface of the Cretaceous rocks. At Giles's Bluff the lower bed of marl is twenty feet above the river, while at this locality it is level with it. A difference of level of about ten feet occurs on the Waccamaw, in an equally short distance.

The marl is covered by a thick bed of sand, showing diagonal bedding. This is the highest point, on the Peedee, at which the Tertiary has been seen.

Leaving the river and proceeding towards Darlington Court House, marl of this formation occurs at wide intervals. First at Mr. Cannon's, near Black Creek, where the bed is a thick, calcareous mass, only exposed in an artificial excavation, and containing but few fossils, among which I could only distinguish *Balanus proteus* and *Petricola pholadiformis.* The country between Black Creek and Lynch's Creek is level, and much covered with swamps, and hence there are but few natural exposures of marl.

At Mr. F. Williamson's a similar bed has been discovered, which is also below the surface, and requiring a considerable excavation for its exposure. I found here,

Fulgur carica,	Pectunculus subovatus,
" *perversus,*	Pecten eboreus,
Voluta mutabilis,	*Arca transversa,*
Fusus quadricostatus,	*Cardita granulata,*
Oliva litterata,	O. disparilis,
Trochus philantropus,	*O. Virginiana.*
Mitra Caroliniensis,	

Both here and at Cannon's the marl is rich, containing 70 per cent. of calcareous matter.

Not far from this, marl is found, at a natural exposure, at Mr. Fountain's, but it was difficult to ascertain its thickness. The fossils on the surface, however, were sufficiently numerous and characteristic to show that it was Pliocene. It rests, as in other parts of the District, on the black shale of the Cretaceous formation.

Dr. Zimmerman's marl is similarly situated. The existence of this black and well known substance, immediately below the marl of Darlington, is a fact deserving the notice of those in search of marl for agricultural purposes, for when it is met with, it is useless to continue the search farther below.

Around the village localities are quite numerous. The marl is generally below the surface, being covered by superficial beds of sand, clay, and the accumulating organic matter of swamps. They are, in all respects, similar, containing nearly the same amount of calcareous matter, and having the embedded organic remains identical.

On the land of G. W. Dargan, Esq. a deposit was discovered, interesting for the remains of the Mastodon found in it. Among these were two perfect molars, one of which, through the liberality of Mr. Dargan, is now in the College Cabinet, at Columbia. The bed, at this place, occurs in a low swamp, covered with three or four feet of black mud—the Mastodon teeth were found immediately under this, and enveloped in the marl. The latter is composed of broken and comminuted shells, but it is difficult to give a complete list of the fossils found in it. I recognised, however, the following.

Fissurella redimicula,	*Anomia ephippium*,
Dentalium dentalis,	*Lucina divaricata*,
Natica duplicata,	Astarte concentrica,
Conus adversarius,	*Arca incongrua*,
Pectunculus subovatus,	*Solen ensis*,
" 5–rugatus,	Panopæa reflexa,
Venus tridacnoides,	Ostrea disparilis,
Carditamera arata,	" *Virginiana*,
Cardium laqueatum,	Artemis acetabulum.

At Col. Ervin's, about a mile distant, a small stream has exposed the eldest and best known Pliocene locality in the State. It is about ten feet thick, composed of fragments of shells and sand. The fossils are in a fine state of preservation, and an extensive excavation afforded an excellent opportunity of observing its fossil contents. I made a collection here, that aided me very materially in settling the true position of this portion of our Tertiary. The number of forms common to these beds and the Tertiary of North Carolina, but not found in Virginia, becomes quite striking: such, for instance, as *Cassis Hodgii*, *Cerithium Carolinensis*, *Conus adversarius*, *Cypræa Carolinensis*, *Lucina Jamaicensis*, *Mitra Carolinensis*, *Mytilus incrassatus*, *Pectunculus 5–rugatus*, and many others, which will appear in the appended list.

Another interesting locality occurs on the land of the Rev. Mr. Campbell;* where, together with disconnected valves of *Gnathodon* and *Cyrena*, I found fragments of the horns of a deer. The existence of these genera of shells, *Gnathodon* and *Cyrena*, that can live only in the brackish water of estuaries, indicates the circumstances under which the Darlington beds were deposited.

There are other interesting localities on Swift Creek, near the village, which are about the northern limits of this formation.

*Mr. Campbell has rendered important service to the District, by his numerous discoveries of localities of marl, and I have to acknowledge my obligations to him for a fine suit of fossils.

On the swamps, between Black Creek and Lynch's Creek, there are other exposures, but as they present nothing peculiar it is unnecessary to give a description. The highest point on the last mentioned creek at which marl is found, is a few miles above Dubose's Ferry. On the left bank it occurs just at the water-line, in one or two places, and on the same side, a short distance inland. On the creek, the marl seemed to be composed principally of *Chama congregata*, but it was almost entirely under water.

In the swamp, on the right bank of the river, I also found a rich bed, some feet below the surface.

Between Effingham and Anderson's Bridge the left bank of the creek is high, and exposes marl at several localities. At J. M. Timmons's the Pliocene rises two or three feet above the water. A short distance from this it is seen again, at Elmore's, and at the bridge it occurs, overlaid by heavy beds of sand and clay. A mile below, marl is again seen, which is the lowest point on the creek. Fossils are not numerous in these beds; but I saw a fine specimen of *Carcharodon* that was found at one of them.

Between Lynch's Creek and Black River a flat country intervenes, which precludes all knowledge of the beds below. At Concord Church I found a bed of Pliocene marl, about four feet thick, which, like the Darlington deposits, rests upon the black shale. Others have been discovered in the vicinity, and on the opposite side of the creek, on the plantation of Dr. Muldrow, and on others adjoining, some exceedingly interesting beds have been found. In structure and composition, as well as in the very perfect state in which the fossils occur, they resemble the beds in the vicinity of Darlington Court House.

I saw, from these, a portion of a tusk of a Mastodon. A very considerable quantity of marl had been carried out on the land at the time of my last visit to this interesting locality, so that I was enabled to collect and study the organic remains of the Sumter beds, with more than ordinary ease. As they present nothing to distinguish them from others, it is not necessary to enumerate the fossils in this place.

South of the Brick Church Mr. McBride pointed out a locality on his plantation, in which all the fossil shells are converted into a mass of carbonate of lime, so that with the exception of *Balanus proteus* and *Pecten eboreus*, I could scarcely distinguish one.

All the deposits here occur on the streams that flow into the river, but never in the river swamp. Generally the marl is overlaid by a stratum of black mud, eighteen inches thick, in which, Mr. McBride informed me, he found the remains of marsh reeds, and boring crustacea. Superimposed upon this, is a bed of sand and clay, five to six feet in thickness.

The next locality along the outer edge of the formation is found below Eutaw, in St. John's Berkley, on the plantation of Mr. T. Porcher. Like the bed in Sumter, just described, it is composed of white, comminuted shells. The fossils that can be identified are barely sufficient to enable one to determine its age. They are *Ostrea disparilis*, *Pecten septemnarius*, *Venus Rileyi*, and *Fusus quadricostatus*.

This must be the locality "below the confluence of the Congaree and Wateree rivers," whence fossils were sent by the late Stephen Elliott, Esq. from which Conrad inferred the existence of the Middle Tertiary in South Carolina.

Like the rest of the principal Pliocene beds, when they are not exposed on the banks of streams, this is found below the surface, and is only seen in the pits where marl is raised for agricultural purposes.

The highest point, on Cooper River, at which I saw any indications of this formation, is at Mr. Carson's, where a large number of fossils, consisting principally of odd valves of *Pecten eboreus*, cemented together, were found, during the excavation of a ditch. Whether these indications have been followed up or not, I am unable to say.

At the Grove, on the left bank of the river, the Pliocene marl has been cut into during the construction of a canal. This marl, lithologically, can scarcely be distinguished from that of the Eocene on the river, and hence *Pecten Mortoni*, a fossil which seems to differ from *P. pleuronectes* only in having the ribs on the inside, in pairs, *P. Holbrooki*, *Scutella macrophora*, and *S. Carolinensis*, were described as Eocene fossils.

As this was the first point at which Mr. Lyell had seen the Tertiary of South Carolina, and the only place at which he had seen any beds newer than the Eocene, it is not surprising that he should have fallen into the same mistake, of citing these fossils as Eocene.*

The upper valve, which he supposes to be that of *O. bellovacina*, belongs to *O. disparilis*, which bears so strong a resemblance to *O. compressirostra*† that they were once supposed to be identical, and it was quoted as a fossil common to the Eocene and Miocene formations.

The large *Spatangus*, which he supposes common to the limestone of Santee Canal, is *Spatangus orthonothus*, Con. *Syn. Amphidetus Virginianus*, Edw. Forbes.

There is not one of these fossils peculiar to this bed. *P. Mortoni* is found on the Waccamaw, on the Peedee, and in Darlington; *S. Carolinensis* occurs at Royal's Landing, on the former river, and *S. macrophora* on Goose Creek. The fossils that I identified here are *Pecten Mortoni*, *P. eboreus*, *Cardium sublineatum*, *Solen ensis*, *Voluta mutabilis*, *Venus cribraria*, *Oliva litterata*, *Scutella macrophora*, *S. Carolinensis*, and *Amphidetus orthonothus?*

Very similar to the bed at the Grove is one on Goose Creek: the marl, however, which is replete with casts, is rather more ferruginous, and somewhat harder. Prof. L. R. Gibbes pointed out the fact that many of the casts of the univalves were truncated at their upper extremity, as if that part of the shells had been filled with air or water, at the time when they were enclosed in their calcareous matrix.

The following list comprises all the fossils of this locality, that I could determine with certainty.

Pyrula carica,	Pholadomya abrupta,
" *canaliculata*,	Tellina biplicata,
" *perversa*,	Pecten Mortoni,
" *papyratia*,	" hemicyclicus,
Natica heros,	" eboreus,
Cypræa Carolinensis,	Lucina anodonta,
Scutella macrophora,	Panopæa reflexa,
	Spondylus sp?

Dr. Johnson, of Charleston, showed me some from a point on the Edisto, below Givham's Ferry,

* Quar. Jour. Geol. Soc. vol. I, p. 432.
† O. bellovacina is considered, by Mr. Lyell, as synonymous with O. compressirostra.

in which I detected *O. disparilis* and other fossils from this formation. This locality, therefore, which I have not seen, is the south-western extremity of the formation in the United States.

There is great difficulty in pointing out the precise limits of the superficial beds of sand and clay of the Pliocene; for in Darlington they run into those of the buhr-stone, towards the North, and, in Sumter, on the West, they stand in the same relation, whilst towards the South and South-east, they are mingled with the upper arenaceous beds of the P. Pliocene.

The sandy beds of the buhr-stone, however, when seen, can, in general, be distinguished by the red and sienna-colored loam with which they are associated, and the soil derived from them is far more fertile.

LIST OF FOSSILS OF THE PLIOCENE OF SOUTH CAROLINA.*

Mammalia.

Mastodon maximus, molars and tusk.	Cervus, horns.

Pisces.

Carcharodon,	Galeocerdo,	Saurocephalus,
Lamna,	Hemipristis,	Cœlorhynchus.

Brachiopoda.

Orbicula lugubris.

Gasteropoda.

Dentalium dentalis,	Voluta mutabilis,
" *politum,*	" *junonia,*
" thallus,	*Fasciolaria distans,*
Fissurella redimicula,	" ?
" *alternata,*	Fusus quadricostatus,
Dispotaa rugosa,	" *cinereus,*
" *corrugata,*	" ?
" multilineata,	" ?
" dumosa,	*Pyrula carica,*
Infundibulum depressum,	" *canaliculata,*
Crepidula fornicata,	" *perversa,*
" *aculeata,*	" *spirata,*
" *plana,*	" *coronatus,*
" costata,	" *papyracea,*
Serpula granifera,	*Ranella caudata,*
Petaloconchus sculpturatus,	*Purpura,*
Natica heros,	Murex umbrifer,
" *duplicata,*	Cassis Hodgii,
" *canrena,*	Buccinum percinum,
" Carolinensis,	" multirugatum,

* The names in *italics* are those of recent species.

Pyramidella terebellata,
Eulima sp ?
Terebra dislocata,
" unilineata,
" Carolinensis,
Scalaria clathrus,
Solarium sp ?
Trochus philantropus,
" ?
" ?
" ?
Littorina irrorata,
Turritella alticosta,
" variabilis?
" sphærula,
" ?
Pleurotoma limatula,
" ?
" ?

Buccinum vibex,
" *trivitatum,*
" *obsoletum,*
" *lunatum,*
Columbella avara,
" ?
Marginella limatula,
" ?
Oliva litterata,
" *mutica,*
Conus Marylandycus,
" adversarius,
" diluvianus,
Bulla canaliculata,
Cypræa Carolinensis,
" *pediculus,*
Mitra Carolinensis,
Cancellaria cancellata,
" ?

Lamellibranchiata.

Pholas costata,
" *oblongata,*
" ?
Solecurtus caribœus,
Solen ensis,
Pholadomya abrupta,
Panopæa reflexa,
Periploma,
Myalina subovata,
Mactra similis,
" *lateralis,*
" *tenuis,*
" congesta,
Cumingia tellinoides,
Crassatella undulata,
Gnathodon cuneatum,
Corbula contracta,
" inequale,
Amphidesma carinata,
" ?
" subovata,
" nuculoides,

Artemis acetabulum,
Venus tridacnoides,
" Rileyi,
" *Mortoni ?*
" *mercenaria,*
" *cancellata,*
" cribraria,
" alveata,
" latilirata,
Cardium magnum,
" *muricatum,*
" laqueatum ?
" multilineatum,
Cardita granulata,
" *tridentata,*
Carditamera arata,
" arinata ?
Pectunculus subovatus,
" parilis,
" 5-rugatus,
" passus,
" lentiformis,

Amphidesma equalis,
" *orbiculata*,
" equata,
" constricta,
Psammobea centenaria, Con.
Lutraria canaliculata,
" *lineata*,
Pandora trileneata,
Petricola pholadiformis,
Tellina alternata,
" *polita*,
" biplicata,
" *flexuosa*,
Sanguinolaria lusoria,
Lucina cribraria,
" Floridiana,
" *divaricata*,
" *squamosa*,
" contracta,
" *crenulata*,
" *trisulcata*,
" *radians*,
" *Jamaicensis*,
Donax variabilis,
Loripes Americana,
Astarte undulata,
" concentrica,
" abreviata,
" radians,
" *lunulata*,
Cytherea reposta,
" *Sayana*,
" *metastriata*,
" subnasuta.

Pectunculus aratus,
" sp.
Arca propatula,
" scalaris,
" lienosa,
" incile,
" *incongrua*,
" *pexata*,
" *cœlata*,
" centenaria,
" æquicostata,
" *improcera*,
Nucula limatula,
" *proxima*,
Chama corticosa,
" congregata,
" *arcinella*,
Mytilus incrassatus,
Modiola Ducatelli.
Pecten eboreus,
" septemnarius,
" Mortoni,
" hemicyclicus,
" *concentricus*,
" ?
Spondylus, (a cast,)
Plicatula marginata,
Ostrea disparilis,
" sculpturata,
" *Virginiana*,
Anomia ephippium,
Cyrena densata?
" *Carolinensis*,

Echinoderma.

Scutella Carolinensis,
" *5-phora*,
" macrophora.

Cirripedia.

Balanus proteus,
" *ovularis*,

Polyparia.

Astrea Marylandica,
Cellipora informata,
Cellipora umbilicata,
Lunulites denticulata.

The following table exhibits the relative proportion of extinct and recent species contained in this list.

	No. of species.	Species recent.	Per cent.
Brachiopoda	1	0	
Gasteropoda	78	39	50
Lamellibranchiata	109	47	43
Cirripedia	2	1	50
Total	190	87	46

The number of recent species is somewhat greater. There are two or three undetermined species of Trochus which, I believe, are recent. *Cardium sublineatum*, Con. will turn out to be *C. citrinum*, (*serratum*,) which is occasionally found on the coast of North and South Carolina. *Infundibulum depressum*, Say. *I. centralis*, Con. was described as a recent species, but I apprehend that it was washed from the P. Pliocene beds along the coast, where it occurs abundantly. I have therefore excluded it from the recent species of this list.

As it stands, the proportion of recent to extinct species is nearly the same as that known to exist in the Norwich Crag and Sub-Appenine beds, which are recognised as Older Pliocene by English Geologists.

Although there is no reason whatever to suppose that the proportion of recent species will not always be very considerable in these beds, yet, in generalizing, it must not be forgotten that this is the first list, of any extent, that has been made of the fossils of South Carolina, and that the existence of the beds from which it is taken was barely known when this survey was commenced by Mr. Ruffin. Future investigations will, doubtless, by enlarging the list of species here given, alter these proportions, but the general result will, I think, remain the same.

Of the eighty-seven recent species of the list, two—*Natica heros* and *Cytherea Sayana*—belong to the coast north of the Delaware. *Dispotæa rugosa* and *D. corrugata* are only found living on the coast of South America. About sixty-three species are, at present, inhabitants of the coast of South Carolina; the rest are found recent on that of Florida, and two or three are common to the seas of the West Indies.

It appears that as we proceed from North to South, the proportion of recent to extinct species becomes greater. If this be so, it would seem that the cause of the extinction of species in the United States was a gradual one, proceeding slowly from North to South.

The species from the New Jersey Miocene are not numerous enough for comparison; but, in 170 species, described by Mr. Conrad, from Maryland, the following 22 recent species occur.

Buccinum trivitatum,	*Cytherea Sayana*,
" *lunatum*,	*Artemis acetabulum*,
" *obsoletum*,	*Lucina contracta*,
Pyrula carica,	" *crenulata*,
" *canaliculata*,	*Venus Mortoni*,
Scalaria clathrus,	" *mercenaria*,
Natica heros,	*Solen ensis*,

Natica duplicata,	*Cardita granulata,*
Saxicava distorta,	*Dispotæa rugosa,*
Fusus cinereus,	*Anomia ephippium,*
Dentalium dentalis,	*Ostrea Virginiana.*

This makes the proportion of recent and extinct species about 13 per cent. The list, of course, is not a complete one, but is taken just as the fossils are described in Mr. Conrad's book.

In 160 species, which I have from the Miocene of Virginia, the following recent species are found.

Pyrula carica,	*Lucina contracta,*
" *canaliculata,*	*Anomia ephippium,*
Natica heros,	*O. Virginiana,*
" *duplicata,*	*Artemis acetabulum,*
Crepidula fornicata,	*Cytherea Sayana,*
" *plana,*	*Dentalium dentalis,*
Buccinum trivitatum,	*Solen ensis,*
" *obsoletum,*	*Cardita granulata,*
Fusus cinereus,	*Venus mercenaria,*
Scalaria clathrus,	*Nucula limatula,*
Dispotæa rugosa,	" *proxima,*
" *corrugata*	" *acuta,*
Lucina divaricata,	*Lutraria canaliculata,*
" *squamosa,*	*Mactra lateralis,*
" *crenulata.*	

We have here 29 species, or about 18 per cent. of the entire number.

The largest collection of fossils from North Carolina was that made by Mr. Hodge;* it comprises about 80 species, of which 27 are now living. This makes the proportion in that State nearly 34 per cent. of recent species.

In Maryland and Virginia Tertiary fossils have been collected with some diligence, but in North Carolina our collections are yet too small to admit of any very reliable conclusions; yet, judging from the grouping of the organic remains, I am persuaded that the beds of that State will range with those of South Carolina, in the Pliocene.

There is one source of uncertainty that must, for some time yet, attend all our comparisons of recent and extinct species—it is our imperfect and very limited knowledge of the Fauna of the whole southern coast, where, it is obvious, we must look for the living representatives of our fossils.

Mr. Conrad's explorations on the coast of Tampa Bay show how much remains yet to be done, before we may, with entire certainty, pronounce species extinct.

When we psssess such a work on the southern coast as "Gould's Invertebrate Animals of Massachusetts," our generalizations, founded on the proportions of recent and extinct species, will be entitled to far more confidence. Besides the identification of species, we must study the habits of the molluscous inhabitants of the shells, as affected by climate; for I suppose that mollusca common to the coasts of Massachusetts and South Carolina would have their habits greatly modified, to com-

* Reports Am. Ass. Geol. and Nat. 1843.

pensate for difference of circumstances. An animal that could live through the winter in shallow water, on the southern coast, may require a greater depth in a cold, northern climate.

There is a variety of *Ostrea Virginiana* that is very common in lagoons and other localities along the coast, which is known as the "Raccoon oyster." The shells are often eight or ten inches in length, and sometimes not more than two inches wide. They generally grow in bunches, attached to each other, and run up to the very level of high water. The uppermost ones are consequently out of the water, and exposed all the time, with the exception of a very short space, at high water. They have but little time to feed, and are, therefore, scarcely edible; but when the young ones are scattered abroad they acquire the characteristic form of the species.

Now in a severe northern winter, oysters exposed for so great a length of time could scarcely live; at all events that variety of oyster is not found fossil farther north than North Carolina: and a Geologist, aware of the fact, could distinguish, by its presence, a group of North or South Carolina Tertiary fossils. There are many P. Pliocene beds along the coast, abounding in fossils buried in the sand, precisely as they lived. Did we know exactly the habits of their living representatives it would be easy to determine whether or not any material change of level had taken place in these beds, since the shells were thus buried.*

That beds extending between 7° of Lat. and 6° of Lon. should present considerable diversity in their organic remains, was to be expected. A collection of Tertiary fossils from Maryland would at once be known, by its containing *Fusus parilis*, *F. rusticus*, *Corbula idonea*, *Panopæa Americana*, and *Mactra ponderosa*. And a similar collection from Virginia would be characterised by such fossils as *Cardium Virginianum*, *Pecten decemnarius*, *P. Virginianus*, *Fusus exilis*, *Venus capax*, *Pectunculus tumulus*, and *Anomia Ruffini*. The North and South Carolina beds are readily distinguished by such conspicuous fossils as *Pyrula excavata*, *Cypræa Caroliniana*, *Conus adversarius*, *Mitra Caroliniana*, *Chama arcinella*, *Pecten Mortoni* and *Area lienosa*. Many of the fossils have a wide range, but are restricted in numbers. *Venus tridacnoides* and *Fusus quadricostatus*, which occur abundantly in Virginia, are quite rare in South Carolina. The genus *Cypræa* first appears in Virginia, but increases in numbers towards the South, till, in South Carolina, it becomes quite common.

After all, it seems to me that beds having so wide a horizontal range, might differ greatly in the relative proportion of recent mollusca embedded in them, and yet be contemporaneous. I can readily conceive how a change might take place on the coast of Massachusetts, at this moment, that would affect the mollusca living there, and yet not be felt by those on the coast of South Carolina—so that when both were converted into dry land, the relative amount of recent species would differ widely.

Post Pliocene.

The Post Pliocene, although wanting the interest always connected with the vast antiquity of the older rocks, is nevertheless highly interesting, as the link connecting the past history of the earth with the present. We have here, before our eyes, the process in operation by which the bed

* There are at present some active students of Natural History in South Carolina that will not allow this interesting field to remain long unoccupied.

of the ocean has been converted into dry land. We can see, at a glance, the first steps in the fossillization of the remains of organic beings, and the manner in which they became embedded in the solid rocks where we find them. Whatever doubts persons may have, who have paid but little attention to the subject, as to the connection between fossils and living forms, here they can have none; for the fossil shells of mollusca have their specific colors and markings as well preserved as those of their descendants, now living along the coast.

The P. Pliocene of the southern Atlantic coast has not received the attention it deserves. Mr. Conrad has published an account of the formation in Maryland, with a list of 27* fossils from a deposit at the mouth of the Potomac, and pointed out the interesting fact that a few of them were only found alive on the southern coast, or on that of the Gulf of Mexico. He also described† a similar deposit on the Neuse, in North Carolina, accompanied by a list of 34 fossils. He found here also *Gnathodon cuneatum*, together with the remains of terrestrial animals.

Mr. Lyell examined, and published his views on, portions of the formation on the coast of Georgia and South Carolina, and corroborated the statements of those writers who supposed that they had seen evidences of subsidence of the coast, of very recent date.

In a "Memoir on the Megatherium and other extinct gigantic quadrupeds of the coast of Georgia," &c. read by William B. Hodgson, Esq. before the National Institute, all that was known of this formation and its embedded fossils is presented in a lucid and interesting form, accompanied by illustrative drawings and maps. As this paper embodies the substance of the investigations of J. H. Couper, Esq. as well as those of Dr. Habersham, it must be read by those who would have clear views of this portion of Southern Geology.

Mr. Vanuxem, I believe, first noticed the existence of this formation in South Carolina, and carried some of the fossils taken from a well in Charleston, to Philadelphia. Mr. Ruffin, in his Report, published a list of 25 species of fossils, prepared for him by Prof. L. R. Gibbes, from beds in the vicinity of the city.

The coast of South Carolina offers excellent opportunities for studying this formation, as it has not suffered much from denudation, and is sufficiently exposed for examination where it is intersected by the rivers and streams that flow into the Atlantic. It is composed of beds of sand, clay, and mud, containing fossils—the whole amounting, probably, to about 60 feet in thickness, overlapping the Pliocene beds on the coast of Horry and Georgetown, and on the rest of the coast, those of the Eocene.

The strata immediately under Charleston are often cut through when wells are sunk. A section of one of these wells, which I owe to Mr. Rogers, who has had much experience in their construction, presents the following order in the superposition of the beds.

*Proc. Nat. Inst. †Am. Jour. Sci. and Arts.

5 to 6 feet.	Sand, below which water is found.
9 feet.	Quick-sand and clay, with occasional remains of trees.
1 foot.	Sand and small shells.
2 feet.	Gravel and oyster-shells.
2 feet.	Mud and conchs.
3 feet.	Fine close clay and young oyster-shells.
20 feet.	Pluff clay, with scales of mica.
	Sand, to Eocene beds.

In the wells sunk near the Ashley, on the western side of the city, a bed of mud, containing stalks of the common marsh grass, (Spartina glabra, Muhl.) is found, but this is evidently an extension of the mud flats on the borders of the river, over which land has been made recently, and probably artificially. Although the fossilliferous bed, in the section, is eight feet in thickness, it is rarely found over four feet, as it is exposed along the coast. Fossils, no doubt, exist below this, but perhaps not so abundantly. Sections elsewhere on the coast differ but little from this: the fossilliferous bed is overlaid by heavy beds of sand, which it is impossible to distinguish from those forming and undergoing various modifications along the coast at this moment.

The formation extends from the coast about ten miles, where it thins out at an elevation above tide of a few feet. Its boundary is, of course, as irregular as that of the fossilliferous beds now accumulating beneath the waters of the Atlantic; indeed if the formation did not contain fossils no longer found living on the shores of South Carolina, it would be difficult to distinguish the two.

On the coast of Horry District a bed is exposed on the beach, in which the shells, mixed with pebbles, are cemented by carbonate of lime, forming a solid rock. Some of the larger shells I found undergoing a change, from the ordinary structure to that of calc spar—not by solution and subsequent filling of the hollow casts with calc spar, but the substance of the shells appears to be undergoing a slow re-arrangement of the particles of which they are composed, whereby they are converted into crystallized carbonate of lime. I have specimens, in which this passage from one structure to the other is very evident.

On Price's Creek, not far from this locality, a bed of loose, disconnected valves of shells occurs, which is six feet thick. The shells are not water-worn, but resemble the beds of shells thrown up by storms, on the shore. It is about half a mile from the beach, and is elevated above tide, five feet. The shells are principally *Venus mercenaria*, *Ostrea Virginiana*, and *Arca incongrua*. I also found among them a West Indian *Arca*, and a species of *Pectunculus*.

In All Saints, Georgetown District, I saw, on the main land, beds of oyster and other shells, belonging to this formation. But one of the most interesting localities is that at Laurel Hill Bluff, on the Waccamaw side of the peninsula, where the river, by encroachment, has produced a perpendicular bluff, thirty feet in height, composed principally of yellow sand. At the base, a bed about eight feet thick is exposed, which is made up of sand and broken shells. At first sight it had the appearance of being thrown up by the waves into its present elevation; but a bed of blue mud, which I found overlying the shells, convinced me that its surface was once at the level of tide, and that its present position, eight feet above it, is the result of a regular uplift, and not the effects of waves. This is the highest elevation at which I have seen the fossilliferous bed of the P. Pliocene of the State.

The fossils that I found here are *Arca ponderosa*, *A. pexata*, *Mactra lateralis*, *M. similis*, *Oliva litterata*, *Donax variabilis*, and *Gnathodon cuneatum*.

There are other localities around Georgetown, and fossil shells of the formation have been met with, during the excavation of the Winyaw Canal, showing that this region is underlaid by it. It is exposed on the Santee, below Mazyck's Ferry, at Fairfield. The bed at this place must correspond with the stiff, blue clay that is penetrated in the wells in Charleston. It is a tenacious and compact clay, containing but few fossils, and those always with the valves united: *Mactra lateralis* and *Pinna seminuda* were among the most conspicuous.

In Christ Church Parish, Charleston District, there are several exposures where this bed comes so near the surface as to be within the reach of the plough. The marl is sufficiently calcareous to be of great economic value. In one instance I found a bed of white calcareous mud, such as is formed by the disintegration of corals.

The next locality to be noticed is one which is found about a quarter of a mile from the river, at Bee's Ferry, on the Ashley. A bed of blue clay, containing *Mactra lateralis*, is exposed in an excavation for a well. This bed, by actual measurement, is elevated above high-water level about five feet, and is one of the few instances presented for ascertaining the amount of elevation of the P. Pliocene. It is true that we do not know the actual depth below high-water at which these beds were deposited, but as they contain generally such shells as *Lutraria*, *Pholas*, *Mactra*, *Arca*, and *Cardium*, that bury themselves in the sand and mud between high and low water line, on the shores of Charleston Harbor, at the present time—it is safe to conclude that the elevation of the P. Pliocene does not exceed, along the whole line of the coast, eight feet. There is no sudden break any where separating it from the beds now in progress of deposition, for it dips gently under the waves of the ocean, and the fossils are often found mingled with living species.

Prof. L. R. Gibbes pointed out to me another locality, lower on the river. The top of the stratum is at high-water mark, and is about three feet in thickness, composed of sand and shells well preserved, although the valves are generally disconnected. The proportion of those in juxtaposition is about equal to what one might find among the shells thrown up on the beach. This rests on a band of fine laminated clay, six inches thick, which is underlaid by blue, stiff mud, with layers of sand between the laminæ, in which are embedded numerous small shells of the genus *Mactra*. The superincumbent stratum is fifteen to twenty feet thick, composed of fine sand, without any marks of diagonal bedding. The interesting section presented here is about 200 yards in length.

I collected about twenty-six species of fossils common to other beds of the formation, and among them I saw, for the first time, *Lucina Burnetti*, Brod. which is now found, living, on the coast of California.

This fossilliferous bed underlies the whole coast, and is seen wherever the streams remove the beds by which they are covered. It may be seen on all the islands, on the shores of the inlets, as on Stono, Abapoola Creek, and elsewhere, on John's Island. It is also exposed on the islands near Beaufort, and at other places near the town.

But the most interesting locality in the State is that at Mr. Simmons's, on Wadmalaw Sound, about twelve miles below Rantowle. The section at this place may be represented thus—

10 feet.	Sand.
2 feet.	Red loam, containing casts of shells.
2 feet.	Clay.
4 feet.	Fossilliferous bed, composed of sand and comminuted shells. Fossils in fine preservation.

The uppermost fourteen feet is perpendicular—the rest slopes gradually under the tide, which rises to the level of the top of the fossilliferous portion of the section.

The appearance of the beach here was striking when I first saw it: laid bare at low-water, it was strewed with shells of all the species now found living on the coast—many of them occupying the position in which they lived and died.

Hundreds of *Lutraria canaliculata* paved the surface, precisely as they bury themselves in the sand, near low-water mark, at this moment; and *Scutella 5–phora* is represented by a very large species, which Prof. Agassiz has determined to be new.

So life-like did these shells appear that it required the presence of forms no longer inhabitants of the coast, to satisfy one that he was not looking at a recent shell bed.

Since the deposition of this, the changes in the elevation of the coast must have been slight at this point, for *Pholas costata* and *P. truncata* are found living, burrowing among their fossil congeners. *Sanguinolaria fusca* is also found living at this place.

The beds of sand overlying the fossilliferous bed correspond very nearly with the beds of moving sand along the coast. This is not so obvious south of Charleston as it is on the coast of Horry, where the line separating the recent sand-hills from the rest of the surface, between the Waccamaw and the coast, cannot be determined. The whole country, excepting where a swamp or marsh intervenes, presents an undulating surface, such as might result from a partial levelling of the moving sand-hills distributed along the coast at present.

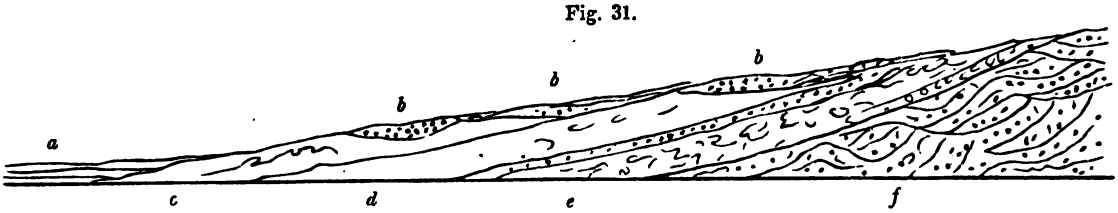
I have, in another place, shown that the beds of pebbles, gravel, &c. of the Tertiary are the debris of the rocks of the upper part of the State, brought down by the action of water. They must not, however, be confounded with *Diluvium* proper, for they contain no angular blocks, nor are the pebbles of such a size as to entitle them to the name of boulders. I have no where in the State seen one a foot in diameter, nor have I met with a single bed that I could refer to this formation along the Tertiary plane, from the Mississippi to the Potomac.

As we proceed southwards, the materials composing the silicious beds of the Tertiary become finer and finer. The large pebbles are succeeded by gravel and coarse sand, and towards the coast these are replaced by the fine sands blown about by the winds.

The blending of these strata on the surface renders it impossible to distinguish the arenaceous beds of the different Tertiary formations, when they do not enclose organic remains. The sandy beds of the buhr-stone are intermingled with those of the Pliocene, which pass into the superincumbent beds of the P. Pliocene, and the latter are, in turn, blended with the moving sands on the coast.

Fig. 31 represents a section exhibiting the relative position of the Tertiary beds of the State.

Fig. 31.



f.—Buhr-stone formation. *e.*—Santee beds. *d.*—Coralline marl. *c.*—Ashley and Cooper beds. *b.*—Patches of Pliocene. *a.*—P. Pliocene.

Alluvium.—Changes on the Coast.

The deposits included under the term Alluvium are well understood, as comprehending those at present in course of formation, such as the beds formed in lakes, on the banks and at the mouths of rivers, and along the coast. In general it is not difficult to distinguish the deposits left, by the overflowing of rivers, on their banks, although they differ in various other important respects.

Without attempting to determine the precise limits of the P. Pliocene and recent deposits on the coast, I shall proceed to notice the changes going on there.

Every one is aware that a vast amount of matter is carried down annually by the rivers into the ocean and deposited, in the form of beds of mud or sand. The size of the particles forming these beds will depend upon the velocity of the streams transporting them. The coarser materials will be deposited first, and by the time the rivers reach the ocean, little besides the finest sedimentary matter will remain suspended in the water. This is one of the causes of the great difference that exists in the alluvial soils, seen on the banks of rivers, as we approach their mouths.

The fine matter held in suspension by the river water, as it enters the ocean, would be dissipated by the currents along the coast, if a barrier were not raised by the ocean itself, which breaks the force of these currents, and produces still water between the beach and the coast.

The Gulf Stream produces an eddy current which washes the coast southwardly, and the sand bars, so common on the coast, are formed in the diagonal or resultant of these two currents.* Those formed at the mouths of rivers must also, it seems to me, be influenced by the force and direction of their waters. These bars, however, are generally formed directly by the ocean, and not by the water of the rivers.

* For this and numerous facts relating to the coast, I am indebted to Capt. Bowman, of Fort Sumter.

The mouth of the S. Santee presents an interesting illustration of this: a narrow sand bank extends into the Atlantic from the north bank of the river, which has been thrown up by the waves. This bank has advanced gradually for the last thirty years, at the rate of about one mile in ten years, as I was informed by Mr. Lucas, who has watched its progress with great care.

The breakers first make their appearance at a distance, and gradually push forward the sand, as they slowly approach the shore. When the sand rises above the surface and the water becomes too shallow to produce breakers, they disappear, and commence again off the shore, and farther south.

In the mean time still water, or even an eddy, is produced on the opposite side of the river, and the fine mud brought down by it is deposited, forming, at low water, an immense mud flat. In the reduced plan of Murphy's Present, in the following pages, this flat is represented by the dotted line near the shore.

The portion of the flat next the channel is composed of coarser materials; between this and the land a sort of lagoon channel is left, but which is gradually filling up with light materials, such as leaves and other vegetable matter, drifted back by the eddy. The depth of these mud flats is only limited by that of the bottom of the river, and hence it is frequently very considerable. When they attain the level of high water they are soon covered by the marsh reed, (*Spartina glabra.*) Their progress in rising is now much slower, because they no longer receive accessions from the river or tides, excepting on extraordinary occasions. The annual crop of reeds, however, produces a gradual accumulation, and the moment any portion is elevated completely above tide it is taken possession of by tufts of rushes.

It is in this manner that the numerous verdant low islands in Charleston Harbor, and along the coast, are formed.

It is observable that on the borders of the channels by which these islands are often separated, they are higher than in other parts. This is often indicated by the growth of shrubs, such as the Myrtle and Baccharis, upon the elevated spots. A few inches of sand, when they are above tide, would fit them for the growth of pines and other trees, and give them all the appearance and character of permanent land.

But it is not even necessary, for the growth of swamp trees, such as the Cypress, (*Cupressus disticha,*) that the land should be elevated above high-water. All that is required to fit them for this purpose is the exclusion of salt water. How this takes place will appear farther on.

I have mentioned that these Islands or flats are protected from the direct action of the ocean waves by a barrier of sand thrown up by the ocean itself, consisting of a sandy beach and a series of low sand-hills, which are constantly changing their outline, and frequently their position.

All the conditions necessary for the formation of these moving sand-hills are dry weather and a certain breadth of beach. Every breeze carries along with it, when blowing landwards, particles of fine sand, till they meet with a log, a bush, or any other obstacle, when they begin to accumulate in proportion to the velocity of the wind, and with extraordinary rapidity—piling up and running over the top. This is continued, if the wind be strong enough, until they rise to a height of thirty or forty feet, which seems to be the greatest height that they attain on the coast of South Carolina.

They seldom recede from the ocean a distance of more than half a mile. When the beach is removed by the encroachment of the ocean, or any other cause occurs to prevent further movement, they are soon covered with such sand-loving plants as *Uniola paniculata* and *Croton maritima*, and even Pines and Palmettoes, and the hills become stationary.

The inclination of the planes up which the sand is driven often amounts to 45°, and taken in connection with the size of the particles, would furnish a rude anemometer, by which the force of the winds producing the hills might be estimated. They are often marked on the surface by minute ridges, in all respects similar to ripple marks: these are the result of very gentle winds. Sections of the hills present exactly the same appearances, as regards diagonal bedding, as are seen in sections of the older Tertiary sands, which were doubtless deposited in water.

The prevailing winds of the coast are indicated by valleys running through the hills intersecting those that were thrown up by winds blowing from other points.*

It was curious to see Palmettoes and other trees growing out of what seemed to be pits in these hills, for the sand did not close in upon the trunks, but formed an inverted cone, in which the trees stand. I suppose that is due to an eddy current produced around the trees, which whirls the sand outwards and upwards. Trees, and even houses, are, however, often covered up by these blowing sands, and future Geologists will be puzzled with the remains that they will enclose.

There are few circumstances, I apprehend, better calculated to teach man lessons of humility, than the approach of one of these to his dwelling. I saw one, on the coast of Horry, under such circumstances. It had already shut out from the house a magnificent view of the Atlantic, and its base had almost reached the yard gate. Although its advance was grain by grain, its progress was as irresistible as a torrent of lava from a volcano. There was nothing to be done but to look on, and hope that something might occur to change its path.

It is fearful to see how completely they defy man's efforts to resist or even retard their progress, as they encroach upon his domain.

At first sight it seems strange that they are not blown farther inland from the coast, instead of being confined to a narrow range, no where exceeding half a mile in breadth. They are arrested by the plants, as I have already stated, that immediately cover them when they are raised above tide. The Cedars, Myrtles, and other shrubs that are invariably found on the land side, break the force of the winds, and in this way are they kept within certain limits. This suggests the only practicable mode of arresting these blowing sands.

On this portion of the coast there are no islands, and the range of sand-hills is on the main land. The reason of this is, simply, that there are no rivers. The Waccamaw flows along parallel with the shore, and drains the intermediate land; so that, for twenty miles, there is an uninterrupted beach, along which a carriage may roll, at low-water, without leaving on the hard sands the slightest impress of its track.

South Island, on Winyaw Bay, is a long narrow strip of sand-hills. Between this and Cat Island there is a marsh one and a half miles wide, and extending to the Santee; it is drained by Mosquito Creek. The sand-hills are stationary, excepting immediately on the shore, and are the sites of pleasant summer residences. Between this and Murphy's Island the same range continues to S. Santee.

Similar features characterise the whole coast: a sandy beach bordering the ocean, in which littoral

*Appendix A. Meteorology.

molluscous animals bury themselves, and which is often covered with the shells of littoral and pelagic species, thrown up by storms; back of this, a low marsh, intersected by channels in which oysters live; the marshes are covered with a coarse, tall grass, and, where more directly exposed to salt water, with *Uniola spicata*. *Auricula bidentata* and *Littorina irroratus* are the only shells found on these marshes, but on their muddy edges vast beds of muscles exist.

Thus far I have only alluded to the accumulations going on upon the coast, or the encroachment of the land upon the ocean. It will be seen, however, that there are other changes in progress, equally important and reciprocal with these—the encroachment of the ocean upon the land. Before proceeding to the consideration of these, it will be proper to take a rapid view of the changes to which the rivers of the State are subject.

In general the channel of a river will be subject to change, so long as the resistance presented by the banks and bed is less than the force of the stream. If the resistance of the bed be greater than that of the banks, the channel will widen at the expense of the latter; but if the bed present less resistance than the banks, it will deepen. It is for this reason that the rivers of the State are narrower below the falls than above, although the quantity of water is generally greater.

When, by any cause, the current is made to impinge with greater force upon one bank than the other, it must be worn away, unless composed of materials offering a sufficient resistance; and a corresponding addition is generally made to the opposite bank. The addition, however, does not consist of the debris of the wasting bank, but of sedimentary matter brought from above, and deposited in the eddy.

I saw, below Silver Bluff, on the Savannah, a sunken steam-boat, that had so directed the current to the South Carolina side of the river, as to wash one hundred feet of the bank in a single season, and make a deposit, to the same extent, on the Georgia side. The falling in of a tree, or the accumulation of a raft of wood, is often sufficient to produce serious changes in the channel of a river, where the banks are yielding.

But the rate is often so slow as to render their progress almost imperceptible. It is in this way that the low grounds and swamps on the rivers are formed, which occur on the banks opposite to the bluffs.* The encroachment generally extends to a depth equal to that of the river, and hence the great depth of the swamps, which are only the changing beds of the rivers, filled up with drifted materials, often composed of purely vegetable matter. It was mentioned that these materials are finer towards the mouths of the streams, and for the simple reason that the transporting power of the latter is diminished with their velocity, so that when they fairly meet the tide it is destroyed altogether; and hence that extensive and most interesting series of deposits lying along the coast, within the limits of tide-water, constituting the rice plantations, which are composed of the finest sedimentary matter, almost entirely of vegetable origin.

I do not mean to say that they are composed altogether of drifted materials; on the contrary, they were once swamps, covered with Cypress trees and a dense under-growth, which, for ages, accumulated vegetable matter, extending, even now, to a depth of twenty or thirty feet. Prostrate logs of Cypress and Cedar are met with in every excavation, and stumps are found below the

*Any one desirous of having vivid impressions of the extent and nature of these swamps, need only cross the Little Peedee, at Gallovant's Ferry, and return by way of Potatoe-bed Ferry, lower down—the sooner after a freshet the better—or cross the Santee, at Murray's Ferry, in February.

surface, standing as they grew. The quantity of timber is often so great as to offer serious impediments to cultivation, on some rice plantations.

And this circumstance—the presence of timber—is sufficient to distinguish these ancient swamps from the other recent deposits on the coast, although many of the former have, at present, no trees upon them, are overflowed by the tide, and present nothing on the surface different from ordinary salt marshes. This is the case with a part of Murphy's Island and Cat Island.

It must be borne in mind that these lands are below the level of tide—indeed it is upon this circumstance that their value as rice lands mainly depends, in relation to irrigation.

We may now return to the examination of those changes produced by the encroachment of the ocean, and the phenomena which it presents, which have been attributed to the

Subsidence of the Coast.

Bartram, in his "Travels," I believe, was the first to point out the evidences of the subsidence of the southern coast, presented in the numerous submerged stumps of trees, so common along the shore. Other writers, since his time, have noticed these stumps, and have referred them to the same cause; and, more recently, Mr. Lyell has examined the coast of South Carolina and Georgia, and has come to the same conclusion, namely, that these submerged stumps "show a vertical depression of the land, to the amount of at least four feet."*

The whole coast of South Carolina is very low. The tidal wave is felt for a distance of forty miles up the rivers from the coast. The most elevated point of land in the city of Charleston is not more than ten feet above tide, and the greater part of the city is not half that elevation: so that the subsidence of a few feet would place the whole under the sea.

I am inclined to think that a depression of level, to the amount of two feet, would destroy the rice plantations, by letting in salt water.

It was intimated that as the subsidence was of very recent date, it may be in progress at this moment. Under these circumstances, and with the prospect before me of witnessing a real case of subsidence, where the proofs were so palpable, it will be readily imagined that I set about the examination with no ordinary interest.

I will mention, briefly, the most noted localities examined, so that any one may satisfy himself of the correctness of the inferences drawn from the evidence they present.

On the left bank of Little River, in Horry, I saw many acres of marsh overflowed by the tide, and covered with Live-oaks, some standing, but the greater number prostrate. The trees were evidently where they could not have grown, and it was equally evident that they were not drifted. The marsh was nothing but a mud flat, filled with oysters and muscles. It presented, at first sight, a remarkable proof of subsidence. Fortunately I continued the examination farther towards the mouth of the river, where I found an isolated knoll of sand, washed at its base by the waves, but still supporting a few oaks, which explained the whole. The mud flat was once covered with sand-hills, upon which the oaks grew; the waves, during a storm, broke over the peninsula, washing away the sand from beneath the trees, many of which were enabled to remain erect, supported by their wide-spreading roots. The ocean had simply reclaimed what once belonged to it. In

* Quar. Jour. Geol. Soc.

consequence of this widening of the mouth of the river, it is fast silting up, which is to be regretted, as it is the only landing on this part of the coast.

A few miles farther to the South, I was shown stumps that are found at least a quarter of a mile from the shore, which were considerably below high water. My informant assured me that his father had, for years, fed his hogs on the spot marked by these stumps.

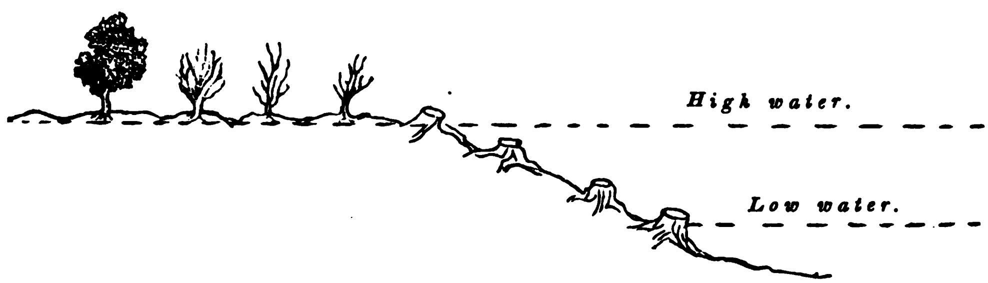
I had not proceeded far with these investigations before I found it necessary to distinguish trees that have "tap-roots," from those without. The Pine, every one knows, has a long, stout tap-root, often ten feet in length. These trees will grow on the verge of the ocean, where they are barely protected from the salt water; and I have often seen them growing on sand, not elevated a foot above tide. Under these circumstances they send down their long roots through the mud or sand. Any encroachment of the sea, barely sufficient to remove this foot of sand, will kill these trees, by admitting salt-water to the roots.

When dead, and before the earth is removed to any great depth, they break off, in most cases, just below the stool, or point of insertion of the lateral roots, because the weakest point, leaving the tap-root firmly fixed in th; ground. Of this character are the stumps to which I have just alluded.

Now a person seeing such stumps below tide-level, without a close examination, would be likely to conclude that they were true stools, and as they could not grow where they are found, would refer to subsidence, what was the result of simple encroachment of the salt water.

My next examination was of an entirely different character. On Wadmalaw Sound there are certain marshes, called the "Church Flats," where real Cypress stumps, with portions of the lateral roots left, standing as they grew, are found as thick as they usually stand in a swamp, but buried below the surface of the marsh, which is level with high-water, to the depth of three or four feet, or perhaps to a greater depth. I commenced the exploration of these flats at the Cedar Islands, of which Fig. 32 represents a section one fourth of a mile in length, extending from the solid land to the channel. This section needs no explanation: the Cypress stumps referred to are seen on the edge of the marsh, as exposed by the channel.

Fig. 32.



These flats were once covered with Cedars, many of which are still living, near the high land; others, though dead, are standing, and the surface studded with cedar roots, which form a tier above those of the Cypress.

At this moment the surface of the marsh is elevated but a few inches above the level of high-tide. A new cut, which the river made here, has exposed these cedar islands to the more direct influence of the salt water, and the Cedars are gradually disappearing before it, and in a few years there will be scarcely one left, unless the salt water may again become sufficiently diluted by the retardation of the fresh water of the river.

The ground upon which these cedars stand is mud, too soft to support the weight of a man; so that a pole may be thrust down into it ten or twelve feet. And it is a fact worthy of notice, that this is the case wherever Cypress stumps are submerged—at least so far as I have had opportunity of observing. They are always buried in soft mud.

These flats have high, firm land every where adjoining them, which have trees growing to their very edge, and we have no reason to assume that it was ever different. I examined the points of contact of the two, with great care, to ascertain whether or not there may be stumps in the firm land, below the level of tide: if so, the proofs of subsidence presented by these Cypress stumps, would be indisputable; but I did not find a single one. Now as I cannot conceive of a subsidence confined to a swamp, for such these marshes once were, and following all its sinuosities, without affecting the firm land adjoining, I am obliged to seek some other explanation of these submerged stumps.

The Cypress swamps of South Carolina, and I believe elsewhere, are composed, for the most part, of a vast accumulation of vegetable matter,* often covered with Sphagnum, Ferns, and a thick undergrowth of shrubs, the whole preventing evaporation and decomposition, and retaining moisture like a sponge.

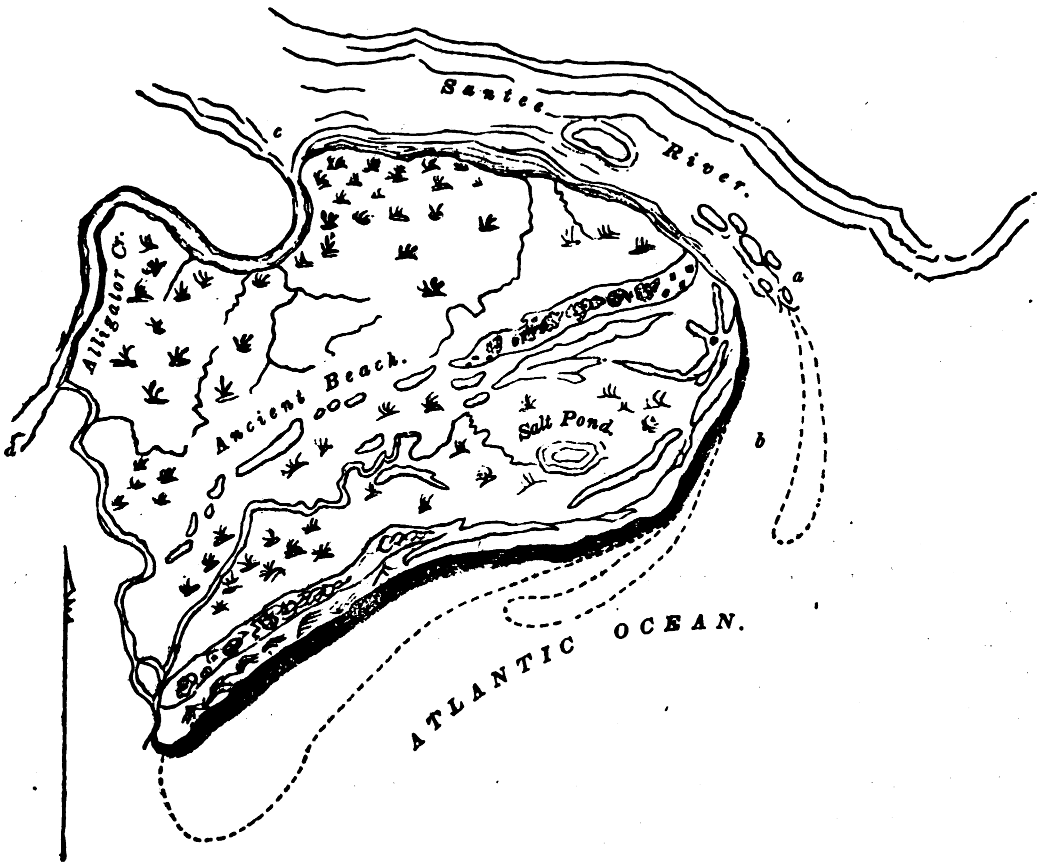
Now the effect of the encroachment of salt water upon such a swamp as this would, in the first place, be to kill the undergrowth, and expose the soil to the sun and light; decomposition of the vegetable matter would proceed rapidly; the trees would decay and fall, breaking off the "air-line." The organic ingredients of the mass of vegetable matter would pass off into the atmosphere, and the rest, saturated with water, would be converted into mud. Can any one suppose that a deposit, thirty or forty feet in thickness, would not sink, under such a process, sufficiently to account for the position of these stumps?

Should the overflow of water continue, a sedimentary deposit would take place above the stumps, and should the salt water be again shut out, another growth would succeed the Cypress, such as the Cedars of the Cedar islands; and these again may be killed, as is the case on those islands, by a second encroachment. How such alternations take place will next be shown.

Fig. 33 is a reduced map of Murphy's Island, at the mouth of S. Santee, taken from an accurate survey, made in 1830.

* See a paper on the Cypress Timber of the Mississippi, by Dr. Dickeson and A. Brown, Sill. Jour. Jan. 1848.

Fig. 33.



That portion of the island lying on Alligator Creek, which is one of the mouths of the Santee, was very recently a salt marsh, but is now a rice plantation; it is filled with stumps, which are buried about fifteen inches below the surface.

The encroachment of this island upon the ocean is marked by a series of beaches, in which fossils are embedded, and an addition of many acres, now going on, is marked by the dotted line on the shore. This increment, together with the extension of the opposite bank of the river, which has amounted to three miles in thirty years, of course confines the fresh water to the river, and forces back, to the same extent, the salt water; the result of which is the recession of the line of brackish water down the river. This is curiously exhibited in Alligator Creek, which presents the remarkable phenomenon of a stream salt at both extremities and fresh in the middle; so that Mr. Lucas, the proprietor of the island, had the rare good fortune to detect this stream in its passage from a salt to a fresh water creek.

At low water the river, at present, is fresh below the junction of the creek, and as the water flows through it from the river, it is also fresh in the creek. At the flow of tide the water is backed up, at *d*, where the creek empties into the ocean. In the mean time the tide flows up the river, and becomes salt above the other extremity of the creek, while the latter remains filled with the fresh water which it had previously received—being, as stated, salt at each end and fresh in the middle. Should the land at the mouth of the river continue to "make," the creek will soon be fresh, excepting at its entrance into the sea. Had this marsh not been converted into a rice field it would be covered again with trees, at no distant period; and the simple removal of the accumulations at the mouth of the river would admit the salt water, and once more convert it into a salt marsh. This alternation would take place without the slightest necessity for an inch of subsidence of the coast.

The sinking of swamp deposits, when exposed to the action of the atmosphere, is well known. There are accounts, in the "Farmer's Register," of lands reclaimed, on James River, by the author of that work and others, that, after a few years, were abandoned, because of this sinking. The soil "rotted away," so that drainage became impossible. Many of the rice plantations are three or four feet below their original level, from this cause: a fact that can be ascertained by comparing the level of the fields with that of the banks of the rivers—the latter being more compact, because composed of sedimentary deposits from the river, and, containing less vegetable matter, settle but little. The removal of wood and the annual crops being trifling, compared with the sinking from decomposition.

It would be exceedingly interesting had we any means of knowing the changes that have taken place on the coast, in a series of years. On an old map, without date, which I saw in the Apprentices' Library, in Charleston, Fort Johnson is noted, as it then stood, on dry land. The remains of the foundation may now be seen on the strand, at low-water. To the north of the Fort the island is wasting for a distance of a mile. The perpendicular bank was once a series of sand-hills, and even now sand is blown up at an angle of 45°. Stumps are seen in the water, 150 feet from the bank, and the remains of an old fort and a cannon are buried in the sands, on the shore, over which the tide rolls. At the date of the map the narrowest point of Kewaw Island was one and a half miles wide; it is now cut in two.

In 1771 Catesby says of "Sullivan's Island, which is on the north side of the entrance to Charleston Harbor, the bay, on the west side, has so encroached, (though most defended, it being on the contrary side to the ocean,) that it has gained, in three years' time, a quarter of a mile, laying prostrate and swallowing up vast Pine and Palmetto trees. By such a progress, with the assistance of a few hurricanes, it probably, in some few years, may wash away the whole island, which is about six miles in circumference."

About nine or ten years ago a portion of Fort Moultrie was washed away. So completely successful have the plans for the protection of the island and fort been, that the dykes thrown out in front have produced a deposit of sand which removes the fort 100 yards from ordinary high-water, and 300 from low-water mark.

Such improvements, though military in design, are nevertheless incidentally agricultural. Whatever tends to protect the mouths of the rivers, must, at the same time, shut out salt water, and so far protect the rice plantations.

The islands south-west of Charleston offer many instructive examples of the changes taking place on the coast.

Morris's Island presents, on the beach side, a long line of sand-hills, rising to the height of thirty or forty feet, and, in some places, covered with Pines and Palmettoes. Inside of this is an immense marsh, intersected by creeks, which once divided the island in two or three places, but which are now silted up by the sand driven in by the waves.

The hills, towards the middle of the island, rest upon a mud flat. As they are driven bakwards by the winds, or washed away in front by the waves, the flat becomes exposed. For more than a mile in length there are numerous stumps in this flat, which, on examination, prove to be tap-roots of Pines, which had penetrated through the sand upon which they once stood, and which has been washed away, leaving the stumps, as if they had grown on the mud flat, which is now below high-tide. Many of these stumps have oysters attached to them.

On Folly Island an interesting example of the effects of the direct influence of the salt water occurs—the simple result of encroachment. Immediately back of the sand-hills, as has been already stated, there is a pretty dense thicket of Myrtles and Cedars, which, at high-tide, are washed by the brackish water that overflows the marsh upon which they grow. They were protected by the beach and sand-hills alone, from the ocean. This barrier was washed away, and the trees and shrubs killed, for a distance of 120 yards, as completely as if a real subsidence had taken place, and the whole had been submerged.

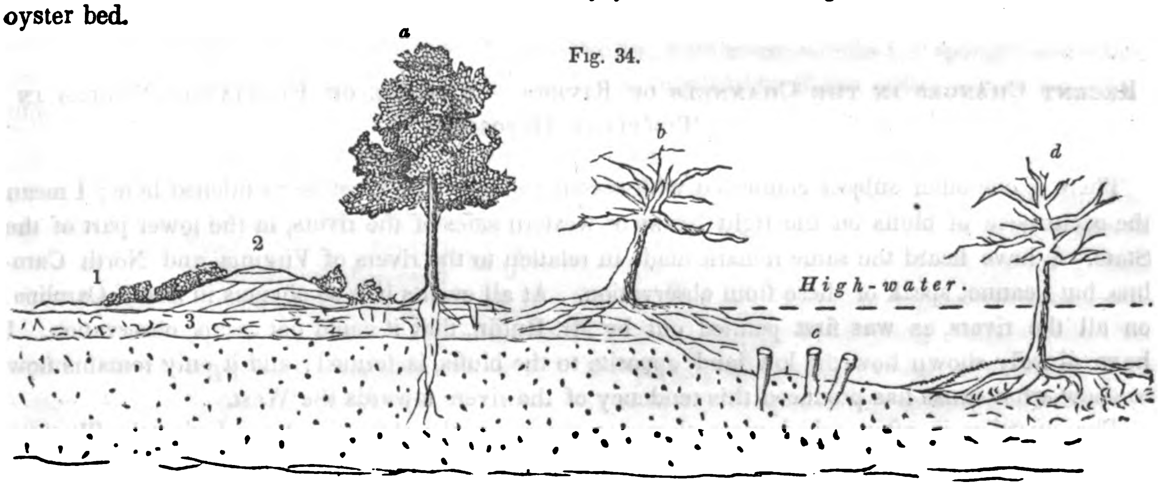
Where trees will grow at or near the level of tide, the conversion of fresh or brackish, into salt, water, by simple encroachment, will kill them, as effectually as if it happened by subsidence.

Bird Key is a long, narrow island, which, Capt. Rivers informed me, within his recollection, was barely seen at high-water. It is now eight or ten feet above tide, and covered with Uniola, Iva, Yucca, and Palmetto. It is, however, wasting away, on the eastern side, and will doubtless soon be reduced to its original level.

Nothing is more common than such changes as these, along the entire coast.

Of the numerous other examples of submerged trees that I have seen, I shall mention but one more, which occurs on Cole's? Island.* Here there are many stumps, of both Pine and Oak, below high-water, and a Live-oak tree stands about sixty yards from the high land, in the middle of an oyster bed.

Fig. 34.



* There is a fort here, built during the last war, of concrete, which is in a fine state of preservation. It stands upon a mound, apparently of Indian origin, for it is filled with the exuvia of such shell-fish as they used for food. On James Island there is a very remarkable accumulation of shells of this sort. It stands upon Dr. Lagare's plantation, and as it is a flat area, surrounded

This would have been a puzzling instance, if the whole process was not presented before one's eyes. Fig. 34, which represents a section across Cole's Island, will explain the appearances presented at this locality. 1 is the "back beach," or flat behind the sand-hills; 2, sand-hills; 3, bed of marsh-mud; *a*, a Pine, with tap-root extending into the mud; *b*, Live-oak, undermined by the waves, but yet attached to the bank; *c*, stumps; *d*, Live-oak standing on oyster bed.

This section needs scarcely any explanation. The Pines grow in the sand, down to the water line, and but a few inches above it, where the slightest encroachment of the salt water kills them, when they break off, generally below the stool, leaving the tap-root standing. The Live-oak, on the contrary, having no tap-root, is supported by its wide-spreading lateral roots, by which it is often retained in an erect position when the sand is washed away; and, on account of its great durability, remains, when there is nothing but the tap-roots of the Pines left.

Near this place another interesting record of the mutations of land and water is seen. A house once stood here, having a well back of it, on the island. The house is gone, but the curbing of the well, which consisted of a cask, still remains on the beach, but below high-water—having sunk into the loose sand. Had the coast, in the vicinity of Charleston, sunk at this rate, St. Michael's Church, instead of being the ornament of the city, would, at this moment, be a geological monument, of the greatest interest.

I have thus presented some of the most striking phenomena which have been supposed to result from a gradual subsidence of the solid crust of the earth, on the coast of South Carolina. If any one will examine the localities that I have indicated, I am persuaded that he will come to the same conclusion that I did, namely, that there is not a single instance of submerged stumps that cannot be traced to the encroachment of the ocean, without supposing any change in the relative level of land and water, on the coast.

Those writers who have referred them to the latter cause, erred, in not having first studied the nature and level of the swamps in which the trees grew whose stumps are found submerged, and in not distinguishing tap-roots from true stumps.

Recent Changes in the Channels of Rivers.—Absence of Fluviatile Shells in Tertiary Deposits.

There is one other subject connected with recent changes that must be mentioned here; I mean the occurrence of bluffs on the right banks or western sides of the rivers, in the lower part of the State. I have heard the same remark made in relation to the rivers of Virginia and North Carolina, but I cannot speak of these from observation. At all events it is so obvious in South Carolina, on all the rivers, as was first pointed out by Mr. Ruffin, that it could not escape observation. I have already shown how the low land, opposite to the bluffs, is formed; and it only remains now to show what cause has produced this tendency of the rivers towards the West.

The question is often asked, were there no rivers on the Atlantic slope, during the Tertiary period? and if so, why have we no fresh water fossil shells in the deposits of that period?

by a circular bank of shells, it furnishes a convenient site for a dwelling. It appears as if the shells were thrown around the huts, in the centre, inhabited by the Indians. It is remarkable that the shells are disposed in layers: a layer of conchs, next one of clams, and then one of oysters—as if eaten as they were in season.

That rivers did exist is proved by the presence of estuary shells. I found, in the Miocene of Virginia, shells of the genus *Cyrena* and *Paludina;* the genus *Gnathodon* has been long known as a common Tertiary form. And if the inclination of the Tertiary plane bore any analogy to that which it has at present, it should not excite surprise that there are so few fresh water shells found.

The rivers of South Carolina abound in fluviatile shells, above the line of brackish water, and yet, after the closest examination, I was unable to find a single fragment of such shells at the mouths of the rivers in the deposits now forming; nor are there any found in the P. Pliocene beds.

The reason is this: there is a space of several miles between the line of brackish water and that where marine shells can live; in this interval, therefore, neither marine nor fluviatile molluscous animals can exist; and as the rivers flow so slowly over their beds, the water has not sufficient transporting power to bring down even a fragment of a shell. Under these circumstances it is impossible that any mixture of fluviatile and marine shells can take place.*

That the rivers had scooped out their channels in the Cretaceous and Eocene beds of the State, before the P. Pliocene was converted into dry land, cannot be doubted, for but a few miles in extent of the coast was below water, and the rest must have been drained, to say nothing of the estuary shells found in the P. Pliocene beds, at the mouths of the present rivers.

I have shown that the coast was elevated, since it was inhabited by the present Fauna, to the height of at least five feet. Now it is scarcely probable that this last uplifting force should have coincided so completely with that which had previously converted the Tertiary into dry land, as not to alter the course of the rivers. A slightly greater elevation of the north-eastern corner of the Tertiary plane would give the rivers the tendency they have at present, to encroach upon their right banks; and should a corresponding elevation of the north-western corner take place at any future period, they would gradually return to their former beds.

Recent Shells of the Coast of South Carolina.†

The following recent shells were picked up on the beach, along the coast, and will serve for comparison with the fossil species. Some of them, however, were found attached to sponges and other floating substances, and may not strictly belong to the inhabitants of the coast; others are only found in fragments, thrown up by storms, and a few probably belong to the P. Pliocene.

Cemoria alternata,	Say,	Buccinum obsoletum,	Say,
Syn. Fissurella "	"	*Syn.* Nassa "	"
Infundibulum depressum,	"	B. trivitatum,	"
Syn. " centralis,	Con.	" vibex,	"
Dentalium eboreum?	"	" acutum,	"
Bulla canaliculata,	Say.	" unicincta	"
Syn. Volvaria "	"	" lunatum,	"
Auricula bidentata,	"	Terebra dislocatum,	"

* The deposits now forming will contain land shells, for I saw, in the bay, near the battery, the little *Pagurus*, or hermit-crab, so common there, running about with *Bulimus decolla us*, of which it had taken possession.

† In making this collection I was kindly assisted by my friends, F. S. Holmes, Esq. and Dr. Burden.

Syn. Melampus bidentata	Say,
Eulima—? sp.	
Natica duplicata,	"
" pusilla,	"
Sigaretus perspectivus	"
Pyramidella—? sp.	
Scalaria clathrus,	"
" lineata,	"
" multistriata,	"
Littorina irrorata,	"
Pyrula carica,	Gmel.
" canaliculata,	Lin.
" perversa,	Lam.
" papyracea,	Say,
Ranella candata,	"
Murex asperrimus,	
Cassis gigas ?	
" sulcosa ?	Lam.
Dolium galea,	

Syn. Cerithium dislocatum,	Say,
Columbella avara,	"
Pleurotoma pusilla ?	
Purpura cataracta,	
Marginella spilota ?	
" limatula?	Con.
Oliva literata,	Lam.
" mutica,	Say,
Crepidula plana,	"
" aculeata,	"
" fornicata,	Lin.
" convexa,	Say,
Cancellaria reticulata,	Lam.
Fasciollaria distans,	"
" trapezium,	"
" tulipa,	"
" arautiaca,	"
Fusus cinereus,	Say,
Ovula acicularis,	Lam.
Turritella concava,	Say.

Teredo navalis ?	
Pholas costata,	Lin.
" truncata,	Say,
" oblongata,	"
" cuneiformis,	"
Solen ensis,	Lin.
" viridis,	Say,
Solecurtus caribæus	Lam.
" fragilis,	
Lutraria canaliculata,	Say,
" lineata,	"
Cumingia tellinoides,	Con.
Mactra similis,	Say,
" lateralis,	"
" oblongata,	"
Amphidesma orbiculata,	"
" equalis,	"
" lepida,	"
Sanguinolaria fusca,	"
Syn Psammobia "	"
S. lusoria,	"
Tellina alternata,	Say,
" polita,	"

Saxicava distorta,	
Lithodomus caudigera,	
Venus mercenaria,	Lin.
" Mortoni,	Con.
" notata,	Say,
" cancellata,	Lin.
" elevata,	Say,
Cardium magnum,	Born.
" citrinum,	Wood,
" muricatum,	Lin.
Cardita tridentata,	Say.
Arca cælata,	Con.
" transversa,	Say
" incongrua,	"
" pexata,	"
" ponderosa,	"
Pectunculus—? sp.	
Nucula proxima,	"
" acuta,	"
" limatula,	"
Chama arcinella,	Linn.
" ? sp.	
Mytilus castaneus,	

Tellina iris,	"		Mytilus lateralis,	Say,
" flexuosa,	"		" cubitus,	
" lateralis?	"		Modiola plicatula,	"
Lucina divaricata,	Lin.		Avicula Atlantica,	Lam.
" crenulata,	Con.	*Syn.*	" hirundo,	Say,
" edentula,	Lam.		Mya arenaria,	Lin.
" radians,	Con.		Corbula contracta,	Say.
Astarte lunulata,	"		Pecten purpuratus,	
Donax variabilis,	Say,	*Syn.*	" dislocatus,	"
Cytherea gigantea,	Lam.		Plicatula ramosa,	Lam.
Artemis concentrica,	"		Ostrea Virginiana,	List.
Cyrena Caroliuensis,			" fundata,	
Petricola pholadiformis,	"		" equestris,	
Anomia ephippium,	Lin.		Pinna seminuda,	
Lingula?			" muricata.	

Balanus ovularis,	Say,	Conopea elongatula,	Say,
Coronula testudinaria,		Anatifa dentata.	

Synopsis of the Organic Remains of the Tertiary Formation of South Carolina.

P. Pliocene.

Mammalia.

Megatherium?

I found some fragments of bones in a bed of mud on Edding's Island, which, it is probable, belong to this animal.

In the P. Pliocene of Georgia remains are found of *Megatherium Cuvieri*, Mitchell; *Elephas primigenius*, Mit. *Mastodon maximus*, Cuv. *Equus curvidens?* Owen; *Harlanus Americanus*, Owen; *Syn. Sus. Americana*, Har. *Bos.* and *Mylodon.*

Pisces.

Carcharias,	Lamna,
Myliobates,	Diodon,

Trichiurus.

Mollusca.

Pteropoda.

Hyalea.

Gasteropoda.

	Cemoria alternata,	Say,		Strombus pugilis,	Lin.
Syn.	Fissurella alternata,	"		Buccinum obsoletum,	Say,
	Infundibulum depressum,	"	*Syn.*	Nassa obsoleta,	"
Syn.	" centralis,	Con.		Buccinum trivitatum,	"

Dentalium politum?	Sow.	*Syn.* Nassa trivitata,	Say,
Bulla canaliculata,	Say,	Buccinum vibex,	"
Syn. Volvaria canaliculata,	"	*Syn.* Nassa vibex,	"
Auricula bidentata,	"	Buccinum acutum,	"
Syn. Melampus bidentata,	"	*Syn.* Nassa acuta,	"
Eulima sp?		Terebra dislocata,	"
Natica heros,	"	*Syn.* Cerithium dislocatum,	"
" duplicata,	"	Columbella avara,	"
Sigaretus perspectivus,	"	Marginella limatula,	Con.
Pyramidella suturalis,	Lea,	Oliva literata,	Lam.
Scalaria clathrus,	Say,	" mutica,	Say,
" lineata,	"	Crepidula plana,	"
" multistriata,	"	" aculeata,	"
Delphinula sp?		" fornicata,	Lin.
Trochus "		" convexa,	Say.
Littorina irrorata,	"	Cancellaria reticulata,	Lam.
Pyrula carica,	Gmel.	Fasciolaria trapezium,	"
" canaliculata,	Lin.	" distans,	"
" perversa,	Lam.	Fusus cinereus,	Say,
Ranella candata,	Say,	Ovula acicularis,	Lam.

Lamellibranchiata.

Teredo navalis?		Petricola pholadiformis,	Lam.
Pholas costata,	Lin.	Venus mercenaria,	Lin.
" truncata,	Say,	" permagna?	Con.
" oblongata,	"	" notata,	Say,
" cuneiformis,	"	" cancellata,	Lin.
Solen ensis,	Lin.	Cardium magnum,	Born.
" viridis,	Say,	" citrinum,	
Solecurtus caribæus,	Lam.	" muricatum,	Lin.
Lutraria canaliculata,	Say,	" Mortoni,	Con.
" lineata,	"	Cardita tridentata,	Say,
Cumingia tellinoides,	Con.	Arca incongrua,	"
Mactra similis,	Say,	" pexata,	"
" lateralis,	"	" lienosa,	"
Gnathodon cuneatum,	Sow.	" ponderosa,	"
Amphidesma æqualis,	Say,	" transversa,	"
" orbiculata,	"	" nom ?*	Linn.
Sanguinolaria fusca,	"	Pectunculus,	
Syn. Psammobia fusca,	"	Nucula limatula,	Say,
Sanguinolaria lusoria,	"	" proxima,	"
Syn. Psammobia lusoria,	"	" acuta,	Con.
Tellina alternata,	"	Pinna seminuda,	Lam.

*Price's Creek, Horry District.

Tellina flexuosa,	Say,		Pinna muricata,	Lam.
" polita,	"		Avicula Atlantica,	"
" lateralis?	"	*Syn.*	" hirundo,	Say,
" Burnetti,	Brod.		Mya arenaria,	Lin.
Lucina divaricata,	Lin.		Corbula contracta,	Say,
" cribraria,	Say,		Pandora trilineata,	"
" crenulata,	Con.		Pecten purpuratus,	Lam.
" radians,	"	*Syn.*	" dislocatus,	Say,
" trisulcata,	"		Plicatula ramosa?	Lam.
Astarte lunulata,	"		Lima squamosa,	Con.
Donax variabilis,	Say,		Ostrea Virginiana,	List.
Cytherea gigantea,	Lam.		Anomia ephippium,	Lin.
Artemis concentrica,	"		Chama sp?	
Cyrena Carolinensis,	Bosc.			

Echinoderma.

Spatangus atropos, Scutella (millita) 5-phora,
Echinus granulatus? Say, " (") ampla.

Cirripedia.

Balanus ovularis, Lam.

Polyparia.

Astrea, Lunulites.

Several of these are unknown, living, on the coast of South Carolina; but, in the present state of our knowledge of the Fauna of the coast, it would not be safe to conclude that therefore they do not exist on it. *Lucina Burnetti* is living on the coast of California; *Arca lienosa* and *Infundibulum depressum* are not known recent, and are fossil in the Pliocene; *Strombus pugilis*, *Cardium serratum* and a few others, are natives of the coast of Florida. Of the corals, *Astrea* is found encrusting shells, and *Lunulites* is very abundant in the sand.

Pliocene Fossils.*

Mammalia.

Mastodon maximus, Cuv. Cervus.

Pisces.

Carcharodon, Hemipristis,
Lamna, Saurocephalus,
Galeocerdo, Cœlorhynchus.

* Those in *italics* are recent also.

It is proper to remark that Prof. Agassiz is of opinion that our fossils are identical with living species, as we suppose. He proposes to point out true characteristics sufficient to distinguish them; and I must confess that I was not a little surprised, when he showed me a character in *Natica heros* that runs through all the fossil individuals, but is not found in the recent species. This opens a wide and inviting field, but in determining the fossils of this list, I was, for want of time, and other reasons, obliged to pass it by, and adhere to the methods hitherto followed in identifying species.

Brachiopoda.

Orbicula lugubris, Con.

Gasteropoda.

Dentalium dentalis,	Lin.
" *politum?*	Sow.
" thallus,	Con.
Cemoria redimicula,	Say,
" *alternata*,	"
Dispotæa rugosa,	Brod.
Syn." costata,	Con.
" *corrugata*,	Brod.
Syn." ramosa,	Con.
" multilineata,	"
" dumosa,	"
Infundibulum depressum,	Say,
Crepidula fornicata,	Lin.
" *plana*,	Say,
" costata,	Mort.
" *aculeata*,	Say,
Serpula granifera,	"
Petaloconchus sculpturatus,	[H. C. Lea.
Natica heros,	Say,
" *duplicata*,	"
" *canrena*,	Lam.
" Carolinensis,	Con.
Scalaria clathrus,	Say,
Pyramidella terebellata,	
Eulima, sp?	
Terebra dislocata,	Say,
" unilineata,	Con.
" Carolinensis,	"
Solarium granulatum?	Lam.
Trochus philantropus,	Say?
" sp?	
" sp?	
" sp?	
Littorina irrorata,	Say,
Turritella alticosta,	Say?
" variabilis,	Con.
" sphærula,	T.
" sp?	
Pleurotoma limatula,	Con.

Cancellaria reticulata,	Lam.
" sp?	
Voluta mutabilis,	Con.
" *Junoniæ*,	Chemn.
Fasciolaria distans,	Lam.
" sp.	
Fusus quadricostatus,	Say,
" cinereus,	"
" undans,	T.
" sp?	
Pyrula carica,	Gmel.
" *canaliculata*,	Lin.
" *perversa*,	Lam.
" *spirata*,	"
Syn. Fulgur pyruloides,	Say,
Pyrula Coronatus,	Con.
" *papyracea*,	Say,
Ranella caudata,	"
Purpura sp?	
Cassis Hodgii,	Con.
Buccinum porcinum,	Say,
" multirugatum,	Con.
" *vibex*,	Say,
" *trivitatum*,	"
" *obsoletum*,	"
" *lunatum*,	"
Columbella avara,	"
" sp?	
Marginella limatula,	Con.
" sp?	
Oliva literata,	Lam.
" *mutica*,	Say,
Conus Marylandicus,	Con.
" adversarius,	"
" diluvianus,	Green.
Bulla canaliculata,	Say,
Cypræa Carolinensis,	Con.
" *pediculus*,	Lin.
Mitra Carolinensis,	Con.

Lamellibranchiata.

Pholas costata,	Lin.
“ *oblongata,*	Say,
“ turgida,	“
Solecurtus caribæus,	Lam.
Solen ensis,	Lin.
Pholodomia abrupta,	Con.
Panopœa reflexa,	Say,
Periploma sp?	
Myalina subovata,	Con.
Mactra similis,	Say,
“ *lateralis,*	“
“ *tenuis,*	T.
“ congesta,	Con.
Cumingia tellinoides,	“
Crassatella undulata,	Say,
Gnathodon cuneatum,	Sow.
Corbula contracta,	Say,
“ inequale,	“
Amphidesma carinata,	Con.
“ subovata,	“
“ nuculoides,	“
“ *æqualis,*	Say,
“ orbiculata,	“
“ equata,	Con.
“ constricta,	“
Lutraria canaliculata,	Say,
“ *lineata,*	“
Pandora trilineata,	“
Petricola pholadiformis,	Lam.
Tellina alternata,	Say,
“ *polita,*	“
“ *flexuosa,*	“
“ biplicata,	Con.
Cardium magnum,	Born.
“ *muricatum,*	Lin.
“ laqueatum,	Con.
“ multilineatum,	“
Cardita granulata,	Say,
“ tridentata,	“
Carditamera arata,	Con.
“ arinata,	“
Pectunculus subovatus,	Say,
“ parilis,	Con.
Arca centinaria,	Say,
“ æquicostata,	Con.
“ *improcera,*	“
Nucula limatula,	Say,
“ *proxima,*	“
Chama corticosa,	Con.
“ congregata,	“
“ *arcinella,*	Lin.
Mytilus incrassatus,	Con.
Modiola Ducatelli,	“
Sanguinolaria lusoria,	Say,
Lucina cribraria,	“
“ *Floridana,*	Con.
“ *divaricata,*	Lin.
“ *contracta,*	Say,
“ *crenulata,*	Con.
“ *trisulcata,*	“
“ *radians,*	“
“ *Jamaicensis,*	Lam.
Donax variabilis,	Say,
Loripes Americana,	Con.
Astarte undulata,	Say,
“ concentrica,	Con.
“ abreviata,	“
“ radians,	“
“ *lunulata,*	“
Cyrena densata?	“
“ *Carolinensis,*	Bosc.
Cytherea reposta,	Con.
“ *Sayana,*	“
Syn. “ *convexa,*	Say,
“ *metastriata,*	Con.
“ subnasuta,	“
Artemis acetabulum,	“
Venus tridacnoides,	Lam.
Syn. “ difformis,	Say,
“ Rileyi,	Con.
“ *Mortoni?*	“
“ *mercenaria,*	Lin.
“ *cancellata*	“
“ cribraria,	Con.
“ latilirata,	“
“ alveata,	“

Pectunculus 5-rugatus,	Con.	Pecten eboreus,	Con.
" passus,	"	*Syn.* " Holbrooki,	Rav.
" lentiformis,	"	" Mortoni,	"
" aratus,	"	" hemicyclicus,	"
" sp?		" concentricus,	Say,
Arca propatula,	"	Spondylus sp?	
" scalaris,	"	Plicatula marginata,	Con.
" lienosa,	Say,	Ostrea disparilis,	"
" incile,	"	" *sculpturata*,	"
" *incongrua*,	"	" *Virginiana*,	Gmel.
" *pexata*,	"	*Anomia ephippium*,	Lin.
" cœlata,	Con.		

Echinoderma.

Scutella Carolinensis, Rav.
" 5-phora,
" macrophora,* "

Cirripedia.

Balanus proteus, Con.
" ovularis, Lam.

Polyparia.

Astrea Marylandica,	Con.	Cellipora informata,	Lons.
Syn. " hirtolamellata,	Lons.	" umbilicata,	"

Lunulites denticulata, Con.

Eocene Fossils.†

Mammalia.

Equus,
Tapir,
Palæotheria,
Manatus,
Zeuglodon.‡

Reptilia.

Chelonia,
Saurian teeth.

Pisces.

Pristis,
Ptychodus,
Hemipristis,
Glyphis,

* I have, from California, a *Scutella*, closely resembling this.

† Since this was written, Mr. Holmes informs me that remains of *Megatherium*, *Dinotherium*, *Mososaurus*, *Delphinus*, *Balæna*, and *Xiphias*, were recognized, by Prof. Agassiz, among the Ashley fossils.

‡ For a description of this animal, see memoir by Dr. R. W. Gibbes, in Jour. Ac. Nat. Sci.

I have not given the synonymes, already amounting to eight or ten, to which the scanty remains hitherto found, have given rise. The Berlin Naturalists, I believe, claim to impose names, to the exclusion of all the others.—Sill. Jour.

Myliobates,	Otodus,
Carcharodon,	Oxyrhina,
Corax,	Lamna,
Galeocerdo,	Cœlorynchus,
Diodon,	Pycnodus.

Cephalopoda.

Rhyncolites,	Nautilus Alabamiensis,	Mor.
	" auriculata,	T.

Pteropoda.

Terebratula Harlani,	
" lachryma,	Mor.
" Wilmingtonensis,	Lyell & Sow.
" abnormis,	T.
" striata,	"

Gasteropoda.

Fissurella tenebrosa,	Con.	Fusus thoracicus,	Con.
Infundibulum trochiforme,	Lam.	" limulus,	"
Crepidula lyrata,	Con.	" papillatus,	"
" lævis,	T.	" pulcher,	Lea,
" dumosa,	Con.	" decussatus,	"
Dentalium arciformis,	"	" robustus,	T.
Auricula gibba,	T.	" crenulatus,	"
Natica striata,	Lea,	" spinosus,	"
" ætites,	Con.	" minor,	Lea,
" limula,	"	Triton pyramidatum,	"
Sigaretus bilix,	"	Monoceros armigeros,	Con.
Actæon pomilius,	"	" fusiformis,	Lea,
Scalaria venusta,	Lea,	" vetustus,	Con.
" amplicosta,	T.	Melongena alveata,	"
" sp?		Pyrula cancellata,	Lea,
Trochus giganteus,	"	" elegantissima,	"
" sp?		" ponderosa,	T.
" aculeus,	"	" sp?	
Meleagris, antiquatus,	Con.	Buccinum lineatum,	"
Turritella carinata,	H. C. Lea,	" spissus,	"
" Mortoni,	Con.	Cypræa lapidosa,	Con.
" humorosa,	"	" semen,	T.
" gracilis,	Lea,	" hemispherica,	"
Cerithium striatum,	"	Terebra costata,	Lea,
" cancellatum,	T.	" venusta	"
Pleurotoma depygis,	Con.	Voluta Sayana,	Con.
" monilifera,	Lea,	" sp?	

Pleurotoma subulata,	T.	Conus sauridens,	Con.
Cancellaria alveata,	Con.	" gyratus,	Mor.
" sp?		" obtusus,	T.
Oliva gracilis,	Lea,		

LAMELLIBRANCHIATA.

Teredo sp?		Venus crassus,	T.
Pholas Poperiana,	T.	" proximus,	"
Mactra prætenuis,	Con.	Astarte? erosus.	"
Lutraria lapidosa,	"	Arca rhomboidella,	Lea,
Crassatella alæformis,	"	" obliqua,	T.
" protexta,	"	Nucula bella,	Con.
Pholadomya Marylandica?	"	" sp?	
Solen sp?		Pectunculus stamineus,	"
Corbula nasuta,	"	Lithodomus politus,	T.
" oniseus,	"	Mytilus sp?	
Tellina papyria,	"	Plagiostoma gregale,	Mor.
" Ravenelli,	"	Avicula sp?	
Lucina pandata,	"	Panopæa elongata,	Con.
" symmetrica,	"	Pecten membranosus,	Mor.
" sp?		" calvatus,	"
Cytherea æquorea,	"	" perplanus,	"
" McCordia,	T.	Lima concentrica,	T.
" ovata,	Rog.	Ostrea sellæformis,	Con.
Cardium Nicolleti,	Con.	" Georgiana,	"
" sp?		" compressarostra,	Say,
Cardita planicosta,	Lam.	" camera,	T.
" alticosta,	Con.	" malleoides,	Rav.
" Blandingi,	"	" panda,	Mor.
" bilineata,	T.	Anomia jugosa,	Con.
" turgida,	"	Perna silicea,	T.
" dubia,	"	Gryphæa mutabilis.	

CRUSTACEA.

Carapace and other parts of several species undetermined.

CIRRIPEDIA.

Balanus humilis,	Con.	Balanus peregrinus,	Mort.
" calceolus,	Holm.	" digitus,	Holm.

POLYPARIA.

Ocellaria ramosa,	Lons.	Farcimea,	
Flabellum cuneiforme,	"	Vincularia,	
Endopachys Maclurii,	Lea,	Hippothoa tuberculum,	Lons.
Cladora recrescens,	Lons.	Eschara petiolus,	"

Tubulifera proboscidea,	Lons.	Escara incumbens,	Lons.
Idmonea maxillaris,	"	" linea,	"
" commiscens,	"	" viminea,	"
" ?		Lunulites distans,	"
Lichenopora,		" contigua,	"

PLANTÆ.*—EXOGENS.

Silicified wood,	Quercus, (the leaves,)
Lignite,	Fagus, "
	Salix, "

RECAPITULATION.

The results of the investigations in the Tertiary formations may be thus briefly presented.

1. That they are situated in a vast depression in the Cretaceous rocks, which, however, are only visible on the East and North-east.

2. That the Eocene consists of three well defined groups: 1. The Buhr-stone formation, composed of thick beds of sand, gravel, grit, clay, and buhr-stone, amounting to at least 400 feet in thickness—and underlying the calcareous beds. Its upper portions are characterised by beds abounding in silicified shells, for the most part identical with the Claiborne fossils. As these are littoral shells they probably occupied the coast while the Santee beds were forming, in deep water. The materials of which this formation is composed are the ruins of the granitic and metamorphic rocks of the upper Districts, which may often be traced to their origin. 2. The Santee beds, consisting of thick beds of white limestone, marl, and green sand. These are best seen on the Santee, where, interstratified with the green sand, they dip gently towards the South. The coralline marl of Eutaw is found near the upper edge of these beds. 3. The Ashley and Cooper beds, which are the newest Eocene beds of the State. The marl of these is characterised by its dark grey color and granular texture, while the remains of fishes and mammalia give its fossil remains a peculiar character, and leave no doubt of the position assigned it, at the top of the Eocene series. These, together with the Santee beds, must amount, at least, to a thickness of six or seven hundred feet.

3. That although these strata contain, throughout, characteristic Eocene fossils, yet they also enclose some Cretaceous forms.

4. That the Middle Tertiary of the State, composed of beds of sand and marl, highly fossilliferous, is scattered, like similar beds in other places, over the Eocene and Cretaceous formations, in isolated patches. That the proportion of recent species increases towards the South; and that the extinction of species seems to proceed in that direction, as is proved by the fact that the recent forms, which are also fossil, belong to a more southern Fauna—there being but one or two exceptions.

* *Carpolites* have recently been found by Mr. Holmes, in connection with *lignite*, on the Ashley. A rounded fragment of coal was brought by the augur, in boring into this bed, at the well in Charleston. This should excite no surprise. Coal exis's in the red sandstone of North Carolina, and as one extremity of this extends into this State, it may have contained a bed of coal, which has been removed by denudation and fragments brought down into the Eocene sea.

5. That in South Carolina the proportion of recent species in this formation amounts to 40 per cent. I have, therefore, referred it to the older Pliocene.

6. That the P. Pliocene is confined to a belt along the coast, of about eight or nine miles in breadth. The fossils are nearly all referable to living species, now inhabiting the coast: a few, however, belong to the Fauna of Florida and the West Indies. An elevation of the coast has taken place since the deposition of these beds, which, it is probable, has given the rivers of the Atlantic slope a western tendency.

7. That the submerged stumps of trees, found below the level of high-tide, along the coast, are not the result of subsidence, properly so called, but must be referred to the encroachment of the sea upon the land, and to the peculiar character of the deposits in which they grew.

8. That the almost entire absence of fluviatile shells in the recent and Tertiary deposits is mainly due to two facts: 1. That there is a considerable space between the line of brackish and salt water, where neither fluviatile nor marine forms can exist. 2. That the streams have not transporting power sufficient to bring down fresh water shells. So long as these circumstances exist, there can be no mixture of fluviatile and marine shells.

CHAPTER VII.

PRACTICAL, OR ECONOMICAL, GEOLOGY.

General views of soils.—Classification of soils.—Physical properties of soils.—Composition of soils.—Composition of cultivated plants.—Manures.—Mineral manures.—Calcareous manures.—Marls of the State.—Effects of calcareous manures.—Rotation of crops.—Draining.—Soils of the State.—Lime burning.—Metallurgy.—Manufacture of iron.—Extraction of gold from its ores.—Materials used in the arts.

Were it necessary to offer any proof of the fact that all soils derive their mineral constituents from the disintegration and decomposition of rocks, it might readily be found in almost every District in the State, beyond the northern boundary of the Tertiary formation; for almost every where the process may be traced from the subjacent solid rock to the soil upon the surface. There is scarcely a subject of more common observation and remark than the sudden changes that take place in the appearance and character of soils; and although it often escapes the notice of observers, they are intimately connected with corresponding geological changes in the underlying rocks.

The principal roads traverse the State from North to South, and thus pass over the upturned edges of the rocks. Changes and alternations of soils are, therefore, frequent, and often striking, in that direction. No one can avoid observing the contrast between the cold, grey soils of the clay slates, in that part of Edgefield and Lexington lying along the Saluda, and the trap soils of Cambridge. The mica slate soils of Abbeville are as readily distinguished from those of the gneiss of Anderson and Greenville; while the soils derived from the talcose slates of Lancaster, cannot be mistaken for either.

This is equally true in relation to the origin of the soils of the Tertiary region, although not quite so obvious; for the deposits of which it is composed are made up of finely comminuted matter, already in a state to enter into the composition of the soil, being, as we have seen, the ruins of the older rocks. They are also more uniform in composition, and changes, dependent upon geological structure, are, therefore, less frequent. Nevertheless the character of the soils may be traced invariably to the subjacent deposits.

In the conversion of rocks into soil, two agencies are principally concerned: the mechanical action of water, influenced by changes of temperature, and the chemical effects of carbonic acid, held in solution by rain and spring water. Those rocks that imbibe this fluid freely, or that are so fissured as to allow of its percolation, are broken into fragments or reduced to dust, by the expansion consequent on freezing. In the crystalline rocks the feldspar, hornblende, mica, and protoxide of iron, of which they are composed, are subject to decomposition by every shower of rain that brings down carbonic acid from the atmosphere.

The nature and progress of disintegration and decomposition have been already explained. It is only necessary, in this place, to state that the surface of the rocks is reduced to a crumbling mass, of variable depth, which, by the continued action of atmospheric agencies, passes into a yellowish clayey stratum, known as the sub-soil; and a portion of this, by the oxidation of the iron and addition of organic matter, assumes a darker color, becomes less adhesive, and constitutes the arable soil, fitted for the growth of plants. Did the soil lose no part of the constituents of the rock from which it is derived, it is obvious that it would be nearly identical with it, in chemical composition; but as the silicious portion alone is insoluble, the rest must be subject to be dissolved, and washed away by the rains—and hence the meteorological, as well as the topographical, character of a country, exerts a powerful influence on the fertility of its soil. The depth to which the rocks are subject to disintegration has also an important bearing in this relation. Granite is frequently very indestructible, and when so, the soil derived from it is thin, and often barren. But along the Atlantic slope, from Maryland to Alabama, this rock undergoes disintegration to a depth for which it is difficult to account. The granitic soils are, therefore, far from barren, and, in South Carolina, are valued, as cotton lands.

It will be recollected that granite proper, is composed of quartz, felspar and mica, and that the felspar contains potash or soda, with which the carbonic acid of the atmosphere, brought down by the rains, combines, forming a highly soluble salt, carbonate of potash or soda, which, to a greater or less extent, dependent on the circumstances, is washed away. When the disintegration takes place upon a steep hill side, and proceeds but to a slight depth, the whole of the potash is removed, leaving little more of the felspar than a silicate of alumina or porcelain clay. The mica is subject, though in a less degree, to a similar process, and it is evident that such a soil must be almost, if not entirely, barren.

I have observed that when a hill is capped with granite undergoing disintegration, that the soil on the sides is much more fertile, and I saw on Stone House Creek, Chesterfield District, an excellent crop of corn, growing on the sides of a hill covered with the crumbling ruins of the rocks that had fallen from the top; the soil seemed to be composed of pulverised granite.

I believe that the comparative excellence of the soils derived from the granitic and metamorphic rocks of the State, is mainly due to the fact, that while the disintegration of the rocks proceeds rapidly and to an extraordinary depth, the decomposition of their mineral constituents advances but slowly, so that when, through injudicious culture or other cause, the soil is washed away by the rains, instead of a bare and hard rock, there is left a subsoil composed of its crumbling constituents, wanting but the addition of vegetable or other organic matter to form again a productive soil.

Although I have taken granite as an illustration of the connexion between rocks and soils, what has been said of it will hold true of the other rocks, which are, for the most part, made up of the same minerals, in various proportions and combinations, and, of course, affecting the soils derived from them to the same extent. When quartz abounds in the rocks, the soil will be light and sandy, but when felspar and mica predominate, the soil will be stiff and clayey. Where mica prevails the soil is generally red, on account of the large quantity of iron in that mineral. The terms, red and grey, applied to granitic soils in the State, only indicate the proportion of iron present, and are no further useful as the basis of classification.

Having said thus much on the origin of soils, we may proceed to the further consideration of their composition and mode of action.

A soil answers a triple purpose in relation to plants. 1. It serves as a support or foundation in which they may extend their roots.

2. It furnishes a supply of inorganic elements for their food.

3. It serves as a reservoir for water, and for organic matter which is taken up, in a state of solution, together with inorganic substances, by the plants.

In the greater number of soils, the inorganic matter or mineral constituents greatly predominate, constituting, generally, 95 per cent. of the entire mass. A soil, however, to be at all productive, must not fall below 1 per cent. of organic matter, and in our swamps it often amounts to 60 per cent.

Oats and Rye will grow on land containing 1 per cent. of organic matter; Barley requires not less than 3 per cent; and Wheat will not flourish in a soil containing less than from 4 to 8 per cent.

In all soils the predominant inorganic constituents are Silica, Alumina and Lime. Silica is well known in the common form of sand; alumina is the basis of clay; and lime is too common a substance to need description.

Silica exists in the soil, in part, in an uncombined state as sand, which may be separated by simple washing, and combined with alumina as a silicate. As one or the other of these predominates, the soil is denominated sandy, argillaceous or calcareous. A soil may be denominated calcareous when it contains 20 per cent. of lime.

A good classification of soils, though highly desirable, obviously presents many difficulties. Taking the two leading ingredients, silica and alumina, as the extremes of the scale, a very simple classification may be formed.*

1. Pure clay, composed of 60 parts silica and 40 alumina, in chemical combination†—no siliceous sand.

* Johnson.
† Such a clay is a silicate of alumina, and not a mixture.

2. Strongest clay soil, consisting of clay mixed with 15 to 30 per cent of sand.
3. Clay loam, containing from 15 to 30 per cent. of sand.
4. Loamy soil, has from 30 to 60 per cent. of sand.
5. Sandy loam, from 60 to 90 per cent. of sand.
6. Sandy soil, contains only about 10 per cent of clay.

To determine the place that a soil should occupy in this classification, all that is necessary is to separate, by washing, the fine particles from a dried and weighed portion, allowing the sand to subside, and weighing it after being carefully dried.

Thaer and Schwertz arranged another scale, founded upon the products of the different soils, and having, like the preceding, sand and clay at the zero points. The soils meet in the centre of the scale, in one which will produce all kinds of grain.

The scale is arranged in the following manner:

0. Moving sands,	0. Stiff clay,
1. Rye land,	1. Wheat land,
2. Rye and buckwheat land,	2. Wheat and oat land,
3. Rye, buckwheat, and oat land,	3. Wheat, oat, and barley land,
4. Rye, oat, and small barley land,	4. Wheat and large barley land,
5. Wheat, rye, barley, and oat land.	

The species of soil adapted to these crops are—

1. Light dry sand,	1. Cold, stiff clay,
2. Moist, very slightly argillaceous land,	2. A lighter moist clay,
3. Argillaceous sand,	3. A warm dry clay,
4. Sandy clay.	4. Rich clay.
5. Clay.	

These examples will, perhaps, be sufficient to give a clear view of what is meant by the classification of soils.

Besides the mineral and other constituents of soils, there are certain physical properties that must be taken into consideration, as conditions of fertility, scarcely less important than the chemical composition of the soil.

They are—the specific gravity of the soil; power of imbibing moisture; tenacity, or resistance presented to the plough; disposition to become dry; shrinking and drying; hygrometric property of soils; absorption of oxygen by the soil; capacity of soils for heat; and the degrees in which soils become heated in the sun.

For the ingenious investigation of these properties we are indebted to Schubler. The following tables are drawn up from Bousingault's account of his experiments.

Specific gravity.—It appears that silicious and calcareous sandy soils are the heaviest, and clayey soils the least in density; that humus, or mould, is lighter than clay; and that, consequently, a compound soil will be of greater or less density, as either of these prevails.

Power of imbibing moisture.—This is a highly important property of a soil, particularly in relation to climate. Every thing else being equal, in a warm, dry climate, a soil possessing this property in a high degree, will exhibit a decided superiority. This property is estimated comparatively, by first drying a weighed portion of the soil, until it ceases to lose weight; it is then completely saturated with water, placed upon a piece of bibulous paper, and when the water ceases to drop from it, the whole is weighed. The increase of weight is due, of course, to the water imbibed.

In this manner the following results were obtained.

Kinds of earth.	*Water absorbed by* 100 *parts of the earth.*
Silicious sand	25
Gypsum,	27
Calcareous sand	29
Sandy clay	40
Strong clay	50
Sandy clay	70
Fine calcareous earth	85
Humus	190
Garden earth	89
Arable soil	52

It appears from these experiments that sands have least imbibing power, and that calcareous soils stand higher than clays, while those earths that contain much vegetable matter in the state of humus, rank highest. In comparing the power of calcareous earth, with that of calcareous sand, we see how soils are affected, in this respect, by the state of subdivision of the ingredients—showing the necessity of attending to the physical, as well as chemical, properties of soils.

Tenacity and Pliability of Soils.—The terms stiff, and light, applied to soils, indicate different degrees of tenacity or pliability; and the resistance presented to the plough by the soil is the measure of this property. This resistance is made up of two forces—the tenacity or cohesion of the soil, and its adhesion to the plough. The following table exhibits the comparative tenacity alone.

Kinds of earth.	*Tenacity.*
Silicious sand	0
Calcareous sand	0
Fine calcareous earth	5.0
Humus	8-7
Sandy clay	57.3
Stiff clayey soil	68.8
Strong clay	83.3
Pure clay	100.0
Garden earth	7.6

There appears to be no direct relation between the power of a soil to imbibe moisture, and its tenacity; for calcareous earths, which imbibe more water than clays, are far less tenacious; and water makes sandy soils stiffer.

The power of frost to reduce the tenacity of soils is well known. This is due to the expansion of the water in freezing, which separates the particles of the soil; and hence the advantage of Fall ploughing. The tenacity of a soil, which was 68, fell to 45, after the action of frost.

Disposition to become dry, or power of retaining moisture.—The rapidity with which a soil throws off moisture, by evaporation, has an important bearing on its fertility, as well as the ease with which it may be worked. The terms cold, and warm, soils, have, in general, reference to this property, which is next in importance to the power of imbibing moisture.

The comparative relative power of the following soils, was ascertained by placing on a small metallic plate, having a narrow rim, a quantity of the soil saturated with moisture. This was suspended to the arm of a balance, and its weight noted. It was kept at a temperature of 66° Fahr. for four hours: the loss of weight, at the end of that time, indicated the water that escaped by evaporation. The following are the results.

Kinds of earth.	100 *parts of the water in, lost in 4 hours, at 66° Fahr.*
Silicious sand	88.4
Calcareous sand	75.9
Gypsum	71.7
Sandy clay	52.0
Stiffish clay	45.7
Stiff clay	34.9
Pure clay	31.9
Calcareous soil	28.0
Humus	20.5
Garden soil	24.3

The sands, as might be expected, are least retentive, whilst the calcareous soil stands next to a garden soil, or loam, in its capacity for retaining moisture; and this explains one of the effects of calcareous manures on light or sandy soils.

Shrinking of soils.—The cracking of soils, during the process of drying, is a common occurrence. Schubler has measured this contraction or shrinking of soils by measuring prisms, in a moist state, and again, after drying in the shade.

Kinds of earth.	100 *parts, cube, contracted to.*
Carbonate of lime, in powder	95.0
Sandy clay	94.0
Stiffish clay	91.1
Stiff clay	88.6
Pure clay	81.7
Humus	84.6
Garden earth	85.1

Hygrometric property of soils.—The property of absorbing moisture from the atmosphere is independent of the retentive power of soils, and is intimately connected with their porosity, and with certain salts which they may contain. Schubler's experiments show the correctness of Davy's opinion, that the hygrometric property of a soil was indicative of its fertility. This property was determined by exposing known weights of the dry soils in an atmosphere saturated with moisture, and at a temperature of 60° to 65° Fahr.

Kind of earth.	77.16 *grs. of soil, spread over a surface of* 141.48 *sq. inches, absorbed in* 12 *hours.*
Silicious sand	0
Calcareous sand	.154
Gypsum	0.077

Light clay	1.617
Stiffish clay	1.925
Strong clay	2.310
Pure clay	2.849
Calcareous soil in fine powder	2.002
Humus	6.160
Garden earth	2.695

This table was continued farther, and showed that after the soils had absorbed a certain amount of moisture, their absorbent power decreased. It appears also that clays are hygrometric in proportion to the absence of sand; and that humus exceeds all the rest in this respect.

Absorption of oxygen.—We owe to the illustrious Humboldt a knowledge of the fact that argillaceous soils, and certain slaty rocks, absorb oxygen. Before the year 1793 he had observed, in the mines of Saltzburg, that the galleries excavated in the rock absorbed that gas from the atmosphere, so as to render it unfit for respiration, and incapable of supporting combustion. He also observed that the earth taken from the mines, only became fertile after long exposure to the atmosphere. He deduced from this the fact, so often confirmed since, that oxidation is absolutely necessary to the fertility of the soil. Bousingault attributes this absorption to the iron that exists in the soil, in the lowest state of oxidation, and which is converted into the peroxide, by the additional dose of oxygen. This explains the injury often done to the arable soil by turning up the sub-soil; for the protoxide, or lowest combination of oxygen with iron, is injurious to plants, and it requires exposure to atmospheric agencies to convert it into the peroxide, which is not hurtful. Increasing the depth of the soil by deep ploughing should, therefore, be practiced with caution, and that portion of the subsoil brought up should not be mixed with the arable soil, till it has been exposed for some time to the atmosphere.

Schubler confirms the observations of Humboldt. Sands, he finds, absorb but little oxygen, but it is absorbed very decidedly by clays, loams, and largely by humus. He also corroborates the statements of Humboldt and M. De Saussure, in relation to the conversion of a portion of the oxygen absorbed by humus, into carbonic acid. He supposes that oxygen is condensed in the pores of the soil, and another portion converts the protoxide of iron into the peroxide.

Capacity for heat.—This property depends inversely upon the conducting power of the soil. It was determined by heating, in a vessel of known capacity, a quantity of the substance under experiment, to 144° Fahr. and the time noted that it required to fall to 70° Fahr. the temperature of the surrounding air remaining the same. The following are the comparative results.

Kind of earth.	*Power of retaining heat.*
Calcareous sand	100.0
Silicious sand	95.0
Gypsum	73.2
Sandy clay	76.9
Stiffish clay	71.1
Stiff clay	68.4
Pure clay	66.7
Calcareous soil	61.8
Humus	49.0
Garden earth	64.8

Sands are known as bad conductors of heat, and hence the high temperature they attain. The temperature of the earths decrease in proportion to the absence of sand.

Capacity to become heated, when exposed to the sun's rays.—It is a fact, long since established, that substances acquire different degrees of temperature, when exposed, under the same circumstances, to the sun's rays. The terms warm and cold, applied to soil, have, generally, reference to color and moisture, and not without reason, for these affect, very materially, the degree of temperature acquired by the soil. The state of the surface, the composition, and the manner in which the soil lies, as affecting the angle of incidence of the sun's rays, are also modifying circumstances.

The results of the experiments are as follows.

Kinds of earth.	*Highest temperature.*	
	Soils moist.	*Soils dry.*
Silicious sand, yellowish gray	37.25	44.75
Calcareous sand, whitish gray	37.38	44.50
Gypsum, whitish gray	36.25	43.62
Poor clay, yellowish	36.75	44.12
Stiff clay	37.25	44.50
Argillaceous earth, yellowish gray	37.38	44.62
Calcareous earth, white	35.63	43.00
Humus, blackish gray	39.75	47.37
Garden earth, blackish gray	37.50	45.25

Besides the physical properties thus presented, there are other modifying circumstances that greatly affect the fertility of arable land. Among these are the depth and texture of the soil. It is not difficult to distinguish, in a newly ploughed furrow, the depth of the superficial layer, or soil proper: it varies from a few inches to twelve or thirteen, and, in extraordinary cases, such as swamps, river bottoms, and where the native forests have deposited the growth of ages on planes, almost level, such as the prairies of the West, it amounts to many feet.

Depth of soil is always of great importance, for it allows the roots of plants to penetrate and draw nutriment from below; besides, by working deeper, we may ameliorate the surface. Deep soils suffer less from excess or deficiency of moisture. The rain, when it falls, is absorbed by the soil, and retained, as in a reservoir.

Climate also exerts a marked influence on soils, as well as on plants. A thin, sandy soil, that is productive in a moist climate, may be almost barren in a drier one; hence the necessity of a knowledge of the meteorological character of a country, in order to arrive at a correct knowledge of the value of its arable land. I apprehend that serious mistakes are often the result of ignorance on this subject, when comparing the practice of agriculturists, where there is much difference of climate. In general terms, a stiff soil is better adapted to a dry climate, and a light soil, to one that is moist.

In some countries deficiencies of moisture are compensated by skilful irrigation—a practice that is totally neglected with us, excepting on the rice plantations, where it is pursued most successfully.

Before proceeding to the consideration of those means of improving soils indicated by geology, it will be proper to examine more closely the conditions of fertility, dependent on chemical composition.

The question is often asked, what are the constituents of a really fertile soil, and in what proportion should they be present? This perhaps will be best answered by presenting trustworthy analyses of soils that are proved, by their productiveness, to be fertile.

The first is the analysis, by M. Payen, of a soil from the banks of the Volga, considered one of the best in the world.

Organic matter	6.95
Silica	71.56
Alumina	11.40
Oxide of iron	5.62
Lime	0.80
Magnesia	1.22
Alkaline chlorides	1.21
Phosphoric acid	a trace.
Loss	1.24
	100.00

The following are analyses by Kane,* of soils that produced excellent crops of flax, in Ireland.

	No. 1.	*No.* 2.	*No.* 3.
Silica and silicious sand	73.72	69.41	64.93
Oxide of iron	5.51	5.29	5.64
Alumina	6.65	5.70	8.97
Phosphate of iron	.06	.25	.31
Carbonate of lime	1.09	.53	1.67
Magnesia and alkalies, with traces of sulphuric and muriatic acids,	.32	.25	.45
Organic matters	4.86	6.67	9.41
Water	7.57	11.48	8.73
	99.78	99.58	100.11

Two soils, from Illinois, gave Prof. Hitchcock the following results. The soils are said to be of the very best quality. No. 1 has never been cultivated, and No. 2 has been in cultivation fourteen years, without manure.

	No. 1.	*No.* 2.
Silicates	73.5	83.0
Organic matter	21.4	11.2
Sulphate of lime	1.4	2.1
Carbonate of lime	3.3	2.8
Phosphate of lime	0.4	0.9
Water	9.5	5.3

The following is the composition of a fertile soil in Sweden, by Bergman.

Carbonate of lime	30.
Gravel	30.
Silicious sand	26.
Alumina	14.
	100.0

*"Industrial Resources of Ireland," a work to which I take this means of acknowledging numerous obligations.

Dr. C. T. Jackson gives the following analysis of a soil in the State of Maine, which has produced forty-eight bushels of wheat per acre.

Vegetable matter	17.5
Silica	54.2
Alumina	10.6
Sub phosphate of alumina	3.0
Peroxide of iron	7.0
Oxide manganese	1.0
Carbonate of lime	1.5
Water	5.0
	99.8

The following analysis of the soil of a sugar plantation, in Louisiana, is by Prof. Shepard.

Water	8.00
Organic matter	7.00
Silica	79.00
Alumina	2.50
Protoxide of iron	2.25
Lime	.78
Magnesia, and loss,	.47
	100.00

These analyses, selected at random, from numerous others, show within what wide limits the conditions of fertility may lie. The proportions of the ingredients of soils is not, I apprehend, so important, provided that there be no deficiency of any.

The impulse that agricultural chemistry has recently received from the researches of eminent Chemists, I fear, has led many to expect too much from researches on soils.

Knowing, as every one does now, that the soil must contain all that is found in the ashes of plants—all the inorganic elements, such as lime, potash, soda, iron, magnesia, &c. and that the rest, the organic portion, composed of carbon, hydrogen, nitrogen and oxygen, may be derived from the atmosphere; and as a soil, to be fertile, must contain the inorganic elements of the plants to be raised on it, it would appear that the simple analysis of a soil would solve the problem of its adaptation to the sustenance of any particular plant, supposing that we know the chemical composition of such plant.

Now I have full confidence in the resources of chemical analysis to accomplish all that legitimately belongs to it, or can reasonably be expected, and all that I say is only intended to prevent disappointment and the re-action that is sure to follow.

Organic matter is well known as a most important ingredient of fertility; yet the mere quantity indicates nothing, unless we know the state in which it exists.

The soils derived from peat-bogs often remain barren for some time after they are reclaimed, by draining, although they abound in organic matter. This is also true of the vegetable mud from our swamps, which requires exposure to the action of the atmosphere, or mixture with other manures, before it possesses any agricultural value. The reason is this: in the instances just mentioned, the vegetable matter is decomposed under water, without access of the oxygen or nitrogen of the atmosphere, and the result is, the formation of inert humus, or ulmine, which, in this state, is incapable of evolving either carbonic acid or amonia. But when vegetable matter is decomposed, under ordinary circumstances, it gives out carbonic acid, absorbs oxygen and nitrogen, forming a new product, to which Hermann has given the name of nitrolin, a substance having nearly the same composition as flesh.*

	Nitrolin.	*Flesh.*
Carbon	57.20	55.20
Hydrogen	6.32	7.00
Nitrogen	12.20	16.80
Oxygen	24.28	21.80
	100.00	100.80

It is the production of this highly nitrogenised substance that gives vegetable matter its fertilizing power in the soil. During its decomposition it gives out carbonic and amonia to the soil, and is converted into dark colored substances, humine and humic acid.

It is obvious, then, that the state of nitrogenization of the organic matter, is far more important than its quantity.

Again, the analysis of a soil is not always an index to its fertility: when a soil is limed the fertilizing effects are not the result of the addition of any new ingredients, but are altogether due to the new combinations formed by those already existing in the soil, and which must have been detected by analysis. The lime, itself, enters but sparingly into the composition of plants. Hence fertilizing ingredients may exist in the soil, be indicated by analysis, and yet be entirely inert.

The judicious agriculturist will not rest satisfied with the knowledge that his arable land contains all the components of fertility, but he will see that they exist under the proper conditions to exert their greatest influence on the products of the soil.

I shall have occasion to show that a soil, from other causes, may be unproductive, at the same time that it may contain all the elements of fertility.

To answer the expectations of agriculturists, analyses of soils must be multiplied far beyond what has yet been done, by having a chemical department attached to every geological survey. No one can suppose that 1000 grains of soil can fairly represent that of a whole plantation, however carefully selected. Uniformity of soil, over a great extent, is only possible under certain peculiar circumstances, and, in the upper part of South Carolina, is not to be expected, even in the same field.

There is one department in which chemistry has fully redeemed its pledge to agriculture—the analysis of the products of the soil and of manures. Plants analyze soils most accurately, and whatever of inorganic matters they contain must be found in the soil. And if we continue to abstract these matters, by repeated cropping, and without making any return, sterility must be the result. Knowing, then, the composition of each crop, we know what is removed from the soil; and knowing also the composition of the manures within our reach, we know what to apply. This is absolute knowledge, and must constitute the basis of every enlightened system of agriculture. We must, by proper tillage, take care that as little as possible escapes from the soil, excepting through the medium of the crops.

When, after a succession of crops, and consequent abstraction of a large amount of its salts, the

* Kane's Industrial Resources of Ireland.

soil begins to exhibit signs of exhaustion, application is made to the chemist to determine what is the matter, or to find out if some little ingredient is not wanting, that may be supplied without any trouble or expense. And supposing that this wanting ingredient be discovered, how is it to be procured? Lime is almost the only substance that we, in this country, can afford to apply in an isolated state. The course to be pursued is obvious: we must study the composition of the failing crop, and add such manures as we know, by their composition, to contain the greatest number or quantity of the elements of the crop, trusting that although not absolutely wanting, the others will not be lost. This, and the development, by proper means, of such substances as may already exist in the soil, are, I conceive, the only rational remedies.

We are, fortunately, in possession of a vast amount of information relating to the chemical composition of cultivated plants, and it will be interesting to present here the analyses of some of those that constitute our principal crops.

Analyses of Cultivated Plants.

The following is the analysis of the cotton plant, from the Santee, made under the direction of the Black Oak Agricultural Society, by Prof. Shepard.*

Cotton Wool.

Carbonate of potassa, (with possible traces of soda)	44.19
Phosphate of lime, with traces of magnesia	25.44
Carbonate of lime	8.87
Carbonate of magnesia	6.85
Silica	4.12
Alumina (probably accidental)	1.40
Sulphate of potassa	2.70
Chloride of potassium, Chloride of magnesium, Sulphate of lime, Phosphate of potassa, Oxide of lime, in minute traces, and loss	6.43
	100.00

"But since it is obvious that the carbonic acid in the above mentioned salts must have been derived during the incineration of the cotton, the following view will more certainly express the important mineral ingredients abstracted by the cotton from the soil for every hundred parts of its ash.

Potassa (with possible traces of soda)	31.09
Lime	17.05
Magnesia	3.26
Phosphoric acid	12.30
Sulphuric acid	1.22
	64.92

* Report to the Black Oak Ag. Soc.

This society has set a noble example in leading the way in the progress of agricultural science in the State, and has already accomplished more than could result from the agricultural dinners and speeches of a century. It is the only society within my knowledge that keeps a meteorological journal; and I very respectfully suggest to the Secretary to add notes on the variation of the line of brackish water in the rivers, in connection with the amount of rain fallen. The progress of marine and brackish water mollusks up the rivers from the coast offers a pretty good index. *Petricola pholadiformis* and *Sanguinolaria fusca* are found as high as Bee's Ferry, on the Ashley.

"For every 10,000 lbs. of cotton wool, then, about 60 lbs. of the above mentioned ingredients are substracted from the soil in the proportion indicated by the numbers appended, omitting fractions.

Potassa	31 lbs.
Lime	17
Magnesia	3
Phosphoric acid	12
Sulphuric acid	1

Cotton Seed.

Phosphate of lime, (with traces of magnesia)	61.64
Phosphate of potassa, (with traces of soda)	31.51
Sulphate of potassa	2.55
Silica	1.74
Carbonate of lime	.41
Carbonate of magnesia	.26
Chloride of potassium	.25
Carbonate of potassa, Sulphate of lime, Sulphate of magnesia, Alumina and oxides of iron and manganese in traces } and loss	1.64
	100.00

"In comparing the above table with that afforded by the cotton wool, a marked dissimilarity presents itself. The ash of the cotton seed is fourfold that of the fibre;* while the former has also treble the phosphoric acid possessed by the latter, as will more clearly appear, when we present the analysis under another form, corresponding with the second table under cotton wool.

Phosphoric Acid	45.35
Lime	29.79
Potassa	19.40
Sulphuric Acid	1.16
	95.70"

This analysis shows the great value of cotton seed as a manure, and indicates what the result must be where such highly fertilizing ingredients are repeatedly abstracted from the soil, without any return.

Analysis of a Cotton Stalk—By J. Lawrence Smith, M. D.

"*The ashes of a healthy Cotton Stalk, six feet high, and an inch in diameter, at the largest part, with some leaves and empty pods, consists of, in* 1000 *parts*—

Lime	303.
Potash	243.
Phosphoric acid	91.
Magnesia	58.
Oxide of iron	4.
Sulphuric acid	13.
Chlorine	8.
Carbonic acid	270.
Sand	5.

*The cotton wool, in 100 parts of weight, gave 0.9247, whilst cotton seed gave 3.856 of ash for the same weight.

"The half per cent. of sand arose from what was on external portions of the stalk, and could not be readily dusted off. The carbonic acid arises from the combustion of the plant, and does not previously exist in it. The chlorine, that is but a little over a half per cent. the sulphuric acid, which is but little over one per cent. and the oxide of iron, which is not one half per cent. may be considered as ingredients of but little, if of any, importance to the plant. Thereby reducing the really important ingredients to *phosphoric acid*, *potash*, *lime*, and *magnesia*. This last, however, is always to be looked upon, in plants, in the light of lime, and it can be replaced by lime entirely, without prejudice to the plant. The analysis which I have made of the cotton wool and seed, as well as the analyses made by others, of the same, show that in these, also, *phosphoric acid*, *potash*, and *lime* are the important constituents."—*Report to the Black Oak Ag. Soc.* 1846.

As the stalks are generally returned to the soil, their composition will not be taken into the account in estimating the amount abstracted from the soil by the cotton plant.

Analysis of the Fibre of Sea Island Cotton—By. Dr. Ure.

Carbonate of potash	44.8
Muriate of potash	9.9
Sulphate of potash	9.3
Phosphate of lime	9.0
Carbonate of lime	10.6
Phosphate of magnesia	8.4
Peroxide of iron	3.0
Alumina, a trace, and loss	5.0
	100.0

Although there is a considerable difference in the proportions of the ingredients present in the two varieties of cotton, as exhibited by these analyses, they both show the presence of all the leading and important salts.

Analysis of Indian Corn.—By Prof. Shepard.

100 parts of the grain left nearly 1 per cent. of ash, composed of—

Silica	38.45
Potassa, (with traces of soda)	19.51
Phosphate of lime	17.17
Phosphate of magnesia	13.83
Phosphate of potassa	2.24
Carbonate of lime	2.50
Carbonate of magnesia	2.16
Sulphate of lime	.79
Silica mechanically present	1.70
Alumina	traces.
Loss	1.65
	100.00

"Omitting the silica, which is unimportant, and the carbonic acid, which is a product of the analysis, we have, in every 100 parts of the ash of Indian corn, the following important constituents.

Potassa	20.87
Phosphoric acid	18.80
Lime	9.72
Magnesia	5.76
	55.15

So that every 1000 lbs. of corn abstracts from the soil 5½ lbs of these most fertilizing ingredients.

Analysis of the Sweet Potato.—By Prof. Shepard.

100 parts of the undried potato gave a little over 1 per cent. of ash, composed of—

Carbonate of potassa, (with traces of soda)	60.00
Phosphate of lime	14.57
Phosphate of magnesia	5.60
Carbonate of lime	5.39
Carbonate of magnesia	3.80
Chloride of potassium	4.60
Sulphate of potassa	4.35
Silica	.70
Chloride of calcium; Sulphate of magnesia and lime; Alumina; Oxides of manganese, in traces; and loss	.99
	100.00

100 parts from the ash from the Sweet Potato tuber contains the following elements.

Potassa	43.59
Phosphoric acid	11 08
Lime	10.12
Magnesia	3.80
Potassium	2.42
Chlorine	2.18
Sulphuric acid	1.90
	75.09

1000 lbs. of sweet potatoes takes from the soil 7½ lbs. of these ingredients.

Analysis of Wheat.—Bousingault.

100 parts of the dry grain gave 2.4 of ash, and of the straw, in the same state, 7.0, containing—

	Grain.	*Straw.*
Phosphoric acid	47.0	3.1
Sulphuric acid	1.0	1.0
Carbonic acid	—	—
Chlorine	traces.	0.6
Lime	2.9	8.5
Magnesia	15.9	5.0
Potash	29.5	9.2
Soda	traces.	0.3
Silica	6.3	67.6
Alumina, &c	—	1.0
Moisture and loss	2.4	3.7
	100.0	100.0

Analysis of Oats.—Bousingault.

100 parts of the dry grain left 4.0 of ash, and the straw, dried, gave of ash 5.1, composed of—

	Grain.	*Straw.*
Phosphoric acid	14.9	3.0
Sulphuric acid	1.0	4.1
Carbonic acid	1.7	3.2
Chlorine	0.5	4.7
Lime	3.7	8.3
Magnesia	7.7	2.8
Potash	12.9	24.5

Soda	0.0	4.4
Silica	53.3	40.0
Alumina, &c.	1.3	2.1
Moisture and loss	3.0	2.9

Analysis of Irish Potatoes, Turnips, and Clover Hay.

100 parts of the dried potato gave, of ash, 4.0; of the turnip, 7.6; and of the clover, 7.7, composed of—

	Potatoes.	*Turnips.*	*Clover Hay.*
Phosphoric acid	11.3	6.1	6.3
Sulphuric acid	7.1	10.9	2.5
Carbonic acid	13.4	14.0	25.0
Chlorine	2.7	2.9	2.6
Lime	1.8	10.9	24.6
Magnesia	5.4	4.3	6.3
Potash	51.5	33.7	26.6
Soda	traces.	4.1	0.5
Silica	5.6	6.4	5.3
Alumina, &c	1.2	0.3	0.0
Moisture and loss	0.7	5.5	0.0
	100.0	100.0	100.0

The following table presents the usual crop of these grains, roots, &c. on Bousingault's farm, in Alsace, together with the quantity of ash abstracted by the crop from the soil.*

Wheat.	*As stored.*	*Dried.*	*Ash.*
Grain	1,500 lbs.	1,285 lbs.	33 lbs.
Straw	3,400	2,550	178

The ash consisted of, per acre—

	Grain ash.	*Straw ash.*
Phosphoric acid	15.51	5.52
Sulphuric acid	.33	1.78
Carbonic acid	—	—
Chlorine	traces.	1.07
Lime	.96	15.13
Magnesia	5.25	8.90
Potash	9.73	16.37
Soda	traces.	.53
Silica	.43	120.33
Alumina, &c	—	1.78
Moisture and loss	.79	6.59
	33 lbs.	178 lbs.

The usual crop of oats,

	As stored.	*Dried.*	*Ash.*
Grain	1,210 lbs.	975 lbs.	40 lbs.
Straw	1,700	1,180	59

Composition of the ashes—

	Grain ash.	*Straw ash.*
Phosphoric acid	5.96 lbs.	1.77 lbs.
Sulphuric acid	.40	2 43
Carbonic acid	.68	1.90

* Kane.

Chlorine	.20	2.78
Lime	1.48	4.91
Magnesia	3.08	1.65
Potash	5.18	14.60
Soda	—	2.60
Silica	21.30	23.85
Alumina, &c	.52	1.21
Moisture and loss	1.20	1.27
	40 lbs.	59 lbs.

The other crops yielded, per acre,

	As stored.	*Dried.*	*Ash.*
Clover hay	4,620 lbs.	3,680 lbs.	283 lbs.
Potatoes	14,560	3,509	142
Swedish turnips	44,800	3,360	255

The ashes gave the following weights of inorganic matters.

	Potato ash.	*Turnip ash.*	*Clover ash.*
Phosphoric acid	16.05 lbs.	15.55 lbs.	17.82 lbs.
Sulphuric acid	10 08	27.79	7.08
Carbonic acid	19.03	35.70	70.85
Chlorine	3.82	7.39	7.35
Lime	2 55	27.79	69.62
Magnesia	7.67	10.96	17.83
Potash	73.15	85.97	75.18
Soda	traces.	10.45	1.41
Silica	7.95	16.32	15.00
Alumina, &c.	.71	3.06	0.85
Moisture and loss	.99	14.02	—
	142 lbs.	255 lbs.	283 lbs.

Knowing the weight of the crop taken from an acre, it will be easy to calculate, from these tables, the quantity of the inorganic elements that are removed each season.

The difference between the weight of the ash of the grain, and that of the straw, is remarkable and interesting. The quantity of potash in the straw of the wheat and oats, is double that in the grain; while the total quantity of the straw-ash of wheat, is nearly five times as great as that in the grain.

This points directly to the necessity of saving the straw and other refuse of the crop, for the purpose of returning them to the soil.

When it is recollected that many of the most important of these ingredients exist in the soil, in very minute quantities, it should not excite surprise that a succession of crops, without any return to the soil, should, in time, so diminish them as to produce sterility. Could we await the formation of a new soil, by the further decomposition of the subjacent rocks, or of the mineral constituents of the sub-soil, and the accumulation of organic matter from the atmosphere, we could, in time, renew the same system of cultivation; but as this is impossible, we must have recourse to some means of restoring to the soil the matters that have been abstracted from it.

This leads us to the subject of manures, on which a few observations will suffice.

Of Manures.

Every thing, added to the land, that tends to preserve or increase the fertility of the arable soil, may be considered a manure.

It is not necessary to discuss the direct application of those substances to the soil in which it is deficient—such as soda, potash, phosphate of lime or bone ash, &c. Under peculiar circumstances, such applications are possible, but with us they are generally out of the question, excepting to a very limited extent.

We must use such materials only as are cheap, easily accessible, and that require but little skill in the preparation, at the same time that they contain the substances that enter into the composition of the crop. In proportion as a manure answers these conditions, it is valuable.

Modern chemical science has shed a flood of light on the interesting subject of manures, in all its bearings. A few of the most important researches on this subject will be presented here.

Manures may be divided into two classes: those of organic origin, including animal and vegetable substances, and those of mineral origin, or mineral manures. Although organic manures are distinguished by the nitrogen which they contain, they also abound in mineral matters of the most valuable sorts. That plants may, and do, derive from the atmosphere a large portion of the carbon and other organic elements which they contain, is quite certain; nevertheless, it is equally true that they take up, by the roots, nitrogen and other organic elements, particularly in the young state, and before the leaves are fully developed—hence the value of organic manures is estimated by the amount of nitrogenized substances they contain, notwithstanding the valuable salts also present in them. Hermbsladt has shown, experimentally, that the value of wheat flour, as food, will vary with the amount of nitrogen in the substance with which the wheat is manured.

Of all manures those of animal origin are the most active and most valuable. In the excretions of animals there will always be present all the constituents of the food, excepting the portion converted into flesh, blood, and bone, by nutrition. The former consist of organic matters, and the latter of phosphate of lime; so that a corn-fed animal will return to the dung-heap all the ingredients of the grain, excepting a portion of the organic matter and phosphate of lime; and so of the rest of its food. When we know the chemical composition of the food, the value of the excrements may be estimated. Léebig, who has popularised this subject in the most interesting manner, has shown that the condition of the animals has great influence on the value of the manures. Lean and growing animals extract more from the food than full grown and fat ones, and consequently leave poorer manures.

Carniverous animals that feed upon highly nitrogenised food, have the richest excrements, and hence the value of night soil, as a manure, and of guano,* which is composed of the excrements of sea-fowls, that feed upon animal matter. A manure, to possess great value, must be complex in its

* The following is the composition of guano, according to Townes.

Oxalate of amonia Uric acid Traces of carbonate of amonia and organic matter	66.2
Phosphates of lime and of magnesia	29.2
Phosphates and alkaline chlorides and traces of sulphates	4.6
	100.0

composition, or, in other words, it must contain several of the elements of the crop to which it is to be applied.

The following tables exhibit the composition of the usual substances constituting farm-yard manure.

*Human Excrements.**

1000 parts, when dried, gave 132 of ash, composed as follows.

Carbonate of soda	8
Sulphate of soda, with a little sulphate of potash, and phosphate of soda	8
Phosphate of lime and magnesia, and a trace of gypsum	100
Silica	16
	132

Excretions of the Horse.

In twenty-four hours the dried excretions amounted to 8.1 lbs. composed as follows.

Carbon	38.6
Hydrogen	5.0
Oxygen	36.4
Nitrogen	2.7
Salts and earth	17.3
	100.0

Excretions of the Cow.

Weight of dried excretions in twenty-four hours, 10.9 lbs. composition as follows.

Carbon	39.8
Hydrogen	4.7
Oxygen	35.5
Nitrogen	2.6
Sals and earth	17.4
	100.0

Excretions of the Hog.

Age, six to eight months, average weight of excrements, dried, in twenty-four hours, 1.6 lbs. composition—

Carbon	38.7
Hydrogen	4.8
Oxygen	32.5
Nitrogen	3.4
Salts and earth	20.6
	100.0

The salts mentioned in the compositions of these excretions are the inorganic elements of the food of the animals, as already mentioned, and are composed of soda, potash, lime, magnesia, &c. Of these excretions the liquid portions are the most valuable, as containing a large proportion of amonical salts, and phosphates.

The litter, which forms a large part of the bulk of farm-yard manure, usually consists of wheat and oat straw, and other refuse of the crops. Corn stalks and leaves are, with us, freely used.

* Berzelius.

The former contains, according to Berger, in 100 lbs. when dried, 8.3 lbs. of ash, in which is found 3.6 lbs. of potash.

Without entering more minutely into the consideration of the composition of the materials of which farm-yard manure is composed, I will present the analysis of such manure, in a half rotted state, which is the condition in which it is used by Bousingault, on his farm.

The average of the richest and poorest contains—

Carbon	35.8
Hydrogen	4.2
Nitrogen	2.0
Oxygen	25.8
Salts and earth	32.2
	100.0

And the ash in 100 parts contains—

Carbonic acid	2.0
Phosphoric acid	3.0
Sulphuric acid	1.9
Chlorine	0.6
Silica sand and clay	66.4
Lime	8.6
Magnesia	3.6
Oxide of iron and alumina	6.1
Potash and soda	7.8

Comparing these results with the analyses given of the plants which constitute the staple crops of the State, it will be seen how completely this substance is adapted to supply what such plants take from the soil. It indicates, I am persuaded, the true course for agricultural investigations to take.

Much has been written, in our agricultural periodicals, on the subject of composts, and more than one mode of preparing them has, I believe, been patented. On this subject I have but one word to say: if the substances placed in these composts have, in themselves, fertilizing ingredients, they are so far, and no farther, valuable. Yet they are thought to acquire some extraordinary virtue by this treatment, different from what would result from decomposition under ordinary circumstances, and I have seen great pains and much labor bestowed, under this impression, at the same time that really valuable manures were allowed to waste unheeded. I am far from underrating the value of accumulations of vegetable matter, intended for manure.

Leaves, weeds, and all such matters, contain a valuable amount of both organic and inorganic elements, that are not to be slighted. But it seems to me a useless waste of labor to bring from the field green weeds, &c. that could be ploughed in with ease, and with every possible benefit to the soil. If they are too stubborn for this, they may be piled up in the corner of the field, in alternate layers with lime—the layer of weeds about one foot, and that of the lime one inch. In twenty-four hours they will be sufficiently decomposed to be returned to the soil.

There is another practice not in accordance with the present State of agricultural knowledge, I mean the burning of the vegetable matter from the woods, and, not unfrequently, from the fields. From the woods, it is burned for the sake of pasturage; but it is obvious that it cannot be continued but at the expense of both the pasturage and the soil; in truth, the practice never could have originated among an agricultural people. The burning of the remains of the crops, is sometimes practiced, under the impression that the ashes which are left are the only valuable part, or that the ashes are the product of the combustion, and would not result from ordinary decomposition. After what has been said on the value of the organic parts of soils and manures, the error of such an impression must be evident. In the greater number of the soils of the State, organic matter is quite as deficient as any of the other elements.

There are, in the State, various sources of mixed manures that are extremely valuable; every where along the coast, there are, at the mouths of the rivers, immense salt marshes, rich in nearly all the inorganic parts of crops.

The following is an analysis, by Professor Shepard, of charred salt-marsh,* from the coast of Georgia.

Water of absorption	6.000
Carbon and inorganic matter	11.000
Silica	65.000
Alumina	6.000
Protoxide of iron	5.500
Carbonate of lime and magnesia	0.141
Chloride of sodium, Chloride of calcium, Sulphate of lime, Sulphate of magnesia, Sulphate of potassa, Sulphate of alumina, Carbonate of potassa.	5.839
	100.000

In the immediate vicinity of the marshes, this substance is applied to cotton, without charring or any other preparation. The charring, at least, diminishes the weight, and it might be profitably transported some distance up the rivers. It would be a capital addition to a manure heap for the purpose of fixing the volatile products of decomposition.

The black vegetable mud, so abundant in the swamps of the State, is also a valuable manure, when properly treated. It may not, however, be applied in the green state, like marsh mud. I have already explained the effects of the partial decomposition of vegetable matter under water. Swamp mud must be exposed to the influence of the atmosphere, or mixed with marl or stable manure, before it is applied to the soil. It is also a valuable addition to farm-yard manure, for preventing the escape of amonia, and for absorbing liquid matters.

Of Mineral Manures.

To this class belong gypsum, lime, marl, &c. In treating of these I shall confine myself, principally, to those found in the State.

Gypsum is a sulphate of lime, and is generally applied to artificial meadows, and to clover, as a top-dressing; on the latter, it appears to have a specific effect.

There appears to be great diversity of opinion on the subject of the application, effects, and

* The term "salt-marsh" is applied on the coast to the mud and other matters of which the marshes are composed.

theory of gypsum. Some suppose that it acts by virtue of the lime, which it parts with slowly and as the plants require it. While Liebig holds that it acts by fixing the amonia brought down by the rain, and retaining it in the soil. But scarcely any one theory explains all the facts—for instance, its specific action on certain plants, its greater proportionate effect on manured and limed land, and its entire inertness on some lands. Nevertheless, a substance that, by a single top-dressing, is capable of doubling a crop of clover, will be continued to be used where its effects are known, and the price not too high.

In some countries, granite, in the first stages of disintegration, is spread on the land with good effect; and decomposed trap rock is applied in a similar manner. In the upper part of the State, there are many places exceedingly favorable for experiments of this sort, where one could be exchanged for the other. It is proper to observe, however, that the felspar of the granite must not have lost its crystaline form, nor be entirely soft, otherwise there will not be a sufficient quantity of potash left to repay the expense of carting, and the mechanical effects of the other ingredients would scarcely justify the experiment.

The debris of the trap rocks would be an excellent application to the light soils by which they are generally surrounded. When taken from any distance below the surface, the earthy matter should be used sparingly, and allowed to remain on the surface for some time, because of the protoxide of iron which it contains.

Clay is very abundant all over the State; when burned it is a good application, having both a mechanical and chemical value. The burning seems to liberate the silicate of lime, and perhaps other salts that may be present in a state that renders them insoluble under ordinary circumstances. In Europe, kilns are constructed for burning the clay; but I saw practiced in Darlington, by Col. Williams, the most simple and the least expensive mode of effecting this object, that has come to my notice. Along side a bank of clay, of considerable extent, thrown from a ditch, logs of wood were placed end to end in a single line; over this the clay was turned, completely covering the wood. One end of the wood was now fired, which continued to burn slowly, and to heat sufficiently the mass of clay, in its progress from one end to the other. The clay thus burned, was spread on the land not far from the spot, and with very satisfactory results.

Calcareous Substances.

Nature has bestowed on the State all the forms of carbonate of lime that can be useful in agriculture. Along the coast there are beds, almost inexhaustable, of recent oyster shells, which could be carried, at a small expense, to the landings, where wood is abundant, and converted into lime. The following analyses will show that their value as a manure is not altogether dependent upon the lime.

Composition of Oyster Shells.*

Animal membrane	0.5
Carbonate of lime	98.5
Phosphate of lime	1.0
	100.00

*Kane.

The animal matter is, of course, dissipated, but the phosphate remains unchanged.* A few miles inland, the Post Pliocene Marls are found, that contain an amount of carbonate, varying, where shells are at all abundant, between 12 and 60 per cent. of carbonate of lime.

A specimen from Wadmalaw gave,

Carbonate of lime,	57.0
Silicious sand,	40.0
Alumina and Oxide of iron,	3.0
	100.0

Another specimen from St. Thomas's parish, near the coast, of a white marl, with the shells very much decomposed, and quite accessible, gave,

Carbonate of lime,	60.0
Silicious sand,	36.0
Alumina and Oxide of iron,	4.0
	100.0

Mr. Ruffin analysed three specimens from Edisto island, which contained respectively 18, 27, and 58 per cent. of carbonate of lime; and another from Distant island, near Beaufort, which gave 47 per cent. Some of the beds in Horry are unmixed heaps of shells, and of course rich in carbonate of lime. The shells in these beds are generally in as perfect a state of preservation as the recent shells on the coast; still, when mixed with the soil, they are soon attacked and decomposed, with the exception of the oyster family, which resist all ordinary agencies with surprising effect.

Besides these there are other sources of calcareous manures in this part of the State. In many places the refuse of old indigo works has been discovered, which is sometimes rich enough in calcareous matter to render it a profitable application to the land.

It is so long since indigo was manufactured in this region, that it has been entirely forgotten, and it is only by the accidental discovery of the old lime that was used in the preparation, that it is brought to mind.† These deposits of lime, mixed with earthy matters and the refuse of the vats, are often extensive, and so equivocal in appearance, that it becomes really difficult to decide on their real character. In general, however, the absence of fossils, and the peculiar appearance of hydrated lime, although converted again into a carbonate, are sufficient to distinguish them from the calcareous deposits that have resulted from the natural decomposition of shells. At a landing on the left bank of the Combahee, above the ferry, I saw a low bluff in which were numerous concretionary nodules of lime, very different from the indigo lime, that must belong to the beds in which they are found. It should not excite surprise, that strata which were deposited when the marls of the Ashley, Cooper, and Santee, formed the coast, should contain lime. I have already shown that these marls were washed by water, which transported their ruins to a distance.

In the point of view in which we are now considering these deposits, it makes but little difference

* It may be worth while to remark, that when bones are burned for the purpose of facilitating the grinding before they are applied to the soil, that the phosphate of lime, of which they are composed, remains undecomposed, the bones barely losing the fatty matter they contain, which, according to Payne, is an advantage; for the grease, it seems, prevents, to a certain extent, the decomposition of the bone dust.

† The manufacture of Indigo still lingers in Orangeburg district. T. W. Glover, Esq., was kind enough to prepare for me an account of the manufacture as practiced there, which is presented. Appendix.

whether we consider them as marl beds, or indigo vats; where they are found, and contain a sufficient amount of lime, they are valuable, by whatever name designated. A specimen from an extensive deposit of this sort on the Combahee was composed of,

Organic matter,	2.00
Carbonate of lime,	36.00
Silica,	39 50
Alumina and Oxide of iron,	22.50
	100.00

The amount of lime is very variable, as might be expected. In some parts of the bed the lime is nearly pure, but in others it amounts to scarcely 5 per cent.

The other marls, and marl stones, of the State, present every variety, from a pulverulent mass to the solid rock. They are generally accessible, and being exposed on the banks of nearly all the navigable rivers, could therefore be transported at a trifling expense, to a considerable distance. They are rich in calcareous matter beyond example; and in addition to this they contain phosphate of lime in a very valuable proportion.*

This exceedingly interesting ingredient is found most abundantly in the marls of the fish bed of the Ashley, where it is derived from the bones of marine and land animals, buried in that deposit. The remains of crustaceous animals, found in nearly all the beds, indicate another source of this substance.

Marl from Bee's Ferry.

Carbonate of lime,	55.00
Phosphate of lime,	4.00
Alumina and Oxide of iron,	9.00
Siliceous matter,	32.00
	100:00

The Analysis of the Ashley marls by Professor Shepard, will be found in the Appendix.

The amount of phosphates discovered by these analyses, brings these marls up to the best in the State, in an agricultural point of view.

Still, I apprehend that the carbonate of lime will always prove the constituent of greatest importance, valuable as the phosphates are. Mr. Ruffin has studied the agricultural value of these marls, with special care and success. His investigations were particularly directed to the determination of the carbonate of lime they contained, and I present the result of his experiments, with a full knowledge of their value.

Table showing the amount of Carbonate of lime in the marls of the Ashley, and its tributaries. as determined by Mr. Ruffin.

From John S. Brisbane's landing, 9 miles above Charleston, taken from the surface on the beach, between high and low tide mark, contained of carbonate of lime, per cent.	64
From the same, taken from the bottom of the river 26 feet below low tide,	75
Lumps of stony hardness, full of impressions of shells, found in great quantity in that neighborhood a few feet above the marl,	6
Marl frym O'Neale's landing,	76
From river bank at Drayton Hall,	63

* The merit of this discovery belongs to Dr. Smith and Professor Shepard.

		per cent.
From	Bee's Ferry	50
"	Magnolia	75
"	Greer's Landing, (near Middleton Place,)	52
"	Pringle's,	75
"	Cattell's Bluff, Clement's land, grenish tint,	52
"	Another part of Clement's land, white,	78
"	Cohen's land,	62
"	John A. Ramsay's,	67
"	Cedar Grove, I. M. Dwight's,	76
"	Oak Forest,	36
"	Wassamasaw swamp, (head source of Ashley,)	72
"	Indian Fields, No. 1, (light brown,)	47
"	do. " 2,	50
"	45 feet beneath the water in outer part of Charleston Harbor, near Fort Sumter, after removing all the recent shells adhering, or enclosed by recent boring shell-fish,	81½

The following are specimens obtained in boring (in 1824) in the city of Charleston, from the different depths stated,

From the depth of		120 feet below the surface, per cent.	65
"	do.	135	56
"	do.	160	69
"	do.	162	44
"	do.	180	59
"	do.	200	54½
"	do.	225	60½
"	do.	227	58½
"	do.	230	55
"	do.	258	58
"	do.	270	66
"	do.	274	79
"	do.	282	79
"	do.	309	74

The marls of the Cooper are on an average richer in carbonate of lime, than those of the Ashley, but they are poorer in phosphates. In specimens examined from various beds on the river, I found it to vary from a mere trace to 1.50 per cent.

The following is the composition of a specimen from Dr. Holmes' marl pit.

Carbonate of lime,	87.50
Silica,	6.00
Alumina and iron,	5.00
Phosphate of lime,	1.50
	100.00

A specimen from Pooshee gave,

Carbonate of lime,	90.00
Silica	4.00
Alumina and Oxide of iron and loss,	5.50
Phosphate of lime,	.50
	100.00

Amount of Carbonate of Lime in the Marls of the Cooper. From Mr. Ruffin's report.

From the Grove, Dr. Edmund Ravenel's, soft and granular, per cent.,	52
" Mulberry, Millikin's, supposed (by the eye) average quality,	60
" " supposed richest,	76
" " supposed poorest,	42
" Lewisfield, Simons',	84
" Point Comfort, R. W. Roper's,	79
" Steep Bluff,	80
" Rectory, (in the road)	80
" Dr. Barker's, clayey marl, upper part of stratum,	43
" Dr. Benj. Huger's, (marl-stone,)	95
" Monk's Corner road, near Moss Grove,	80
" do near Broughton's Swamp, (peculiar marl,)	46
" Col. James Ferguson's, similar to last,	58
" do. nodules like chalk, in last,	96
" H. W. Ravenel's, near Santee Canal, on head waters of Cooper, ordinary kind,	95
" Isaac Porcher, jr., 5 feet under a swamp leading to Cooper,	67
" do. another specimen, lower,	81
" Philip Porcher's,	86
" Frederick Porcher's, marl-stone,	92
" Somerset, Wm. Cain's, ordinary marl	87
" Deveaux's old mill-pond, 5 miles north of Pineville,	87
" Robert Mazyck's, near Santee Canal, besides a large proportion of green sand, contained of carbonate of lime,	25
" do. overlying earth of the last, much green sand, and of carb. lime,	17
" do. white marl-stone under all the green marl,	90
" Goose Creek, Brodie's land, (brownish,)	66
" do. Wm. Kelly's (brownish,)	68
" do. do. (yellowish,)	78

On the Santee strata of solid rock are found, interstratified with yellowish pulverulent marl. The latter is excavated with ease, but the former must be burned before it can be made available as a manure. This hard rock, or marlstone, contains, on an average, 94 per cent. of carbonate of lime. The bed of green sand, mixed with carbonate of lime, which, as we have seen, is exposed at more localities than one, maintains the character it has elsewhere as a manure, as Mr. Mazyck has demonstrated.

Amount of Carbonate of Lime in the Marls and Marlstone of the Santee, Edisto, and Savannah, &c. as determined by Mr. Ruffin.

	per cent.
From Ball's Dam, Dr. J. S. Palmer's, Charleston District, carbonate of lime	91
" Col. J. S. Palmer's (landing of old Jamestown,) with considerable green-sand	66
" Dr. Robert Gourdin's, Lenud's ferry, Georgetown District	93
" do. marlstone, lower stratum	97
" Lequiex's, Williamsburg, marl	91½
" Glass's do	94
" Eutaw, Wm. Sinkler's, near mansion, Charleston Dist.	94
" do within deep sink, near Eutaw Spring	88
" do marlstone, protruding above the surface of the battle-field	92
" Dawshee cove, lower part	95

From James Gaillard's, marlstone 93
" Rock Creek, near mill, soft marl 94
" upper stratum 95
" do. surface marlstone 93
" do. soft marl, with also a notable proportion of green sand 94
" Below and near Nelson's ferry 83
" Vance's ferry, Orangeburg, upper layer, taken 25 feet above and back from the river 86
" do. lowest above the river (or 6 feet above low water) .. 90
" do. marlstone, layer between the two last 92
" Avinger's, 25 feet above the river, marl 84
" A. Felder's* 94
" Keating Simons's, softer layer, under the over-hanging shelf of marlstone, and near surface of river 96
" do. inland and top of stratum 82
" Cavehall, Dr. Cheves's 86
" do marlstone in the cavern 80
" Hale's mill, upper layer, Orangeburg, (containing no green sand) 84½
" Hale's mill, lower layer, with about 25 per cent. of green sand, (by the eye) and carb. lime 51
" a branch of Stout's Creek, green sand about 20, and carb. lime—(highest known exposure near the Santee.) 35
" under layer of last marlstone 64
" Potato Creek, Sumter, Nelson's marl 91
" Heatly Hall, (on Half-way Swamp, Orangeburgh) 90
" Pinckney's mill-pond 41
" Pinckney's mill-dam 69
" beneath low water, in Scott's lake, Sumter 84
" F. Dantzler's, Charleston Dist 75½

Marls, &c. of Edisto River and its tributaries.

From Slater's land, one and a half miles above Johnson's (or Binnaker's) bridge, Barnwell 36
" Johnson's bridge, near surface and yellowish 38
" do. near surface, and bluish 36
" do. 8 feet deep 31
" Walker's (or Stokes's) bridge, soft and sandy 31
" do. marlstone 87
On Four-holes Swamp, near head, from Zimmerman's, and about 5 of green sand 86
do. John A. Tyler's (formerly Dr. Jamison's) marl, or softer part* 93
do. do. marlstone* 94
On Cawcaw Swamp, Wannamaker's land 62
do. M. Pooser's (highest exposure found) 26

Marls, &c. of Savannah, and its tributaries in Barnwell.

On a branch of Lower Three Runs, near Boiling spring, Col. Hay's .. 74
From a spring half a mile lower 62
On main stream of Lower Three Runs, W. Holly's low ground 64
do. another specimen 62
Thin, soapy layer, forming the upper surface of the marl, and found in different parts of the bed of the creek 22

* This has been used largely for burning lime for sale.

From Gillett's mill, Gen. Erwin's, firmer parts	64
" do. softest part, (granular)	46
" Rev. Elliott Estes's land, on Savannah River, (above Lower Three Runs)	92
" do. marlstone	90
" Major J. G. Brown's, Lower Three Runs, upper part	50½
" do. 10 feet below surface	32

Of Little Salkehatchie and its branches.

From Dowling's Mill,*	7
" Cedar spring, on Lemon Swamp, (Miller's land)	73
On Ashepoo river, from F. Fraser's	92

The marls of the Pliocene, mineralogically considered, present two well marked varieties: the yellowish white marls, from which the shells have almost all disappeared, and the gray marls of Darlington, Sumter, and of the upper beds on the Waccamaw, where the shells are well preserved, and very numerous. In the yellow marls, composed of casts of shells, cemented together by lime, one is likely to be deceived in the amount of that mineral present in them, for a large part of what appears to be sand is composed of crystalized lime. This is the case with the marl on Goose Creek, as well as with some of those on the Peedee and Waccamaw. Of the two varieties, the yellow is richer in lime. But it is remarkable that an average of the whole shows a greater amount of lime than is found in the richest marl in Virginia.

The newer geological formations of South Carolina are as distinctly marked by the amount of carbonate that they contain, as by their organic contents. The marls of the cretaceous beds have from 25 to 70 per cent. of lime. In general, the soft marls are poor, the larger amount of lime being mostly confined to the marl stones. During the deposition of the Santee beds, lime abounded. It was not all derived from the decomposition of shells, but resulted, in part, from the debris of corals, and from lime held in suspension in water, producing a white, calcareous mud, and hence the large amount of lime in some of the beds. The lime began to diminish during the period in which the Ashley beds were deposited—white, calcareous mud still predominating. The Pliocene deposits are remarkable for the uniformity of the quantity of lime they contain. This arises from the fact that the lime is derived immediately from the shells, and in but a few instances is there the appearance of any other source. The shells being all of the same species, and distributed in the Miocene sea in about the same proportion, the beds enclosing them present great uniformity.

Some of the Pliocene marls which I examined are composed as follows.

Marl from Tilly's Lake, Waccamaw.

Carbonate of lime	65.0
Silica	20.0
Alumina and iron	15.0
	100.0

From Mr. McBride's, Black River, Sumter.

Carbonate of lime	70.0
Silica	20 0

*This was a part detached from the upper surface, in excavating for the mill site, and was not worth notice, except as indicating that marl may be found, probably much better, lower in the bed.

Alumina and oxide of iron and loss	9.5
Phosphate of lime	.5
	100.0

This was a white, granular marl, with few shells.

From Dr. Mulderow's, Black River, Sumter.

Carbonate of lime	67.0
Silica	16.5
Alumina and iron	16.5
Phosphate of lime	a trace.
	100.0

From Mr. Williamson's, five or six miles south-east of Darlington C. H.

Carbonate of lime	60.0
Silica	25.0
Alumina and iron	15.0
	100.0

From Dr. Zimmerman's, south-east of Darlington C. H.

Carbonate of lime	68.0
Silica	22.0
Alumina and oxide of iron and loss	9.6
Phosphate of lime	.4
	100.0

From Mr. Dargan's, Darlington C. H.

Carbonate of lime	64.5
Silica	15.0
Alumina and iron	20.0
Phosphate of lime	.5
	100.0

Table showing amount of carbonate of lime in the Pliocene marls. Mr. Ruffin.

	per cent.
From Giles's Bluff, Peedee, (overlying secondary) yellow marlstone	78
" H. Davis's land, back from above, yellow soft marl	60
" do. another place	64
" do. another	66
" Godfrey's Ferry	69
" do. harder layer	89
" Gibson's land, lower stratum, in cavern, on Peedee	81
" back, near spring	74
" Witherspoon's Bluff, (above Giles's,) 13 feet above low water	62
" do. 6 feet above	74
" Goose Creek, near Cooper River, G. H. Smith's land	82
" do another part of same exposure	80
" Branch of Swift Creek, near Darlington Court House, J. F. Ervin's, blue, taken 3 feet below surface of stratum	64
" do. at eight feet	69
" do. James Gibson's, yellow	63
" do. do. another specimen	64
" Black Creek, five miles south-east from Darlington Court House, John Fountain's land, yellowish	57

From J. W. Singletary's		62
" J. M. Timmons's,	No. 1	54½
" do.	No. 2	50
" do	No. 3	48

The marls of the Peedee are easily recognised, by their dark color: the softer varieties, when dry, change to a gray, or ash color. The marl stone has been burned to supply lime, for building—a purpose which it is said to answer very well. The upper portions of some of the beds contain iron pyrites, which, by spontaneous decomposition, forms sulphuric acid, which, trickling down the surface of the marl, in the form of sulphate of iron, combines with the lime and alumina, forming sulphate of lime and of alumina. It is found presenting the appearance of effervescence, where it is exposed to the atmosphere. I have not, however, seen pyrites in sufficient quantity to be at all injurious, and I only mention this fact to show the effects of lime, in correcting what would otherwise be injurious. When sulphate of iron is found in the soil, in large and injurious quantities, it may be decomposed and converted, as in this case, into sulphate of lime or gypsum.

Table of the amount of carbonate of lime in the Cretaceous Marls. Mr. Ruffin.

	per cent.
Throughout this, the soft marl, which is generally rather poor, and the very hard and compact marlstone, which is generally rich, are presented in alternate layers,	
Marl, dark bluish gray, from bluff at Birch's Ferry, carb. lime	36
do. at Birch's Ferry, 5 feet from bottom of the bed	33
do. do. 10 feet	51
Marlstone, do. 12 feet	66
Marl, clay wall, (J. A. Jolly's,) above mouth of Jeffrey's creek, surface	24
do. Willow Creek, Gordon's	45
Marlstone, do.	77
Marl, Bingham's, on stage road, supposed average of his digging	32
do. Leggett's, upper part	57
do. Giles's bluff, Henry Davis's	42
do do. next to low water mark	14
Marlstone, do.	86
do. Myers's land	84
do. do. (another specimen)	76
do. (pale yellow) Gibson's bluff, upper layer	82
Marl, bluish gray, do. lower	10
Black River marlstone ledge, at Avant's (or Brown's) upper ferry	72
do. soft black earth underlying the last, only	2
Stony Run, Georgetown, marlstone	55

Marls of Lynch's Creek.

	per cent.
From Sparrow Swamp, at top	18¾
" same, 3 feet deep	21
" do. 6 feet deep	25½
" do. marlstone	66
" Henry Ham's, Sparrow Swamp, 5 feet deep	25
" B. Lawrence's, Lynch's Creek, top	15
" Furney Ham's do. 6 feet deep	27½
" S. Coward's do. 3 feet deep	27½

Effects of Calcareous Manures.

Every thing connected with lime has been recently so thoroughly discussed, and the results of so many successful applications have been published, that liming and marling are no longer considered in the light of experiments, in the State.

Lime, in some form or other, is recognized among the fertilizing ingredients of every country where agriculture has made any real progress, and its effects have, on this account, been studied with corresponding care.*

Without entering into the discussion of the benefits to be derived from the application of lime, I will endeavor to present, in the simplest manner possible, the theory of the action of calcareous manures in general, as the surest guide to their proper use.

1. A certain amount of lime is found in the ashes of all plants, and may be fairly reckoned among their necessary constituents.

2. It promotes the decomposition of vegetable matter, such as the roots and other remains of preceding crops; and by thus bringing it into that peculiar state in which it absorbs nitrogen, it converts inert vegetable matter into a highly active nitrogenized manure.

Decomposition is assisted by the neutralization of the organic acids, such as galic acid, which are the result of the process, and are highly anticeptic. It also acts as a solvent, as the alkalies do, of the silicates, and hence, probably, its effects on clays.

3. It acts mechanically upon arable lands, thereby altering their physical properties. It diminishes the tenacity of stiff clay soils, and materially lessens their retentive power, while, on the other hand, it stiffens and renders light soils more retentive.

Knowing that lime, which is a simple manure, adds but one constituent of plants to the soil, and even that one is taken up very sparingly, no one will think of applying it directly to the roots of growing plants, as they would complex manures, that yield several elements, in small quantities. Its effects on vegetable matter, distributed through the soil, such as roots and stubble, point directly to the proper mode of applying it, as well as the proportion in which it should be applied. Experiment, which is the safest guide, has indicated 150 bushels per acre, of pretty good marl, as the quantity that may not be exceeded, on the ordinary soils of the State.

Where vegetable matter abounds, and there is great depth of soil, it is difficult to fix the limits, as may be seen in the western prairies, where cotton flourishes literally, in marl, intermingled with black vegetable mould. Other things being equal, stiff, clayey soils require a larger dose.

Of caustic lime a greater quantity than 40 bushels an acre would be unsafe, in our climate, on common soils. This contrasts strangely with the dose of from 200 to 500 bushels, common in England. Whether lime be used in the caustic state or in that of marl, intimate mixing with the soil near the surface is of the utmost importance. Marl should be allowed to remain exposed on the surface as long as possible, before it is ploughed in.

The inquiry is often made, do not calcareous manures exhaust the soil? They do, by causing it to give up freely the organic matter it contains, and this is the prime object of the application.

*For a full examination of the subject see "Essay on Calcareous Manures."

Lime alone, applied to the land, will be certain to impoverish it; and hence it is a dangerous instrument in the hands of an injudicious planter. Lime adds so little, itself, and helps the crops so bountifully to what is already in the soil, that if the supply be not kept up by the addition of organic matter, the consequence is obvious.

It was, probably, this effect of lime that gave rise to the term "stimulants," applied to mineral manures. It does not, however, convey a correct idea of their action, for they are really as much a part of the substantial food of plants as any other of their elements.

Rotation of Crops.

Besides the agency of manures, other means of improving the soil have been introduced, and none with greater success than the rotation of crops. To those countries whose staple crops and whose climate enable them to practice it to its full extent, scarcely any improvement in agriculture has been fraught with greater blessings.

Before the functions of plants, and their relations to soils, were clearly understood, many attempts were made to explain the fact that when land has become exhausted, by the cultivation of successive crops of the same plant, it may again be restored, after the intervention of two or more crops of different plants, so as to be capable of producing a crop of the first plant. Without stopping to notice these explanations, I will point out what I believe to be the true one.

Every one knows that when land has been exhausted, by repeated cropping, it may be restored, by resting for a certain length of time. If the soil has been a "naturally fertile" one, that is to say, if the subjacent rock, or the sub-soil, be such as produces a good soil, the time necessary for such restoration will be much shortened. The effect will be produced in a still shorter time by the thorough breaking up of the soil, and by the exposure of fresh surfaces to the agencies of the atmosphere. Now this is effected simply by the decomposition of the mineral ingredients of the soil, and by the rotting of the roots or other vegetable matter that may have remained in it from previous crops. In a word, by this process there is, to a certain extent, a new soil produced, which may again be cultivated. So that by simple resting, a soil may acquire a certain degree of fertility.

The objection to this mode of renovation is, that it is connected with a considerable loss, by requiring the land to remain idle—a loss which is felt in proportion to population, or the scarcity of arable land.

Now if, while the process described above is going on, we could cultivate a crop of another plant, it would lessen, very materially, the loss complained of. A plant, to succeed another in this way, must not exhaust the soil of the same ingredient, to the same extent, as the plant that preceded it; and if a third plant be found that differs from both of these, in what it requires from the soil, it may follow in the rotation, and by this time the soil may have recovered from the exhausting effects of the first plant.

The chemical composition of cultivated plants solves the problem of the selection of the proper plants for a rotation, always, of course, taking into the account their adaptation to the climate, commercial or other value, &c., which are considerations that belong to the practical agriculturist. For example, besides the elements common to all cultivated plants, the grasses and grain plants require a great quantity of silica; others, such as beets, turnips, and Irish potatoes, take from the soil a large amount of potash; and clover, with all the pea tribe, and tobacco, require much lime. Plants thus constituted are obviously those that should succeed each other in a rotation.

The following table from Liebig's investigations will render this still more obvious.

The crops given were found to abstract from 2.47 acres of land the quantity of salts in the table.

	Alkaline Salts.	*Salts of Lime and Magnesia.*	*Silica.*
A crop of wheat, - - - -	120½ lbs.	78½ lbs.	260 lbs.
A crop of peas, - - - -	198½ "	371 "	46 "
A crop of beets, without leaves,	361 "	37¾ "	—

And the quantity of phosphates taken up are,

Peas.	*Wheat.*	*Beets.*
117 lbs.	112 lbs.	37¾ lbs.

Now from these numbers it is plain, that if any one of these plants be cultivated in a soil that supplies annually an amount of these salts short of what the plant requires, there must be a failure of the crop. Thus a soil that cannot afford a large annual amount of alkaline salts is unfavorable to the growth of the beet, at the same time that both wheat and peas may grow quite well. Peas, it is evident, can only be raised where salts of lime and magnesia are abundant, while both wheat and beets may flourish.

There is no want of silica in any soil, and seeing the large quantity of this taken up by wheat, one might naturally enough suppose it the least impoverishing of all crops, yet the reverse of this, is the fact, for it is well known that the grain crops are of all others the most exhausting.

Bousingault, who unites the rare qualifications of a profound chemist, and practical agriculturist, and therefore whose deductions are entitled to the utmost confidence, has explained this, both by experiment in the laboratory, and in the farm on the large scale.

He raised wheat on a soil deprived artificially of its nitrogen, and found that it only contained the amount of that gas that was in the seed, showing that it acquired none from the atmosphere, while peas raised under similar circumstances, contained much more nitrogen than the seed, proving that it took the surplus from the atmosphere. And thus it is that the grain crops exhaust, by deriving all their nitrogen from the soil.

His experiments on the large scale were as follows:

Wheat was raised two successive years with manure, and one year of fallow, giving for the produce 4318 kilogrammes of wheat and 7500 of straw per hectare, at an expense of 20.000 kilogrammes of manure. These when dried gave the following results.

	Wgt. dry.	*Carbon.*	*Hydro.*	*Oxyg.*	*Nitro.*	*Ashes.*
Wheat,	2836	1037.4	164.5	1230.8	65.2	68.1
Straw,	5550	2686.2	294.2	2159.0	22.2	388.5
Total,	8386	3723.6	458.7	3389.8	87.4	456.6
Manure,	4140	1482.1	173.9	1068.1	82.8	1333.1
Difference,	4246	2241.5	284.8	2321.7	4.6	876.5

It appears from this table, that all the ingredients of the crop were greatly increased above those found in the manure, excepting the nitrogen, which is nearly equal in both. The carbon is nearly trebled, proving the truth of the theory that ascribes this constituent to the atmosphere. The hydrogen and oxygen are also greatly increased, and in the proportion in which they enter into the composition of water. The nitrogen, it is plain, was derived from the manure alone, for the slight difference presented in the table must be set down to the errors unavoidable in experiments in a large way.

Let us now examine the experiments of M. Crudd, a distinguished agriculturist, on the culture of green crops.

Lucern was cultivated for five successive years, followed by a crop of wheat manured with 44,000 kilogrammes of manure per hectare, put on at the commencement.

Plants.	*Produce dry.*	*Contents in Nitro.*
Lucern, 1st year,	3.360 kilos.	79 kilos.
" 2nd "	10 080 "	237 "
" 3rd "	12.500 "	295 "
" 4th "	10,080 "	237 "
" 5th "	8.000 "	188 "
Wheat, 6th "	1.580 "	31 "
Straw,	3.976 "	12 "
Total of Nitrogen,		1078 "
Amount of Nitrogen in manure employed,		224 ".
Gain in Nitrogen,		854 "

This illustrates most admirably the value of ploughing in green crops, and taken in connexion with the preceeding one,the sort of crops that should be thus treated. Even the roots of such crops, that remain in the soil, must to some extent mitigate the exhausting effects of grain crops, on the nitrogenised ingredients in the soil.

Of course where farm-yard manure, which, as we have seen, contains all that plants require, exists in sufficient quantity, there will be no necessity for any rotation of crops. This is also true where the soil is of extraordinary fertility, such as rich bottom lands and those of prairies, where the same crop has been raised in succession, for twenty years or more. Many of the rice plantations present also good examples of this sort, with the exception, that irrigation supplies much that is taken off by the crop, nor can I conceive, otherwise, how they could bear the enormous drain of 40 to 70 bushels of rice per acre, when in many cases even the straw is not returned to the soil.

The substitution of root crops for grasses is considered in Europe among the capital improvements in husbandry. The following compiled by Dr. Kane, showing the actual nutritive material derived from an acre of land by various crops, may have some interest.

Crop.	*Weight*	*Starch & Sugar.*	*Gluten.*	*Oil.*	*Total.*
Wheat,	1500 lbs.	825 lbs.	185 lbs.	45 lbs.	1055 lbs.
Oats,	1700 "	850 "	230 "	95 "	1177 "
Peas,	1600 "	800 "	380 "	45 "	1225 "
Potatoes,	9 tons.	3425 "	604 "	45 "	4076 "
Turnips,	20 "	4500 "	550 "	— "	5040 "
Carrots,	25 "	5600 "	1120 "	200 "	6920 "
Meadow hay,	1½"	1360 "	240 "	120 "	1720 "
Clover hay,	2 "	1800 "	420 "	180 "	2400 "

Of Draining.

There are no agricultural improvements more intimately connected with geological science than drainage operations, and where conducted upon an extended scale, a knowledge of geological structure is absolutely necessary to entire success.

The rain water that falls upon the earth's surface, either passes of directly off the surface to a lower level, or sinks into the porous beds till it meets with one that is impervious; this it follows to the outcrop, where it vents itself in one or more springs. The line of outcrop of such impervious strata may often be traced along hill sides by means of these springs. Where the impervious strata occur near the surface, and the country has but little inclination, swamps are often the result, and where they are found far below it, the opposite effect is produced. Such alternations of porous and impermiable beds are common in every country,* as is shown by the frequency of ordinary wells, which are dependent upon this structure, for their supply.

Where the rocks are highly inclined, so that their upturned edges form the surface of the country, it rarely suffers from excess of water, which finds a ready passage between the strata, particularly if they are slaty; but regions so situated are apt to suffer from the opposite extreme, as was painfully illustrated in the slaty portions of Spartanburg and the adjoining districts, during the late excessively dry season; they suffered even more than the sandy parts of the State. The reverse of this takes place where the rocks are horizontal or impervious. The immense tablets of gneiss that cap the mountains of the State, where their surfaces are level give rise to miniature swamps, as may be seen on the top of Table rock, and Whiteside.

When a porous bed of considerable extent, one for instance that is made up of sand and pebbles, occurs between too impervious strata, an immense reservoir is formed, which is filled by the rains, if the strata are inclined, at the extremity where the porous bed comes to the surface. If the superincumbent impervious bed be perforated so as to tap the reservoir, the water will rise to the level, or nearly so, of the highest point of the reservoir. If the point where the overlying bed was perforated be lower than the upper edge of the reservoir, the water, of course, will flow out at the surface, or even rise to a considerable height above it, dependent upon the difference of level just stated.† Such fountains are known as Artesian wells.

It will appear from the geological structure of the Charleston basin, that it presents all the conditions found in those places where borings for these wells have been most successful. In a report based upon this fact, which I had the honor of presenting to the Mayor and City Council of Charleston, recommending an attempt to procure water for the city, by boring, I stated 600 feet as the probable depth that would be required to reach the water-bearing bed. Since this was written, a well has been commenced in the city, and at Fort Sumter, under the direction of Capt. Bowman. At the Fort, the green sand which underlies the Ashley beds appeared to have been reached at somewhere near 300 feet, which was the depth of the well at my last visit to the place.

This corresponds with the position I had assigned that bed, but the proportion of green sand was not as great as that in which it is found on the Santee; still it was highly interesting, as the only green sand found, occurs at the junction of the Ashley and Cooper and Santee beds, and is seen again thinning out in Orangeburg. In a new district, the depth assigned for Artesian wells must be taken with considerable latitude.

Previous to the celebrated well at Grenelle, 1000 feet was the greatest depth reached by any successful attempt at boring for water. The geologists at whose instance this well was commenced, by the French government, had calculated 1200 to 1500 feet as the probable depth at which the water

* And hence the great success of those who seek for veins of water, by means of the divining rod.
† From 'Artois,' a French province, where they have been in use for 600 years.

bearing rock would be reached. When this depth was attained without success, both government and people became impatient. Confident of the correctness of the principles upon which the undertaking was based, M. Arago urgently recommended the prosecution of the work. His representations were successful, and the boring was continued to the depth of 1800, when the reservoir was reached, and a vast volume of water rushed up, crowning this remarkable undertaking with the most brilliant success. The well furnishes at present about half a million of gallons in twenty-four hours.

The sinking was commenced with an auger 12 inches in diameter, and so continued to a depth of 500 feet, when it was changed for one of 9 inches. At the depth of 1100 it was reduced to 7½ inches, and at 1300 feet to one of 5 inches, with which the sinking was completed.

The temperature of the water is 82° Fahr.

In this country, the most successful sinkings for water have been made in Alabama, although there is but little known of them out of the State. They are commenced with as much confidence as are ordinary wells elsewhere, and instances of failure are very uncommon. In the single county of Greene there are upwards of 40 "bored wells," varying between 170 and 600 feet in depth, all constructed by private individuals, for their own use.

They are always sunk by contract, and by persons who make boring and excavating reservoirs their business. The price varies, with circumstances, within certain limits, which may be set down at present between 50 cents and $1 per foot,* the proprietor always boarding the hands employed, three in number, the contractor and two black men. Any thing done beyond the simple boring, such as tubing, &c., is an extra charge. Accidents arising from the breaking of tools, the time lost, &c., are at the expense of the contractor. The simplicity and adaptation of the tools to the work, and the skill and dexterity with which they are used, are all admirable, and perhaps unequalled in any country. Every contrivance has the stamp of "back-woods" force and originality, every material used is such as is every where accessible, and every tool such as the most ordinary workman could construct.

The Alabama wells, on account of the great number in a limited area, are exceedingly interesting, in relation to the supply of water, as affected by the number of wells. The quantity of water furnished by a new well becomes less after some time, but this is found to be the result of the obstruction caused by the falling in of the sand, and when this is removed, the quantity is again increased. No diminution is perceived from the increased number of the wells. Four of the most copious fountains in the State are but a few hundred yards distant from each other. The quantity of water varies from a very feeble stream to 360 gallons per minute. This difference is due to the relative levels of the points where the sinkings are made; the quantity of water of course is diminished by the resistance that the head has to overcome.

The following table exhibits the temperature of the water of some of the wells in Greene county, Alabama, in relation to their depth. The temperature was taken as the water issues from the spout, and does not show that of the water at the bottom of the well, for in some of them water is found at various depths, which is mingled together as it comes from the spout; still the results are interesting, as illustrating the general increase of temperature towards the earth's centre.

The temperature of the ordinary wells of the county is 64°.

* The diameter of the Augur never exceeds 4 inches.

No.	*Depth of Well.*	*Temperature.*	
1	173 feet,	64°	Fahr.
2	193 "	66°	"
3	258 "	64°30'	"
4	368 "	65°	"
5	415 "	65°	"
6	420 "	66°	"
7	468 "	66°30'	"
8	525 "	70°	"
9	544 "	72°	"

To return from what may appear a digression, though really connected with the subject. The springs formed by the percolation of water through fissures and porous strata, unite their waters as they flow down hill-sides, and form rivulets; these by their union produce rivers, which scoop out channels in their course to the coast line. The face of the country in this way is drained. Where the declivities are steep, the water passes off rapidly, and inundations are rare; but where the bed of a river towards its mouth has but little inclination, it is unable to vent the water that rushes down the steeper descents above, and which constantly accumulating, spreads out laterally, producing inundated land, and swamps.

The simplest mode of relieving the lands on the banks of sluggish streams, is the removal of obstructions, and the clearing out of the channels of such streams. An interesting example of the effects of this process occurred on the S. Edisto; in order to improve the stream, for the purpose of rafting lumber, it became necessary to remove submerged logs, accumulations of dead timber, &c. When this was completed the water had fallen 3 feet, which drained some very valuable rich swamps on the banks. Next to this is the effect produced on drainage by straightening the channel of a stream. It is obvious that straightening the course of a meandering river increases its velocity; if a stream 10 miles in length, having a fall of 20 feet, or 2 feet per mile, be reduced by straightening to 5 miles, the fall becomes 4 feet per mile, the volume of water vented is proportionately increased, and its surface of consequence lowered. In navigable streams such improvements require great caution; but there are numerous small streams in the State, particularly those that flow along the strike of the rocks, that would be greatly improved by a little labor bestowed in this way. It seems to me that the improvement of such streams, in relation to health and drainage, would be a proper subject for the premiums awarded by Agricultural Societies.

Many of the upper districts present no other possible local cause of disease, than the obstruction of these streams, and the effect upon the rank growth of a warm climate. Mr. Ruffin was struck with this fact, and pointed out the remedy in his Report.

The shutting out of the water of a river, by embanking, is a mode of reclaiming land that requires great judgment, and often considerable capital, and can consequently only be undertaken when the land is of great value. In the tide swamps, reclaimed for rice culture, it is necessary to enclose the land completely, in order to have the water under entire control, the drainage being conducted through flood gates. The rice plantations are perhaps the best models that the country affords of this mode of reclaiming lands. But, in ordinary cases, that occur above the tide line, the land reclaimed is not enclosed altogether. The embankment is commenced at the upper end of the land to be drained, and is continued downwards until a sufficient fall is secured to allow of a free passage for the springs and surface water. The embankment is now discontinued, and when a freshet occurs, of course the water is shut out; and when it rises to an extraordinary height, even the back water can only overflow it when its level at the lower end of the embankment is equal to that of the land reclaimed; besides, such an overflow does but little injury, excepting when the crop is on the ground. The cause of failure in attempts at improvements of this sort, generally arise either from contracting the bed of the river too much, by the embankment, or the defective construction of the latter. There is great temptation to encroach upon the river, for, immediately on the river bank the land is usually higher than it is farther from it. But it is better to forego this advantage, considerable as it is, and give the river a 'wide berth,' than to endanger the entire improvement.

Very serious mistakes are committed in the construction of dams and embankments, for want of knowledge of the enormous force exerted by a mass of water in motion;* in such cases it is best to be on the safe side.

There are two capital improvements of this character in the State; one on the Peedee at Society, and the other on Santee at the head of the canal, that will long remain monuments of the judgement and perseverance of the proprietors.

At the junction of the high land and the swamp, there is very generally a space lower than that part of the swamp intervening between it and the river; advantage is often taken of this depression, a ditch is cut, and a part of the water of the river turned into it, which soon excavates a considerable channel; the river, by being thus divided is lowered, and the land to be drained is converted into an island.

The extensive swamps of some of the rivers of South Carolina offer, it appears to me, a fine field for the profitable investment of capital in their improvement. The cost, and prospects of success and profit, are susceptible of pretty accurate calculation, from data that it is the business of the engineer to furnish. There is a vast amount of land of this sort in the State, the improvement of which, to be profitable, should be conducted on a scale that would place it beyond the reach of private enterprize.

The swamps of the State in relation to drainage, admit of a two fold division, those on the banks of rivers, and that result from their overflow, and those that are produced in depressions having impervious bottoms that retain the surface water and that flowing in from the sides. When the latter, as is often the case, are sufficiently elevated, and far removed from the channels of drainage, they may be reclaimed by a canal, and the question becomes one of expense and profit. Before any improvement of this sort is undertaken, we should be satisfied that our swamp is not composed of light spongy vegetable matter, such as is produced by certain mosses, for if so, it will be sure to sink, as decomposition proceeds, which will be very rapidly, when once drained, till the surface is below the drains; when our draining operations must be renewed or the whole abandoned. These sphagnous swamps generally occur where there is nothing washed in from the surrounding land to give them solidity.

There is a vast amount of labor wasted, in the defective location and construction of ditches, and it is much to be regretted that we have no men who study the subject of draining, and pursue it as a business. It appears to me that it would be a proper and useful addition to the duties of our surveyors, to examine the ground to be drained, estimate the amount of water to be vented, locate and proportion the ditches accordingly for the ditcher; but instead of this the matter is often committed to persons utterly ignorant of its principles.

* Experiments made on the force of waves in the British seas, give that force, in storms, at 3 tons per square foot.

There are in Barnwell, the lower part of Edgefield, and elsewhere in the State, extensive ponds, that from the geological structure of that region, I am persuaded might be drained at little expense, by a simple process that is practised in Europe with success; I mean by boring. I have explained the manner in which these ponds are formed; now if the impermeable bottom be perforated by boring or by a common well, until a bed of sand or gravel be struck, the water, if conducted into it, will disappear. The orifice must be protected by a covering of pebbles and sand through which the water may percolate, otherwise mud, &c., may be carried down and the drain obstructed. Series of springs along hill sides are often tapped in this way, and made to sink, instead of overflowing the bottom lands. In deep excavations, on rail roads, particularly when they run along the strike of the slaty rocks, slides often take place, which are dangerous, and the removal of the fallen earth expensive. An ingenious and simple mode of preventing this has been practiced. It consists in boring into the side of the cut, giving the hole a sufficient slope to allow the water to run off; iron tubes having their sides perforated, are introduced into them, by which means the land is drained, and the cause of the sliding removed.

The waste, by the washing away of the soil from hill-sides, in broken and hilly ground, is a serious evil, that requires no ordinary care to prevent. Horizontal ploughing, or ploughing with an inclination barely sufficient to carry off the water collected in each furrow, has been proposed as a remedy, and tried, to some extent, in the State; but, however true in principle, the difficulty, in practice, is so great, that it has, I believe, been generally abandoned; or else it has degenerated into mere zigzag lines, which are rather an injury than a benefit. This has been superseded by hill-side ditches—a system more efficient, and far less difficult in practice. The principle consists in having the sloping ground traversed by ditches of sufficient capacity and inclination to vent the water of the furrows, which are so arranged as to empty themselves into these ditches.

I saw, in Fairfield and Pendleton, with much pleasure, that improvements of this sort were making considerable progress. With regard to grading the ditches, it is plain that the nature of the soil must be taken into account, as well as the quantity of water to be carried off.

In a light soil subject to wash, the inclination must be barely sufficient to carry off the water; otherwise a greater evil may be produced than the one to be remedied. The capacity of the ditch must be increased in order to compensate for the slight inclination. In stiff, tenacious soils the slope of the ditches may be greater, and the capacity regulated accordingly. The number of ditches required will also be determined by these circumstances, and the height of the hill-side, and of course no general rules can be given.

Operations of this sort are not, like other things, good so far as they go, but may be absolutely an injury, unless properly done. And even when properly constructed, the ditches require constant repairs, cleaning out, &c. in order to their full effect. Where the soil is always kept bare, I know of no means of preventing the washing of steep hill-sides, more practicable than this.

A system of drainage, to be effective, must not only take off the surface water, but the arable soil must also be drained to a considerable depth; for, though no water may appear upon the surface, the soil may be saturated with moisture, and until this can escape freely, no permament improvement of the soil can be effected.

The effects of drainage on the soil are much more complex than is generally imagined. They have been studied with great care by Dr. Madden, who, some years since, presented a paper to the

"Highland Agricultural Society," of Scotland, in which was given the result of numerous experiments, illustrative of the subject—from which it appears,

1. That excess of stagnant water in the soil prevents the free access of atmospheric air, which has been shown to be necessary to the fertility of the soil. On the contrary, when the water has a free outlet through the soil into the drain, every shower of rain displaces the water in the soil, which is followed by atmospheric air, and a healthy downward current of water and air is established, instead of an upward one of stagnant water, produced by evaporation.

2. The temperature of an undrained soil is greatly diminished, as compared with one well drained—the difference amounting to $6\frac{1}{2}°$ Fahr. in experiments continued for several days.

In winter a drained soil will assume the temperature of the atmosphere, but in an undrained, the temperature will remain at between 39° and 40°, owing to the fact that water has its greatest density at that temperature, and hence increase of heat or cold causes it to become lighter—so that in either case, there is no transmission of particles downwards, after this temperature has been attained, and consequently no decrease of temperature, and the relation between the temperature of the air and the soil, so necessary to vegetation, is deranged.

3. The effects of excess of water in the soil, on the results of the decomposition of organic matter, has been already alluded to. Instead of the highly nitrogenized substance into which vegetable matter is converted, when decomposed in the air, or in a porous and properly drained soil, there is left a black inert matter. Besides, as oxygen is necessary to decomposition, and all the air present in an undrained soil is that dissolved in the water, it can derive but little from that source—it must take it from the water itself. Hydrogen is therefore set free, which unites with the carbon, forming carbonetted hydrogen, which takes away a portion of carbon from the soil, if it be not even injurious to the growing plants. In a well drained soil pervaded by atmospheric air, the hydrogen set free might have united with nitrogen to form amonia.

4. The evaporation going on from a wet soil keeps the growing plants constantly in a damp atmosphere, thereby retarding the healthy exhalation from the surface of the leaves, so necessary to their healthy growth.

5. But perhaps the most interesting effects of drainage are the influences exerted on the chemical changes going on among the salts in the soil.

Bertholet had, long ago, shown the modifications to which affinity is subject, dependent upon the circumstances under which matter may be placed. For instance, if carbonate of lime and muriate of soda, (common salt,) be brought together with excess of water, no chemical change can take place; if, however, they be barely moistened, decomposition commences, and two new salts, muriate of lime and carbonate of soda, are formed. They are both soluble, and highly valuable—the carbonate of soda increasing the solubility of the organic matter in the soil, and the other increasing its absorbent and retentive powers. If excess of moisture be again present, these salts return to their original state.

If a mixture be made of sulphate of lime and carbonate of amonia, and moistened or mixed with moist sand, so as to represent the state in which a well drained soil exists, an interchange takes place, and sulphate of amonia and carbonate of lime are formed. Now by this process the volatile carbonate of amonia is fixed and retained in the soil. This is the basis of Leibig's theory of the fixation of amonia by sulphate of lime, or gypsum.

If the sulphate of amonia be brought in contact with carbonate of lime, decomposition again, in the reverse order, takes place, provided that there be no excess of water, and that the two be not altogether dry, but having that degree of humidity which is found in well drained soils, and carbonate of amonia and sulphate of lime are again formed. Now it must be recollected that it is the carbonate of amonia alone that is useful to plants, although it is laid up, as it were, for use, in the form of sulphates. So muriate, phosphate, and oxalate of amonia, produce no useful effect; but when brought in contact with carbonate of lime, under the circumstances of humidity and porosity existing in well drained, cultivated land, they are converted into carbonate of amonia. This shows the value of carbonate of lime in the soil, even where it may be found in another form. Does it not explain the more energetic action of gypsum on marled land? Does it not also indicate marling as the proper remedy for the excess of muriate of soda and other salts, in recently reclaimed salt marsh?

The noxious salts that often exist in soils saturated with stagnant water, are removed by drainage, and the soil in effect deepened. Nothing is more common than to see a crop grow luxuriantly for some time, in its early stages, and after that to fail totally. Before the introduction of systematic draining, in Scotland, this used to take place over considerable districts of country. The cause was this; a soil may be drained to a depth of two or three inches, and yet may be wet below that. This depth of soil may be sufficient for plants at first, but when they grow larger, and extend their roots deeper, the soil drained is not sufficient to furnish the conditions required for healthy growth, and the effect above stated is the result.

Numerous other examples might be given, to show the favorable conditions induced in the soil by drainage, but these must suffice.

Ploughing, in some of its effects, resembles draining, and ranks high among the mechanical means of improving the soil. Sub-soil ploughing is, indeed, a mode of draining that, under certain circumstances, is quite efficient. It has an obvious advantage over deep ploughing, where it is not safe to turn up the sub-soil, at the same time that it is necessary it should be broken and rendered permeable.

Attention to the nature of the sub-soil will prevent the mistakes committed in deep ploughing, where it is turned up. When the sub-soil is good it may be brought to the surface, but always cautiously, especially where the soil is not a deep and porous loam; and there is the more caution required where a pretty good soil has been made, by good tillage, on a poor subsoil. Yet deep ploughing is the only practicable means of increasing the depth of the soil, a condition of great importance. A deep, porous soil is less liable to the waste from washing than a thin one, because the rain sinks into it, and is retarded in its downward progress. Drainage and gradual deepening of the arable soil should always go hand in hand.

Soils of the State.

The classification of the soils of the State, which is here proposed, is one founded on their geological relations, or, in other words, upon the rocks from which they are derived. The name will always convey some general idea of the character of the soils, at least in the upper part of the State. The soils of the Tertiary formation are not so easily classified, as they are derived from materials that were once suspended in water, or rolled along by its force, and deposited, generally without any order having reference to mineralogical character. The modifications which they present are, therefore, often due to the physical features of the country, and their relative position. Although the whole region is underlaid by lime, it is only in a few limited spots that it has exerted any influence on the soil. The alluvial soils derive their character from the rocks over which the rivers flow, whose debris they bring down. The materials of which these soils are formed become finer as they approach the coast, in proportion as the transporting power of the water becomes less. Nearly all the rivers of the State flow, for a considerable distance, over marl, the finer particles of which they carry with them in their progress, to enrich the alluvial soils towards the coast.

A few of the rivers, as the Edisto and its branches, that do not rise high up the country, but flow through extensive swamps, bring down much vegetable matter, which gives a peculiar character to the alluvial on their banks.

Classification of Soils of the State.

1. Granitic soils, including those derived from gneiss.
2. Trap soils, including those derived from rocks in which hornblende abounds.
3. Mica slate soils.
4. Talcose slate soils.
5. Soils of the clay slates.
6. Soils of the Tertiary formation.
7. Alluvial soils.

In the general views of soils, given in the preceding pages, the characteristics of the granitic soils of the State were pointed out. The soils of the coarse, crystalline, and feldspathic granites are loose in texture, of a gray color, and are almost invariably appropriated to the cotton crop, wherever they are found. Taken altogether, they are among the best upland soils of the State, excepting occasionally, when found on the tops of ridges, where there is often little left besides the quartz grains, the other constituents being washed away.

The following analyses of soils are intended to illustrate the general character of the soils of the State, and no more. Analyses of soils, to answer the requirements of agriculture, at the present day, by determining the composition of every variety of soil in the State, would require the undivided labor of many years.

Analysis of Granitic Soils.

No. 1 is from Union, near the village; No. 2, from the hills near Grindal Shoals; No. 3, from the Saluda, near Neely's Ferry.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter	5.50	3.62	2.60
Silica	82.40	84.30	90.00
Alumina	6.20	5.80	7.40
Oxide of iron	2.40	2.00	3.00
Lime	0.20	0.50	—
Magnesia	0.50	0.40	1.00
Potash and soda	trace	0.50	0.60
Water and loss	2.80	2.88	5.40
	100.00	100.00	100.00

These soils were all in cultivation. No. 3 had suffered much from washing, and small fragments of feldspar could be seen in it.

Of the following soils, No. 1 is from Newberry, between the village and Ashford's Ferry; No. 2 from Montecello, Fairfield; and No. 3 from the side of a ridge, near Peay's Ferry.

	No. 1.	*No.* 2	*No.* 3.
Organic matter	6.20	7.00	2.00
Silica	79.30	80.00	75.00
Alumina	5.20	6.30	8.00
Oxide of iron	1.75	2.20	3.10
Lime	0.04	1.00	.50
Magnesia	——	0.50	trace.
Potash and soda	0.06	0.30	——
Phosphoric acid	——	trace	——
Water and loss	7.45	2.70	11.40
	100.00	100.00	100.00

No. 2 is a fertile soil, and well cultivated. The sub-soil is decomposed granite, with crystals of hornblende disseminated through it. No. 1. which is from a level tract of land, is also a productive soil.

Of the following, No. 1 is from Liberty Hill, Kershaw District; No. 2 from Chesterfield, and No. 3 from York, near the village.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter	2.18	1.20	4.50
Silica	74.00	86.40	71.60
Alumina	10.00	6.60	9.40
Oxide of iron	3.50	2.20	3.70
Lime	1.00	1.00	1.40
Magnesia	0.40	——	0.50
Potash and soda	trace	trace	0.06
Water and loss	8.92	2.60	8.84
	100.00	100.00	100.00

These may be taken as a fair representation of the soils derived from the true granites of the State.

The soils from the gneiss resemble these in general character; but they are not, like them, subject to so much waste from rains.

The following soils have this rock for the sub-soil. No. 1 is from Edgefield, above the village; No. 2 from Abbeville, near Pinson's Ford, on Saluda; and No. 3 is from the Tumbling Shoals.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter	5.30	1.20	3.00
Silica	80.40	83.00	80.00
Alumina	7.62	5.40	7.00
Oxide of iron	1.60	2.00	4.00
Lime	1.40	0.60	0.02
Magnesia	1.00	0.75	——
Potash	.16	——	0.50
Phosphate of lime	trace	——	——
Water and loss	2.52	7.05	5.48
	100.00	100.00	100.00

The sub-soil of No. 1 consisted of a light, yellow clay, with crystals of feldspar scattered through it, and small concretions of iron ore. Though a productive soil, it would have been greatly benefitted by deep draining.

Of the following, No. 1 is from Anderson, below the village; No. 2, from Spartanburg, three miles north of Limestone Springs; and No. 3 from Greenville, east of the village.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter	1.20	4.20	2.60
Silica	88.00	70.00	75.00
Alumina	5.40	8.00	10.10
Oxide of iron	2.30	3.00	2.50
Lime	1.00	2.00	0.40
Magnesia	——	1.00	0.50
Potash	——	——	——
Phosphate of lime	——	trace	——
Water and loss	2.10	11.30	8.90
	100.00	100.00	100.00

Of the following, No. 1 is from the top of Glassy Mountain, Greenville; No. 2, from Pendleton, North of the village; and No. 3 is decomposed gneiss, from an excavation in front of the residence of the Hon. J. C. Calhoun.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter	6.00	8.00	——
Silica	66.60	70.00	80.00
Alumina	11.60	10.00	9.80
Oxide of iron	4.00	2.40	2.00
Lime	1.00	0.90	0.30
Magnesia	0.06	1.00	0.40
Potash	0.40	0.60	0.70
Sulphate of lime	——	0.80	——
Water and loss	10.34	6.30	6.80
	100.00	100.00	100.00

Soils of the Trap Rocks.

Nothing can be more striking than the contrast between the soils of the Trap rocks, and those by which they are surrounded. Their warm deep brown color, distinguishes them from the other soils of the State; and the only soils for which they can be at all mistaken, are those derived from the hornblende slates, which they resemble in colur and texture, but the color of the latter inclines more to yellow. They are known in Laurens as mulatto soils, in allusion to their color.

The Trap soils are more uniform in character than any other soils in the State, at the same time that they are much more influenced by the physical features of the country; owing to their peculiar subsoil.

The rock passes in the last stages of decomposition into a yellow clayey substance resembling wax, which is not very plastic, but is exceedingly impervious to water, and hence, where the land is not broken or sufficiently inclined to allow the water to pass off, the soil becomes unproductive. For this reason the extensive trap region of Chester has never been brought into cultivation, excepting in spots, where it is undulating. And yet this soil is precisely the same as that of the Flat-woods land, so highly prized in Abbeville, excepting so far as the Abbeville lands have been improved by cultivation.

I was informed that this region was once a naked plain, with but a few scattered Post Oaks, the stumps of which are yet seen. The soil bears in appearance a resemblance to what are called Post Oak prairies in Alabama.

I believe the Black Jack Oak, which is the common growth of this part of Chester, has produced a false impression in relation to the soil where it predominates.

The indications presented by trees, of the value of soils, are not reliable, beyond the neighborhoods where direct observations have been made; for what is true in one place, may mislead in another, and I think that this tree indicates the relations of the soil to moisture rather than to fertility.

Thorough draining, breaking up of the sub-soil, deepening the arable soil by judicious ploughing, and the addition of organic matter, are the means of bringing the Chester lands up to the best in the State.

I have noticed that trap soils are preferred for grain, rather than for cotton, where a choice is presented. But unfortunately they do not constitute a large portion of the soils of the State, but intersect it in narrow strips.

The following analyses show the composition of these soils. No. 1, is from the Flat-woods, N.W. of Calhoun's Mills, from a well cultivated plantation. No. 2, is from the Meadow Woods not cultivated. No. 3, is from Fishing Creek, Chester, not cultivated.

	No. 1.	*No.* 2.	*No* 3.
Organic matter,	9.20	3.40	1.90
Silica	52.00	53.00	60.00
Alumina,	22.10	19.30	20.50
Oxide of Iron	9.00	14.10	8.70
Lime,	2.50	1.80	2.90
Magnesia,	trace	0.50	——
Potash and Soda,	0.40	trace	0.20
Phosphate of lime,	trace	——	——
Water and loss,	4.80	7.90	6.70
	100.00	100.00	100.00

Of the following, No. 1, is from a well cultivated plantation near Cambridge, Abbeville. No. 2, is from Dutchman's Creek, Fairfield; and No. 3, from an exhausted field about 18 miles south of Yorkville.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter	10.05	7.30	2.20
Silica,	48.30	56.00	69.00
Alumina	19.36	20.10	16.60
Oxide of iron,	8.40	6.20	7.20
Lime,	4.00	3.00	2.00
Magnesia,	——	trace	0.50
Potash and Soda	0.90	0.50	——
Phosphate of lime,	0.10	trace	——
Water and loss,	8.89	6.90	2.50
	100.00	100.00	100.00

So great is the effect of a judicious culture on these soils, that scarcely any correct idea can be formed of their fertility, from their chemical composition.

I was not a little surprised at first to find such soils exhausted, and in many cases abandoned. An instance of this sort, on a considerable scale, occurs at Cambridge, and No. 3 is another. The abundant crops that they yield at first, and subsequent bad managament, soon removes the organic matter; the arable soil becomes thin by washing, and defective drainage accomplishes the rest. But as these soils are among those denominated naturally fertile, they are soon restored by rest and proper treatment; for, as I have heard it sometimes expressed, they are not exhausted but tired.

The hornblende slates are found out cropping in the direction of the trap dykes, and the soils may be mistaken for each other. I have already said that their color is sufficient to distinguish them. They are much lighter in texture, although ranking among stiff soils, and they never rest upon a subsoil at all resembling that of the trap soils.

I give three analyses of hornblende slate soils. No. 1, is from Laurens near the Saluda; No. 2, is a soil from the slates extending from Spartanburg across Greenville, below the mountains; and No. 3, is from Pendleton, near Sloan's ferry.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter,	6.50	4.30	5.00
Silica,	60.04	68.40	70.10
Alumina,	13.56	14.20	12.00
Oxide of Iron,	6.30	7.00	8.00
Lime,	2.19	2.00	1.60
Magnesia,	1.00	——	0.50
Potash and Soda,	0.50	0.05	trace
Phosphate of lime,	——	trace	——
Water and loss,	9.91	4.05	2.80
	100.00	100.00	100.00

Soils of the Mica Slates.

These soils, in South Carolina, are in general pretty good, where quartz is not too abundant. The plantations along the road between Edgefield and Abbeville present opportunities of observing the character of these soils. Mica slate lands are not subject to be broken up by ravines, to the same extent as those of the granite.

Where these slates rest upon gneiss, or alternate with it, they form a good subsoil by disintegration, and having more feldspar in their composition, they give rise to better soils than the same rocks in some of the upper districts. The mica slate soils of Abbeville are for this reason good soils, while the soils in Spartanburg, in the region of the Cowpens, are thin and unproductive. On examining the subjacent slates it will be found that they are filled with lenticular quartz grains of various sizes; when the rock is disintegrated, these, being indestructible, remain on the surface and often cover it. A similar structure to this may be seen in the slates west of Oconee mountain; and towards Brasstown, the hills are covered with these lenticular pieces of quartz, coated with mica. Of course a poor soil must be the result. Between the mountain and Chatuga the slates are soft, and the soil good in proportion.

I give the analyses of three specimens of soils from these slates. No. 1, is from Abbeville, below the Court House; No. 2, is from Greenville, near Tiger, and No. 3, from Pickens, above Oconee station.

	No. 1.	No. 2.	No. 3.
Organic matter,	6.90	7.00	3·40
Silica,	74.30	69.40	79.60
Alumina,	8.40	9.30	6.40
Oxide of Iron,	6.00	4.00	5.00
Lime,	0.60	1.00	0.40
Magnesia,	1.00	0.70	1.00
Potash and Soda,	0.70	0.35	0.25
Phosphate of lime,	——	trace	——
Water and loss,	2.00	8.25	3.95
	100.00	100.00	100.00

Soils of the Talcose Slates.

These are certainly the poorest soils in the upper country. They are found in the gold regions of the State, but it will be recollected that gold is found in other rocks that must not be confounded with these slates. The following are analyses of these soils from the gold bearing rocks of Lancaster. No. 1, from the vicinity of the mines South East of the village, and No. 2 is from the Northern part of the District, both cultivated soils.

	No. 1.	No. 2.
Organic matter,	6.40	4.50
Silica,	70.00	80.00
Alumina,	5.00	6.00
Oxide of iron,	3.00	2.00
Magnesia,	1.60	1.90
Potash and Soda,	——	——
Phosphate of lime,	——	trace
Water and loss,	6.00	5.60
	100.00	100.00

Soils of the Clay Slates.

The soils of these rocks border the Tertiary through its entire extent on the North, and cover a considerable area on Stevens' Creek, in Edgefield. They are poor and thin, and when worn out, are reclaimed with difficulty; they do not, however, suffer to the same extent from retentiveness, as similar soils do that rest on horizontal rocks. The slates being highly inclined, and much fissured, allow the water to pass off freely.

Where the slates are not too much intersected by quartz veins, they form the basis of a soil that with good management may be rendered productive. I saw some good farms on these rocks near Mr. Crogan's, Chesterfield, where they contain less silica, and where, instead of being gray, like the Edgefield soils, they are red.

No. 1, is from Stevens' Creek, Edgefield; No. 3 from a field North of Columbia, and No. 2 from Lexington, near the Saluda.

	No. 1.	No. 2.	No. 3.
Organic matter,	2.40	6.70	5.60
Silica;	80.72	76.30	80.30
Alumina,	12.00	10.40	9.00
Oxide of iron,	1.60	2.00	2.40
Lime,	trace,	1.00	0.50
Magnesia,	0.05	0.50	trace

Potash and Soda,	trace,	0.40	0.30
Phosphate lime,	——	trace,	——
Water and loss,	3.33	2.70	1.90
	100.00	100.00	100.00

Soils of the Tertiary.

The sandy hills in the upper part of the region occupied by this formation, are covered with pines; the subsoil being sand, gravel and clay; the soil is thin and poor, and is kept so by the annual burning of the vegetable matter, that otherwise, in time, would accumulate, when the land is at all level.

In the vales between the hills, and on the hill sides, the soil is often productive, and is cultivated with ease. There are few soils more grateful, or that yield a more ready recompense to industry; it continues to produce as long as there is an atom left of any thing that can sustain a plant.

The following analysis of a soil* from the land of J. D. Legare, Esq., at Aiken, by Professor Shepard, will show the character of the cultivated land alluded to.

Surface Soil.

Water of absorption,	5.500
Organic matter,	8.500
Silica,	77.000
Protoxide of iron,	4.005
Alumina,	5.000
Lime with traces of magnesia and phosphoric acid,	0.050
	100.055

Sub. Soil.

Water of absorption,	8.00
Silica,	81.00
Peroxide of iron,	3.50
Alumina,	5.50
Carbonate of lime,	0.40
Traces of magnesia and loss,	1.60
	100.00

The following soils are from lands in cultivation. No. 1, from Platt's springs, Lexington; No. 2 from Richland, below Columbia; and No. 3, from near Bennettsville, Marlborough district.

	No. 1.	*No.* 2	*No.* 3.
Organic matter	6.50	9.00	5.40
Silica	80.00	76.50	77.30
Alumina	5.60	6.60	4.80
Oxide of iron	3.00	2.40	5.00
Lime	0.60	1.00	0.80
Magnesia	——	0.50	1.00
Potash and soda	——	trace	——
Phosphates	trace	——	——
Water and loss	4.30	4.00	5.70
	100.00	100.00	100.00

Below the sand hills, about twenty or thirty miles, extending from the Upper Three Runs, through Orangeburg, near the village, and across into Sumter, there is a belt of country covered by a far bet-

* Southern Agriculturist.

ter soil; the type of which is found in the yellowish red loams associated with the burrstone proper; and which is best seen around the village of Orangeburg, and thence to McCord's ferry.

The following analyses present the average of this soil.

No.1, from Orangeburg village; No. 2, from Lang Syne; No. 3, from Sumpter, near Statesburg.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter	5.60	7.00	4.40
Silica	66.90	71.00	80.30
Alumina	9.60	8.50	6.60
Oxide of iron	6.00	4.00	3.70
Lime	2.00	1.56	0.90
Magnesia	.50	1.00	trace
Potash and soda	trace	.50	——
Phosphate of lime	——	——	——
Water and loss	9.40	6.44	4.10
	100.00	100.00	100.00

I am persuaded that much of the fertility of these soils must be attributed to their physical properties, as well as to the amount of lime present in them. In appearance they resemble the mulatto soils of the hornblende rocks, but are less stiff. On approaching Statesburg from Sumterville, the transition to these soils is remarkable.

For analyses of the cotton lands on the head waters of Cooper, made by Dr. J. L. Smith, under the direction of the Black Oak Agricultural Society, see Appendix.

No. 1, of the following is good cotton land; the specimen is from a plantation in Darlington, a few miles S. E. of the village; No. 2, is from Marion, east of the Court House; No. 3, is from Beaufort, near Coosahatchie.

	No. 1.	*No.* 2.	*No.* 3.
Organic matter	8.00	3.50	2.60
Silica	70.00	78.00	86.50
Alumina	8.60	6.60	6.00
Oxide of iron	5.00	4.70	2.00
Lime	.06	——	0.60
Magnesia	trace	trace	——
Potash and soda	——	.04	——
Phosphate of lime	——	——	——
Water and loss	8.34	7.16	2.30
	100.00	100.00	100.00

The following exhibits the composition of two soils, one from an unproductive piece of land in Horry, near Little River, and No. 2, from a drained pond near the Lower Three Runs, Barnwell district.

	No. 1.	*No.* 2.
Organic matter,	9.75	11.00
Silica,	67.00	65.00
Alumina,	9.60	10.00
Oxide of iron,	5.60	4.30
Lime,	.40	1.00
Potash and Soda,	trace	trace
Phosphate of lime,	——	——
Water and loss,	7.65	8.70
	100.00	100.00

No. 1 was evidently suffering from imperfect drainage. A dose of marl would be of great advantage to both these soils; that, together with a thorough breaking up and exposure to the atmosphere, cannot fail to render such land productive.

For the composition of the soils of the islands along the coast, appropriated to the growth of Sea Island cotton, see Prof. Shepard's Report, in Appendix.

The mud from the salt marshes is applied just as it is taken from the marshes. And the tall marsh grass, (*Spartina glabra*,) is frequently placed in the drill, and, it is said, with good effect.

Alluvial Soils.

The alluvial soils of the State are exceedingly valuable—of which the rice plantations present magnificent examples. Taken altogether, there are no lands in the State, or perhaps in the country, cultivated with greater care, so far as manual operations are concerned, than these plantations. It is true it is at the expense of much labor, for ploughs are seldom used—the whole being strictly hoe culture. These soils are often of great depth, amounting, in many cases, to from ten to twenty feet. On some of the rivers the whole is composed of black mud—being decomposed vegetable matter, mixed with sedimentary matter; and although differing entirely from it, in chemical composition, it bears a strong resemblance to the mud of peat bogs, and, like it, too, it has a vast quantity of wood buried in it.

The composition of these soils will appear from the following analysis by Prof. Shepard. The specimens analyzed are from the Tide-swamp plantation of Col. R. F. W. Alston.

The quantity of organic matter is quite large, both in surface and sub-soil; indeed the two are but rarely distinguishable in soils derived from deposits of fine sedimentary matter.

	Soil No. 10.	No. 4.	No. 13.	No. 7.	No. 10.
	From the subsoil, many feet deep.	Taken from field No. 4, about two inches deep.	From field No. 13, two and a half inches deep.	From field No. 7, Exchange Plantation.	Surface soil No. 10, two inches deep.
Water expelled by heating at 300° F.	7.00	6.00	6.00	7.20	6.80
Organic matter with remainder of water (not previously expelled at 300° F.) driven off by full ignit'n	27.00	24.00	14.00	27.00	27.20
Silica	55.00	60.00	70.00	55.00	57.00
Peroxide of iron	4.00	4.00	5.00	4.00	5.00
Lime (with traces of magnesia)	1.00	0.80	1.00	1.00	0.50
Alumina and loss, (the latter may be reckoned at fm. 1.50 p.c. to 0.50 p.c.	6.00	5.20	4.00	5.40	3.50
	100.00	100.00	100.00	100.00	100.00

The dry soil, No. 4, on being thoroughly wetted, gained ---------- 101.4 per cent.
No. 13, " " " " ---------- 99
No. 7, " " " " ---------- 102.8
No. 10, (top soil,) " " " ---------- 103.3

The following table shows the composition of these soils. No. 1 is from the rice land on Combahee; No. 2 is from Mazyck's Ferry; and No. 3 from a reclaimed swamp, on S. Edisto, above Rocky Swamp.

	No. 1.	No. 2.	No. 3.
Organic matter	20.40	10.00	28.00
Silica	56.00	64.00	60.00
Alumina	9.20	11.40	4.00
Oxide of iron	3.00	4.00	2.40
Lime	1.10	0.80	.50
Magnesia	0.50	0.50	——
Potash and soda	0.40	trace	trace
Phosphates	——	——	——
Water and loss	9.40	9.30	5.10
	100.00	100.00	100.00

No. 1 is among the best rice lands in the State; No. 2 is one of the stiffest rice soils that I have seen, and is almost entirely a river deposit; No. 3 has not yet been brought into cultivation. The marl which abounds on the spot would be an excellent application to a soil containing so much organic matter.

Lime Burning.

Limestone, marlstone, marl, and all the varieties of calcareous rocks, are made up of carbonate of lime, more or less mixed with impurities. 100 parts of pure carbonate of lime is composed, in round numbers, of 44 carbonic acid united to 56 of lime. The object of lime burning is to obtain the lime in its caustic state, that is, freed from the carbonic acid, which is driven off at a high temperature. The lime, in this state, combines rapidly with water, and falls to a fine powder; combines again with carbonic acid, and, when mixed with sand, forms an artificial stone, or mortar.

The object of burning lime, in agriculture, is to obtain it in such a state that it may be spread upon the land without difficulty. Besides this, it acts with more energy on organic matter, produces all the effects of carbonate of lime in a shorter time, and, for this reason, requires greater caution in its application.

The weight is diminished one half, by burning, at the same time that its bulk is doubled, if it be allowed to absorb moisture, or to "slack," as it is technically called—two important facts connected with lime, where it has to be hauled to any considerable distance.

Interstratified, as the limestones of the upper country are, with gneiss and mica slates, they sometimes pass into them, and, in quarrying, require a little care to separate the two. In general, this only takes place for an inch or two, at the lines of junction of the rocks.

Analysis of Limestone, from the Limestone Springs.

Carbonate of lime	90.56
Silica, with scales of mica	6.40
Oxide of iron and traces of magnesia	3.14
	100.00

This was an average specimen from the quarry at the kiln.

Crystalline Limestone, from the Saluda, Laurens District.

Carbonate of lime	92.00
Silica, alumina, and iron	7.00
Carbonate of magnesia	1.00
	100.00

Lime of Garlington's Quarry.

Carbonate of lime	86.00
Silica, alumina, and iron	13.50
Carbonate of magnesia	00.50
	100.00

This was from a quarry just opened. In the old quarry the centre of the bed differs but little from this, but at top and bottom it is quite impure.

Limestones of York.

A specimen at the lower bed, used at the iron works.

Carbonate of lime	85.00
Silica, and scales of mica	10.00
Alumina and iron	4.50
Carbonate of magnesia	0.50
	100.00

From Hardin's Bed.

Carbonate of lime	86.00
Silica	11.00
Alumina and iron	2.50
Carbonate of magnesia	0.50
	100.00

From the highest exposure in York.

Carbonate of lime	75.00
Silica, and scales of mica	16.00
Alumina and iron	9.00
Carbonate of magnesia	trace.
	90.00

From Brasstown Creek, Pickens District.

Carbonate of lime	70.00
Silicious matter	25.00
Alumina and iron	5.00
	100.00.

Notwithstanding that lime has been burned for a number of years, there is not a single well constructed lime kiln in the State. Those that are pretty well built are defective, particularly in the construction of the fire-places. They are either so small as to allow but a little wood to be placed in them at a time, or so large as to admit a volume of cold air, (for there are no doors,) that must carry off the heat that otherwise would be employed in burning the lime. There is consequently a vast and unnecessary expenditure of time and fuel.

The simplest mode of burning lime is to pile up alternate layers of wood and limestone, the latter broken into fragments three or four inches in diameter; the outside of the pile is roughly plastered with clay, so as to stop up all the openings, excepting at the bottom, where holes are left sufficient for draft. Such a pile may be burned in the quarry, and would involve no carriage of the limestone, till it was burned. The plastering is important, especially in windy weather, and, at all times, a great saving of fuel.

Where lime is burned constantly, kilns of a permanent character are built, and the larger they are the less the cost of burning. The interior of the kiln must be of some substance that will stand the intense heat required. For this purpose the mica slates answer well, where the granular quartz rock cannot be procured. Fire clay is also abundant along the limestone range in York; and, whatever the material used for the lining, this will form the best mortar.

In selecting the site, of course convenience to the quarry will be a prime condition, and, if possible, a hill-side should be selected. In Philadelphia it is sometimes found cheaper to have two kilns side by side, than to draw the lime and store it, when burned. When one kiln is burned the lime is allowed to remain in it till sold out. In the mean time the other is in operation; and this alternation is kept up, which saves one handling, and removal of the lime from the kiln.

I have prepared some plans of kilns, from the most approved structures, of this sort, which are here presented.

Fig. 35.

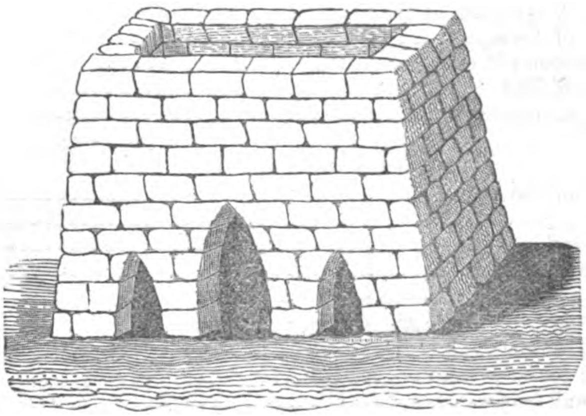
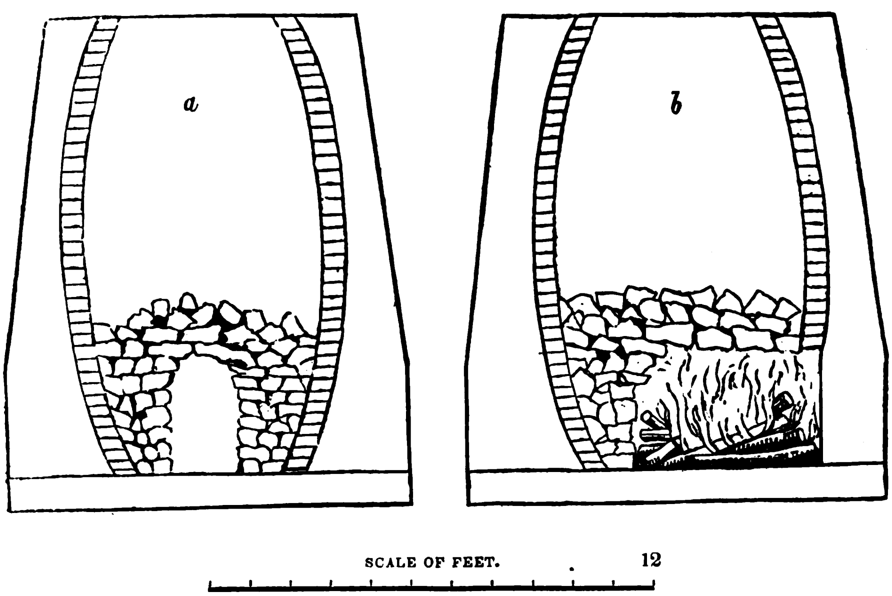


Fig. 35 is an exceedingly simple plan of a kiln used at Thomaston, in 1839.* Three arches are built of the limestone to be burned, into which the wood is thrust during the firing. The rest explains itself.

Fig. 36.



*Jackson's Report.

Fig. 36 is a small kiln, containing about 200 bushels, in use in New Hampshire. *a* is a section across the kiln, from right to left, supposing the observer to be standing in front; and *b* is a section at right angles to this, showing the manner in which the arch is constructed of the loose limestones. The cost of such a kiln is $150.

Fig. 37.

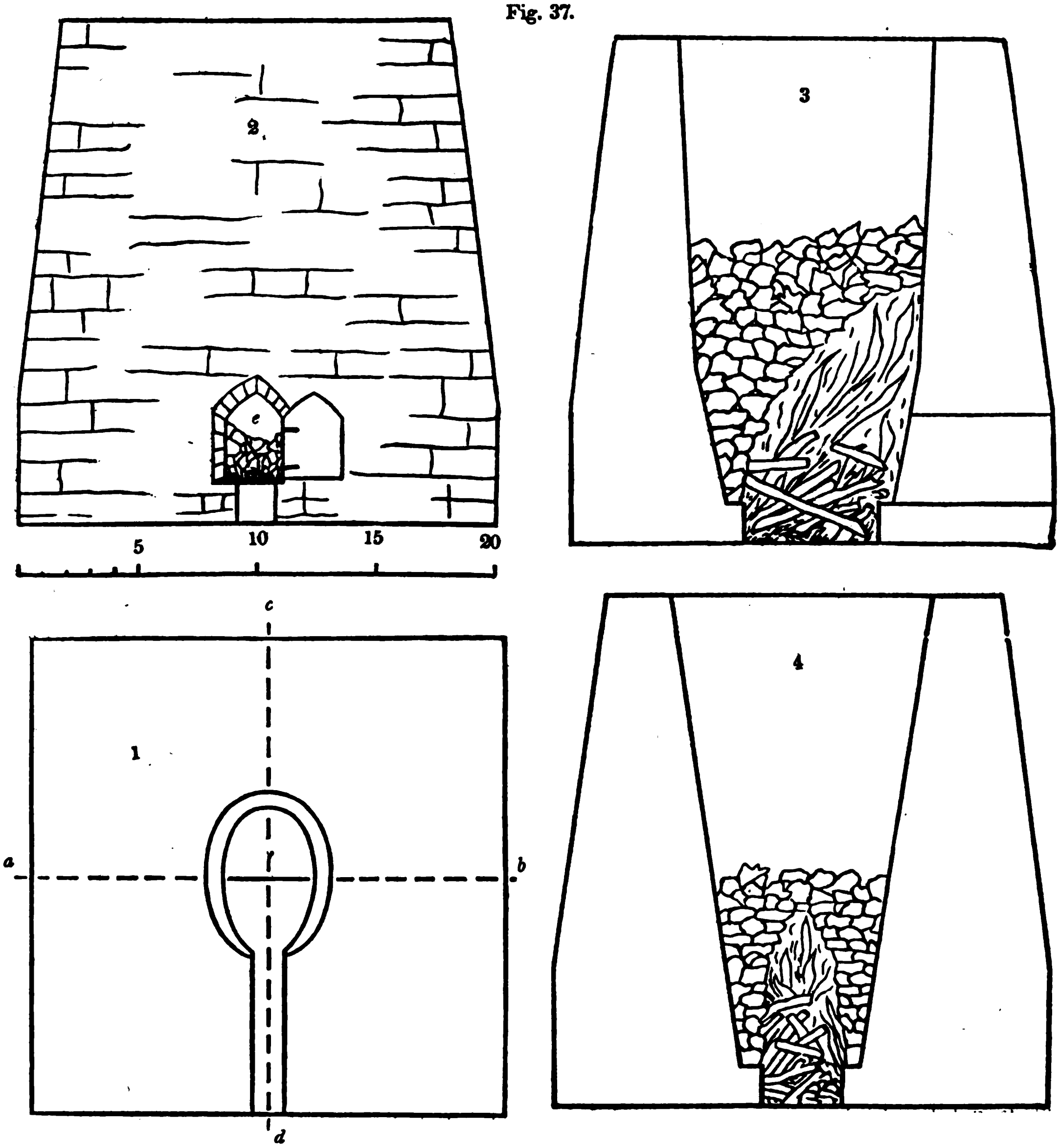


Fig. 37 is a plan of a large kiln used in Philadelphia. The plan is represented by 1. 2 is a front elevation; *e* is the opening for firing, which is closed by means of an iron door, 3 is a section on *c d*, and 4 is a similar section on *a b*.

In this kiln the height of the arch is peculiar, as may be seen in 3. This is constructed, as representod in the section, by allowing each layer of the stones to project a little, at the same time that the back is built up; otherwise, of course, the whole would fall. This vast furnace is filled with wood, thrown in through the door-way, which is immediately closed. From forty-eight to sixty hours are required for the burning of such a charge as this kiln holds. Two men are employed constantly, who, during the operation of burning, relieve each other.

As there is a certain waste of fuel inseparable from those kilns that require to be cooled down after each charge, perpetual kilns have been invented to obviate this defect. In such kilns the lime is drawn below, and a fresh charge thrown in above, at the same time that the firing is kept up, without intermission. Of course such kilns are required where the demand is constant.

Fig. 38.

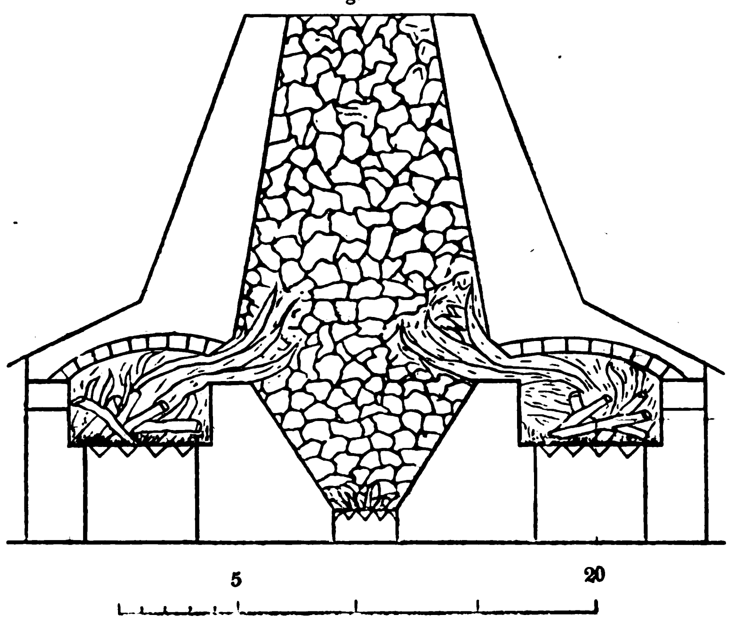


Fig. 38 is a section of a perpetual kiln. With the exception of the furnace on each side, it differs little from the ordinary kiln. It is put in operation by first filling that part below the fire-places with layers of wood and limestone, which are fired and burned. Upon this the broken limestone is piled up, till the kiln is full. The furnaces are next set in operation; and when the limestone has been subject to the heat for a sufficient length of time, the burned lime below is drawn through a hole, left for the purpose, which also serves as an air-hole. The top of the charge, of course, sinks, and fresh limestone is thrown in. The quantity of lime taken at each drawing is learned by a little experience. The drawing explains the rest.

Lime is burned, in New Hampshire, at seventy-five cents per tierce: the tierce is said to contain six bushels. At Thomaston, a cask of lime is delivered on the wharf for seventy cents. The price of the empty cask is forty-two cents; and that of wood varies from one dollar to four dollars and fifty cents per cord. The limestone of South Carolina is so situated that wood costs comparatively little, yet the market is supplied from the North.

The little lime that is burned in the State is sold, at the kiln, at twenty-five cents per bushel, without casks. Until a permanent demand is created little can be done, and the cost of transportation is yet too high to admit of supplying the market, beyond the immediate neighborhood. Should the contemplated rail-roads come within reach of the limestone beds, the State could be supplied, at a price with which the Northern lime burners could nor compete.

Besides the sources of lime in the upper country, the rich marlstones of the Tertiary are well adapted to burning. On the Santee this stone is as hard as the blue limestone, and would furnish lime with equal facility, besides possessing the vast advantage of a location on the banks of the river.

Some of the rich marls of the State would make excellent lime, but for one disadvantage connected with the burning. At a certain stage of the process they crumble, and thus choke the kiln, and this sometimes happens even when the marl is pretty coherent.

Before proposing a method of burning marl, that will remove this difficulty, it may not be out of place to say a word or two on the subject of raising marl from excavations.

Many of the beds of marl worked in are below the surface, and water becomes troublesome. The difficulty of using the common pump, in such cases, arises from the cutting of the piston by the gravel and fragments of shells brought up with the water. To obviate this, a very simple pump is used, which is entirely free from this defect, and the numerous instances of vexation arising from the use of the common pump, induce me to introduce a plan of it here.

Fig. P.

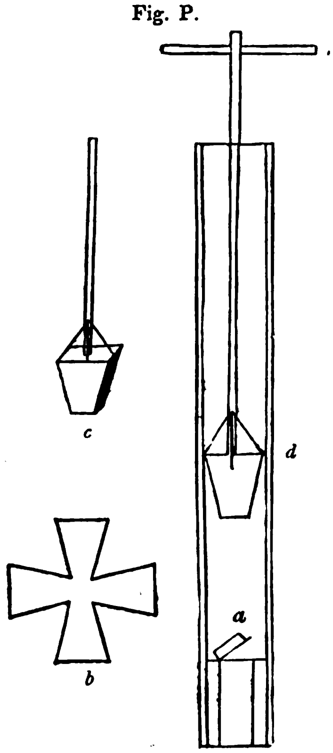


Fig. P. represents all the parts of this simple machine. It is composed of a square box, made water-tight, and three or four inches square, according to the force to be applied, and the water to be removed, and of a length depending on the depth of the pit. As it works well when inclined, of course it may be much longer, without inconvenience. Indeed it is an advantage, as there is no lever as in the common pump. *a* is the valve, placed as represented here; *b* is a piece of sole-leather, cut to form the bucket; when the sides are closed, by sewing, it forms a square bag, which is attached to the piston-rod, as represented at *c*. The sides are secured by straps, nailed to the rod. *d* shows the pump completed.

For raising the marl, when the pit is not deeper than eight feet, it is cheaper to throw it with a shovel, but where it very much exceeds this, unless a scaffold be erected and the marl thrown out at a second pitch, other means become necessary. The method of carrying it in baskets is an unnecessary waste of labor, and should never be practised.

One of the best and simplest machines for this purpose is one which is used at Fort Monroe, for raising sand from the ditch to the top of the works. This machine has received Mr. Ruffin's sanction, and I have copied it from the last edition of the "Essay on Calcareous Manures." I have seen it in operation, and am satisfied of its efficiency and adaptation to the object for which it was designed. The force employed is that arising from the weight of two men, applied to a wheel; and it is well known to be more effective than the force of the men applied to a windlass.

Fig. A.

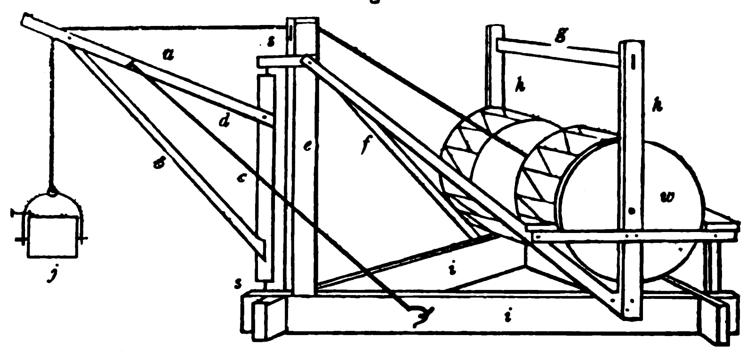


Fig. A, is the side view in perspective.

i, i. The base, consisting of 3 pieces of scantling, each 12 feet long, and 11 inches by 5, notched on to each other, about 6 inches from the end, as to be flush on top, forming an equilateral triangle.

e. The principal post, 8 feet, 8 by 6 inches, secured to the base, and braced by the braces *f.* Near the top of this post 2 iron sheeves or pulleys are placed, one on each side, and secured by pieces spiked over them. The chains pass over these pulleys.

f. 2 braces 11 feet long, 4 inches by 6.

h, h. Two uprights, in which the gudgeons of the wheel turn; they are bolted to the base, and connected at top by the piece *g*, 10 feet, 6 inches long, 4½ by 6 inches, which also serves as a hand rail for the men to steady by when working on the wheel. These uprights are further secured by cross pieces connected with the braces, and bearing in front and rear of the wheel two steps, on which the men stand as they go on or off the wheel.

w. The wheel, 4 feet in diameter, the steps 3½ feet long 8 inches wide, made of 1½ inch plank. The ends of the wheels are formed of two thicknessess of inch plank placed crosswise, the inside being grooved to receive the steps, which are placed about 8 inches apart. The axle of the wheel is 10 feet 6 inches long and 8 inches in diameter; the portion around which the chain winds is enlarged, so as to suit the force employed on the wheel, or the weight to be raised, by nailing on strips of plank, over which a few turns of old rope may be placed, to prevent the slipping of the chain.

To prevent confusion, only one crane (or arm) is represented in this figure.

The crane post, represented as turning on two iron pivots in pieces *s s*, one bolted to the principal post *e*, and the other spiked to the base. The crane post is 6 inches square.

a. The crane jib, 7 feet 6 inches long, 6 by 7 inches.

b. The strut to the jib, 8 feet 6 inches long, 4 by 6 inches. Near the extremity of the jib an iron sheeve is fixed, over which the chain passes.

c. Is a three quarter inch rod of iron, secured to *a* by means of a staple, and having a hook at the other extremity, which drops into a staple at *i*. This rod serves the double purpose of a stay and a guide, by which (when unhooked) the arm is drawn to one side, for the purpose of landing the box. When fixed, as represented in the drawing, it serves to retain the crane in its proper position. When the box is raised, the rod is unhooked, and by means of it the box is landed.

Fig. B.

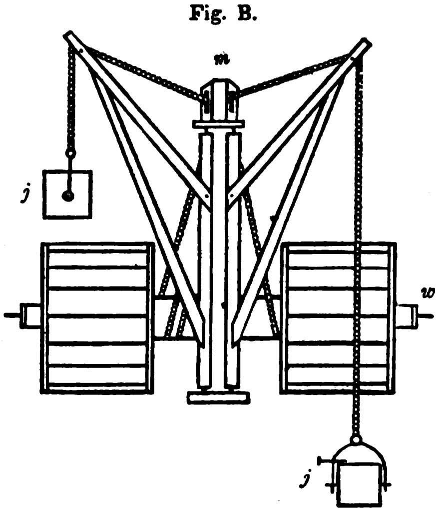


Figure B is a front view, showing the relative position of the cranes, which are represented as turned aside. The chain is seen winding around the axle. It is evident that the men must pass to the opposite side of the wheel, as each box is drawn up.

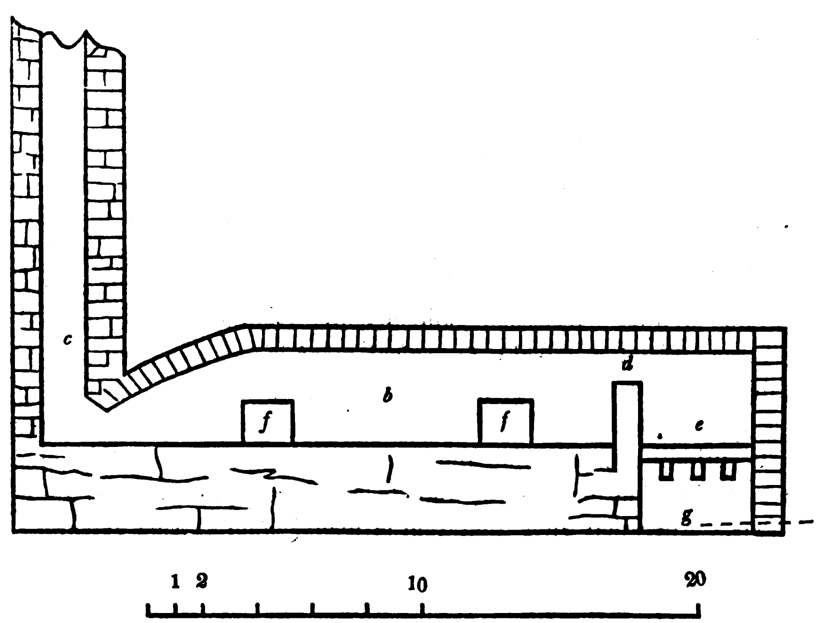
jj represent two views of the boxes, which are square, and may be 21 inches every way; they will contain nearly 6 cubic feet each. They are suspended by two pins placed a little below, and to one side of the centre, so as to turn over and empty themselves, when a small iron pin, seen at *j*, is withdrawn. Three men can be employed to advantage at the wheel, two remaining on, whilst the third gets off to land the box. Should the box not be heavy enough the diameter of the axle can be enlarged, so as to make up in time what is lost in weight. Should it be too heavy for the force employed, the diamiter may be lessened.

Burning Marl for Lime.

On certain parts of the coast of England, accumulations of calcareous sands are found, that have been applied extensively to the adjoining lands. The sands contain 60 per cent. of carbonate of lime, and to extend their economic value still further, a method of converting them into lime has been adopted, it is said, with entire success. Now this is precisely what is wanted for burning our rich marls, and with such means the blue limestone would have no superiority over them.

The furnace consists of the common reverbatory furnace, in use at the iron works. The following is a plan, from the dimensions of those used in England.

Fig. 39.



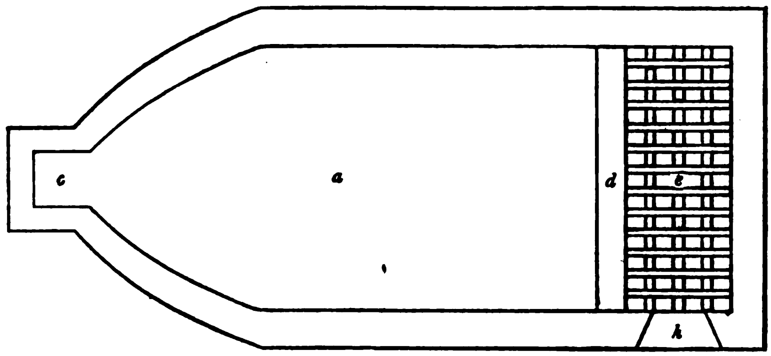


Fig. 39 is a plan and section, *a* the plan, and *b* a longitudinal section; *e* the fire place, *d* the bridge, *f* the doors through which the furnace is charged and the lime withdrawn, *g* the ash pit, *h* the door of fire place, and *c* the chimney.

The marl is to fill the whole space *a*, to the level of the top of the bridge, over which the flame is reverberated, producing intense heat, that is sufficient to calcine the sand in six hours.

I cannot see why any demand for lime may not be supplied, by such a process, from the inexhaustible beds of rich marl of the State.

Metallurgy.

With the exception of the manufacture of iron, there is scarcely any operation in the State that comes under this head; for the extraction of gold from the ores can scarcely be ranked with metallurgic processes.

Iron, on account of its connection with the progress and arts ot civilization, as well as for the vast value it receives from labor and skill, has, in every country, raised at all above barbarism, excited the greatest attention.

Malleable or native iron is of doubtful existence, in our globe; it is always combined with oxygen in certain proportion, and is further mixed with such foreign substances as silica, alumina, &c. To remove these impurities, and to obtain the iron in the malleable state, in the greatest quantity and of the best quality of which the ore will admit, and at the least possible expense, is the problem, to the successful solution of which the skill and attention of the Iron Master must always be directed.

The preliminary steps, of course, must always be an accurate knowledge of the materials operated upon, in all their relations. We have as yet no schools in which the practice and principles of Metallurgy are taught; the consequence is, that we have the principles without the practice, or more frequently the reverse of this. New establishments, that commence with untried materials, suffer most from this cause. What is called a 'practical man' is employed, who is perfectly skilled in carrying out all the processes that long experience has taught him were best adapted to the materials on which he was accustomed to operate. He finds himself placed under new circumstances, and with materials entirely different from those to which he was accustomed; his old processes he discovers are inapplicable, and his want of knowledge of principles prevents the introduction of the proper modifications. Alteration after alteration is made, often at vast expense, the profits of the company are swallowed up, or their means exhausted, and doubt or mistrust hangs over the whole enterprise, if it be not abandoned altogether. And this is the plain and simple history of many a Southern manufacturing establishment.

Nothing is deemed an ore that does not contain, at least, 20 per cent. of iron. I have already pointed out the general character and position of the ores of the State, and it only remains now to examine their chemical composition.

A glance at the map of the iron region, will show how very remarkably the ores lie in relation to each other; if there is such another locality, in the United States, presenting, as this does, the three great workable ores, lying side by side, I am not aware of it.

These ores differ in their composition very materially, and in practical operations these differences must be kept distinctly in view. The brown hematite or hydrous peroxide of iron, contains about 14 per cent. of water in combination. It is the ore used exclusively at the Cowpens, and at the Pacolet works. It presents several varieties, which need not be described here, as there are only two recognised at the works, namely, the 'honey comb' ore, a porous variety containing yellow ochre, and the compact variety including fibrous hematite, which is not so highly prized at the furnaces as the former, and is said not to work so well.

The following is the composition of the honey comb ore, from the Jackson bank, near Cherokee ford.

Peroxide of iron,	79.50
Water,	12.10
Insoluble matter.	8.00
Oxide of Manganese,	0.40
	100.00

This ore therefore contains 55.50 per cent. of iron.

A specimen of the fibrous variety gave:

Peroxide of iron,	81.00
Water,	13.00
Insoluble matter,	5.70
Oxide of Manganese,	0.30
	100.00

This ore, therefore, contain nearly 57 per cent. of pure iron.

Both of these varieties are worked, as I have said, at the Pacolet works, and it may be mentioned in proof of their practical value, that the pigs made from them are puddled without the intervention of the finery furnace. Nails of excellent quality are made from the iron, no bad test of its tenacity and other good qualities.

The red hematite, I have shown, has resulted from the magnetic ore, and in truth this ore is very frequently a mixture of the two. At some distance below the surface, black grains of the protoxide become quite abundant; it often assumes the grey color of magnetic ores, but a stroke of the hammer shows the red powder, characteristic of the red hematite.

A good specimen of this ore from the Hardin bank, yielded:

Peroxide of iron,	86.00
Insoluble matter,	13.60
Oxide of Manganese,	.40
	100.00

This ore, therefore, yields 58 per cent of iron. It has at the works a good reputation, for the ease with which it is reduced, and is used at the furnaces at the ford, and at King's Mountain.

The magnetic ores are highly interesting, from the peculiar excellence of the iron they yield. At the mines, three varieties of this ore are recognised.

1. The dark colored, dull, pulverulent variety, which is disposed to be somewhat lamellar, and which, though not so rich as the others, is much prized, both at the bloomery forges and blast furnaces.

2. A granular ore, which presents the appearance of masses of cemented grains, of small size and partly crystaline.

3. The compact ore, which is found in beds, almost entirely free from foreign matter; it is hard and tough, and has a highly metallic lustre. Fragments of this variety, when exposed on the surface, become highly magnetic.

Of these ores it is difficult to give a correct view, for much of the talcose and silicious matter with which they are mixed may be separated mechanically, and ought not to be set down to the ores.

A specimen of variety 2, from which so much of the gangue was removed as could be suspended in water, after the specimen was pulverised, yielded,

Peroxide of iron,	86.00
Insoluble matter and Magnesia,	12.00
Manganese,	trace.
	100.00

which gives for this ore 60 per cent. of iron. I apprehend that this is about an average of what may be expected from 1 and 2, when at all washed.

The next shows the composition of the compact variety.

Peroxide of iron,	91.00
Insoluble matter,	8.66
Oxide of manganese,	.34
	100.00

It contains 63 per cent. of iron.

There is another variety of ore near the top of the hill, at People's Creek. I unfortunately lost my specimens from this bed; but I am persuaded that it is largely mixed with oxide of manganese. The existence of manganese in an ore is desirable, when the object is the production of steel, for it furnishes oxygen to the carbon of the iron, and thus reduces it to the proportion for that metal.

In extracting iron from the ore, the process is purely chemical, and rough as the whole may seem, it is susceptible of the most rigorous analysis. For our purpose, it will be only necessary to state the general principles. To separate the iron from the oxygen, and the impurities, which consist of silica, alumina, and magnesia, other substances are placed in the furnace, with which these form new combinations, leaving the iron free to fall to the bottom of the furnace, or hearth, by its greater specific gravity, whence it is drawn off, in the form of pig iron. The substances thus used are charcoal and lime, or other ingredient that serves as a flux.

The carbon of the charcoal unites with the oxygen of the ore and passes off, as carbonic acid, while the lime unites with the silica and alumina, which, by themselves, are infusible, and produces a glassy slag, which floats on the fused iron, and is drawn off. There are other combinations formed, but these are the principal. The proportion of the materials is, of course, important, and should be noted with care.

There is a certain point of richness at which ores work more freely, and to bring the poor sorts up to this point, a mixture with richer ores becomes necessary. But, in all cases, the nature of the ores must be kept in view. It is the practice of some of the furnaces to mix the brown, red, and magnetic ores, for the purpose of giving the iron the desired qualities. For instance, the magnetic ores produce a soft, but exceedingly tenacious iron, well adapted for bolts, chains, cables, &c. but not well fitted for horse-shoes or wheel-tires. The brown ore produces a harder iron; and, by mixing both, one of medium quality is produced. Now it appears to me that this is a very doubtful practice; and, at all events, this tempering could be quite as well done in the subsequent process to which the pigs are subjected, when the two could be combined.

It will be recollected that the brown and red ores are peroxides, having two equivalents of iron, combined with three of oxygen, and that the magnetic ore is composed of two equivalents of peroxide, combined with one of the protoxide—consequently the magnetic ores have less oxygen to part with than the others, and would be reduced before them. Theoretically, then, the practice of mixing the three ores must be wrong.

The difference between the red and magnetic ores is not so great, as I have shown that they contain a portion of the protoxide, and the deeper in the vein the more is present.

Unless there be some better reason for this admixture than the mere tempering of the iron, this practice should be examined more closely.

The brown ore alone produces good iron, adapted to all ordinary purposes, and it is easy, as I have said, to combine the pigs with those of the magnetic ores, in the finery or elsewhere.

The compact magnectic ores, although much richer, are less valued, because they are much more unmanageable than the other varieties; and this difficulty is not peculiar to South Carolina ores, but is felt elsewhere.

We owe to Prof. Emmons* the knowledge of some highly interesting investigations, made by Mr. Henderson, at the Adriondac Iron Works, Clinton County, New York, and undertaken with the view of elucidating some of the difficulties attending the reduction of magnetic ores.

It has been already stated that these ores are composed of one atom of protoxide, and two of peroxide; but it appears, from these experiments, that the two do not exist in any thing like an intimate combination, but, taken in mass, the ores consist of an irregular mixture of the two. Before proceeding to the experiments, it will be necessary to mention briefly a process, discovered by Mr. Clay, for reducing rich ores, by means of a far less amount of charcoal than the old method. The ore is first pulverised, then mixed with fine charcoal, and placed in a fire-proof retort or crucible—the air being carefully excluded during the process. The vessel containing the ore is raised to, and retained at, a cherry-red heat, for six or eight hours—the combustion being kept up by the oxygen of the ore, which combines with carbon, and forms carbonic acid—leaving the iron deprived of its oxygen, or reduced. The particles of the reduced ore are next welded, by being raised to a white heat, in the forge, and then placed under the hammer. And, what is highly interesting in an

*New York Reports.

economical point of view, it is said that, for this latter process, dry wood, branches of trees, &c. may be used.

We shall now be better able to see the force of Mr. Henderson's experiments. He exposed fragments of the ore, in contact with pure charcoal, in a crucible, excluding atmospheric air, for the space of thirty hours, to a red heat. He next filed and polished the pieces, when two different colors were observed on the polished surfaces—the one dark and dull, the other bright and metalic. Moreover, the dark portions were found to be brittle, but were acted on by the magnet, while the portions having the bright lustre were malleable, being truly metallic iron.

To account for these changes, we must again recur to what has already been said, in relation to the fact that magnetic iron is a mixture of the protoxide and peroxide. In the experiment the former parted with its oxygen, and was consequently reduced to the state of malleable iron; whilst the portion of the ore consisting of the peroxide also gave up a part of its oxygen, and was converted into the protoxide, which appeared in the specimens as the dark magnetic portions.

It appears, still further, that the different varieties of ores were made up of very different proportions of these oxides; the black ores being converted into metallic iron, with, however, small black portions disseminated throughout: the metallic portions representing the amount of protoxide, and the black, disseminated specks or crystals, the proportion of the peroxide in the specimen. On the other hand, the fine-grained compact ores showed a large proportion of the peroxide, for the dark portions of the polished surfaces greatly exceeded the parts converted into malleable iron, which represents the protoxide.

From these experiments of Mr. Henderson it also appears that if the process be continued until the whole be reduced to the metallic state, after the peroxide is reduced to iron, being in contact with charcoal, while the peroxide is parting with its last atom of oxygen, the former oxide combines with carbon, and is converted into steel, so that the mass will be a mixture of steel and iron.

From this brief account of these experiments, it seems to me that the cause of much of the difficulty experienced in working the magnetic ores will be obvious. It points out, too, the reason why the compact varieties of these ores, although absolutely richer than the others, are not equally valued at the works.

It seems also that, to a certain extent, these ores contain, in their composition, a remedy for these difficulties, for it appears that it is the protoxide alone that is affected by the magnet; and hence we have, from this quality, the means of separating the two oxides by the magnetic machine.

It has been proposed to roast these ores, and by this means to convert a portion of the peroxide into the protoxide, by causing it to part with a portion of its oxygen. The ores are also found to be more magnetic after roasting. After being pulverized, the ore is passed through the magnetic machine, which consists of a cylinder about two and a half feet in diameter, and five feet in length, studded with bar magnets on the insides. As the ore passes over these, the protoxide is collected and retained, while the peroxide passes off with the impurities. The ore is brushed from the magnets into a trough placed to receive it. Such a machine as this is capable of separating five or six tons a day.

The impurities with which the ore is mixed, are best removed by washing, after the ore is pulverised, by passing a stream of water over it. The stream must not be too rapid, otherwise much of the finer particles will be washed away. Perhaps the best method will be one similar to that called "bucking" in the washing of lead ores, where a brisk current of water is passed over the ore, as it passes in a narrow trough from the stamps, the whole subsiding into shallow vessels, where it is kept gently agitated, at the same time that the water overflows the trough, and carries with it the earthy impurities, leaving the ore, which from its greater specific gravity sinks, and is collected for use.

In allowing the ore to pass along a trough with a current of water, the friction of the particles among themselves, and against the sides of the trough, tends to rub off the adhering gangue. When the ore drops into the shallow troughs, the agitation should be gentle, and two of the troughs placed side by side, so that what escapes in the first may be caught in the second.

These ores are so valuable that they will repay any moderate amount of labor bestowed upon them. The value of the iron of these ores would be greatly enhanced, were it converted into boiler plates, or other articles requiring great tenacity.

In England, there is no iron manufactured by means of charcoal, but for special purposes; bar iron is made by refining, with a mixture of charcoal and coke, and the bar thus manufactured sells for $70 per ton, for such purposes as chain cables, nail rods, boiler-plates, piston rods, &c., and in this way the manufacturers have been able to compete with the iron of northern Europe, where charcoal is the ordinary fuel, the latter iron being now only used for the manufacture of steel for cutlery. Yet we are using iron thus manufactured, and from ore precisely the same as the Swedish, for the very commonest purposes.

The consumption of fuel is so enormous, in every process connected with the manufacture of iron, and forms so large an item in the expense, that every means of lessening it should receive the utmost attention.

The hot blast, which has produced such a change in the consumption of fuel in Europe, has not yet been introduced in any of the blast furnaces of the State.

The mode of applying the hot blast is simple. A small furnace is lined with a contorted tube, which is heated to any required degree. Through this tube the air passes from the blowing machine, to the tuyeres. The effect of this improvement has been to lessen the amount of fuel employed; to increase the work of the furnace, and to enable a smaller quantity of flux to answer.

According to Dr. Clark's account of the Clyde Iron works,

In 1829, 1 ton of iron required 8 tons 1 cwt. 1 qr. of coal.
In 1833, " " " 2 " 5 " 1 " "

The charge for the furnace was, in

	1829.	1833.
Coke,	5 cwt.	Coal 5 cwt.
Roasted ironstone,	3 cwt. 1 qr. 14 lbs.	5 "
Limestone,	3 qrs. 16 lbs.	5 "

The temperature of the blast was 300° Fahr. Such an enormous saving as this needs no comment. Now with us it is the economy of fuel, for obvious reasons, that we should most of all look to.

But besides this, another improvement has been introduced, scarcely inferior to it. I mean the use of the gaseous matter that escapes from the trundle head of the high furnace. Without entering into the details of the processes going on in relation to combustion in the furnace, let it suffice to say, that from 55 to 65 per cent. of the combustible matter placed in the furnace, is carried off in the form of gaseous matter, so that only the remainder of the heating value of the fuel is actually consumed in the process of smelting.

To economise this vast loss, a simple plan is adopted; in the upper part of the furnace, where the fuel is not yet ignited, a cylinder of iron is placed, and sustained by stays, a short distance from the brick work; the gases meeting with less resistance here, than in passing through the solid materials placed in the furnace, they rush into this empty space between the cylinder and brick work. Flues lead from this space into iron chambers, where they unite, and from this the gas is delivered by nozzles into the puddling and other furnaces; the chimney of the furnace being sufficient to draw in the gases from the chamber; and in this way the fuel consumed in the high furnace is found sufficient for the conversion of the ore into bar iron.

There is some difference in the quality of the iron produced by the hot and cold blast, but it is too trifling for comparison with the vast saving of fuel effected, especially when we consider the quality of the ores of this region, and that charcoal is the only fuel used.

There seems to be a tendency, at some of the works, to return to the old Catalan forge or bloomery, and certainly if such a retrograde movement be at all admissible, it is here, where we have the ores best adapted to this primitive mode. The black, granular magnetic ores, that, when broken, present a dull, and not a metallic lustre, are composed, for the most part, of the protoxide, and are easily reduced, because they contain, as already stated, less oxygen.

Mr. Swann, the superintendent of the King's Mountain Iron Works, has applied, with great apparent success, the hot blast to these forges. The air is heated by surrounding the forge with a contorted tube, through which the air is blown.

The result of this operation, as compared with that of the high furnace, is sufficiently remarkable to be presented here.

Cost of blooms from 3000 lbs. of pig iron, by the cold blast high furnace.*

For producing 3,000 lbs. pig, at 1 cent,	$30 00
180 bushels charcoal, at 4 cents,	7 20
Refining, &c.	5 00
Total	$42 20

3,000 lbs. of pig will make 2,000 lbs of blooms, and these, when rolled, produce 1,666 lbs. of bar iron. By this process, then, the production of 2,000 lbs. of blooms costs $42 20.

Cost by the hot blast bloomery, of the same.

Raising and carriage of ore for 2,000 lbs. of blooms,	$9 00
200 bushels charcoal, at 4 cents,	8 00
Cost of blooming,	6 66
Washing ore,	1 00
Total,	$24 66

Here, then, it seems that the entire cost of the blooms, by the hot blast forge, is not as much, by six dollars, as the bare cost of the production of the pigs, by the high furnace. The only item

* The term blooms is applied to the iron prepared for the rolling mill.

wanting here, to render this comparison a fair one, is the amount of ore used in both cases for producing the same quantity of iron.

The forge, under ordinary circumstances, requires more; but it can, in no case, come any where near compensating for so great a difference in the cost. If there be no mistake here, this subject is worthy of the most serious consideration. The peculiar character of the ore used by the bloomery, in obtaining these results, must not be lost sight of.

In offering these remarks, suggested by the ores of the State, my object was not, of course, an outline, much less a treatise, on the manufacture of iron—but simply to direct attention to some of the prominent points that appeared to me not yet clearly worked out in our processes, and yet upon which much seems to depend.

I have prepared, from the same scale, vertical sections of three furnaces, that may, for the sake of comparison, have some interest.

Fig. 40.

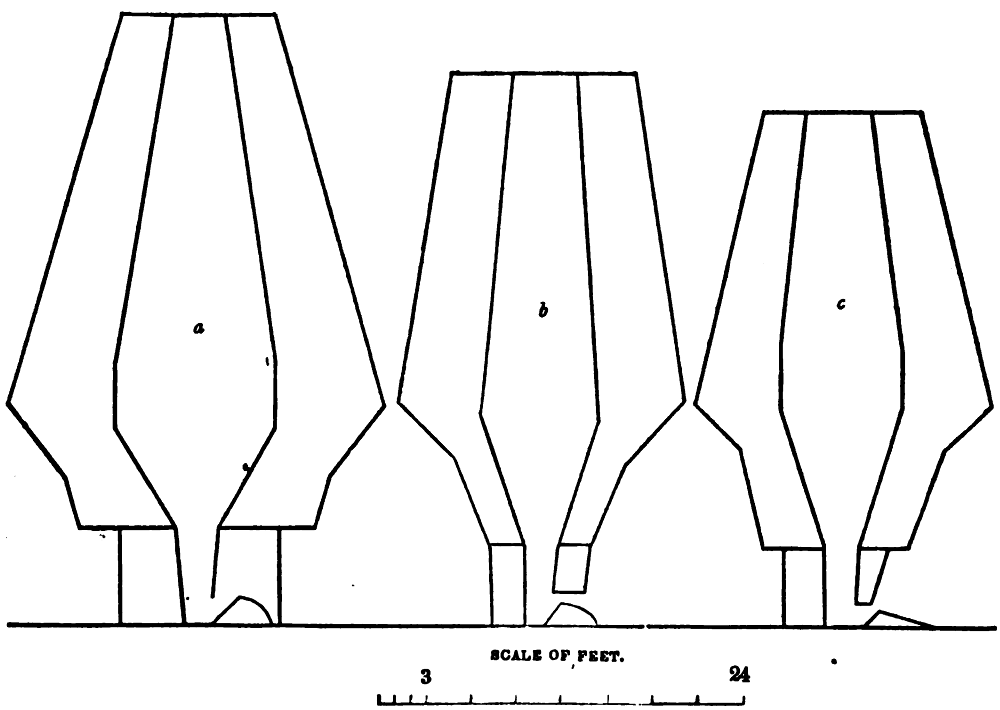


Fig. 40. *a* is the blast furnace, in use in Derbyshire, England, for coke; *b*, South Carolina furnace, for charcoal; and *c*, the furnace used at Barum, Norway, also for charcoal. The angle of the boshes is a matter of some importance, and must vary with the nature of the ore, and the fuel employed. Where the ore is easily reduced, and the fuel strong, the boshes must be steeper. In this respect the Norway differs from the South Carolina furnace, although the fuel, and, I believe, the ore, are the same.

Of the mining processes connected with the ore, I can only say that the ore has been procured at little expense, as it is, in nearly all cases, taken from the top of the bed; the inclined position of the slates being highly favorable to this mode of extracting it. The mining, therefore, is generally little more than quarrying in open trench. In a few cases shafts have been sunk, but rarely below water level.

There are, in the State, about eight blast furnaces. Two of these belong to the South Carolina Manufacturing Company, and are situated in Spartanburg District. They have a furnace on Cherokee Creek, and own the mines near the Cowpens. The dimensions of this furnace are as follows.

Height,	28 feet.
Width at boshes,	7 " 6 in.
Hearth,	1 " 10

And the charge is,

Ore, (brown hematite,)	12,000 lbs.
Charcoal,	600 bushels.
Limestone,	1,500 lbs.
The yield is about,	5,000 lbs. of iron.

The price of charcoal is two and a half cents per bushel; and cost of raising the ore, one dollar and fifty cents per ton.

The principal part of this company's works is on the Pacolet, where they have a blast furnace, bloomery, and puddling furnaces, rolling mills, and a nail factory in operation. The annual product is about 600 tons.*

The King's Mountain Company have a high furnace on King's Creek, but their principal works are on Broad River, a mile or two below Cherokee Ford, where they have a high furnace, bloomery, forges, fineries, and a rolling mill. In 1840 the cost of pigs was eighteen dollars per ton, made with 290 bushels of charcoal.

The Cherokee Manufacturing Company's works are situated on the right bank of Broad River, at Cherokee Ford, and consist of four high furnaces, with fineries, puddling furnaces, and rolling mills in proportion, together with an extensive nail factory. No expense has been spared in rendering this establishment complete, so far as the works are concerned. The work-shops are spacious and well constructed. About 900 tons of iron are the annual product of these works, and the consumption of charcoal 260 bushels per ton. Charcoal is delivered at the furnace at four cents per bushel.

If iron is not manufactured in the State as successfully as elsewhere, it is certainly not due to any deficiency in natural advantages; for water power is abundant and unfailing, fuel is as cheap as it is any where else, where charcoal is used, and the superiority of the iron manufactured from this fuel ought to compensate for any advantage in cost, in favor of stonecoal.

The price of common English bar iron, manufactured with coke, is $30 per ton, whilst the Swedish and Russian bar, manufactured with charcoal as fuel, sells for $75 to $125 per ton, or even higher. This is a vast difference in favor of charcoal-made iron, and worthy of the most serious attention of iron-masters. The cost of transportation is a considerable item in the market value of the South Carolina iron. Now, such articles as this iron is fitted to make—as boiler-plates, pis-

* For these statistics I am indebted to Mr. Clarke.

ton-rods, bars for wire drawing, &c.—would bear the cost of transportation, and would not materially increase the cost of production.

I have shown that the ores are of excellent quality—a practical proof of this is presented in the fact that all the castings, hollow ware, &c. are made from the metal, as it comes from the high furnace—there being not a single air furnace or cupola for the purpose in the State; and I have already stated that the brown ore iron is puddled from the pig.

All the ores lie side by side in great abundance, together with lime, fire-stone, and fire-clay of good quality. The labor is as cheap, if not cheaper than elsewhere, so that it is not easy to see what elements of success are wanting.

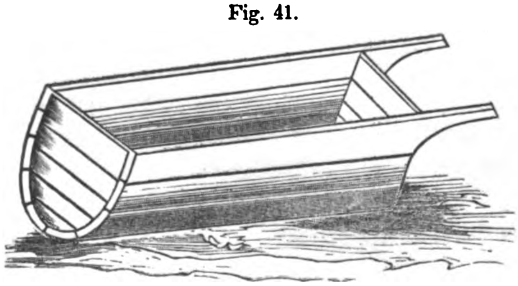
Extraction of Gold from the Ores.

The gangue in which the precious metal is contained, in South Carolina, consists of: 1. Compact quartz and hornstone; 2. Talcose slates; 3. Oxide of iron, sometimes in striated cubic crystals, derived from pyrites; 4. Iron pyrites.

There is but little known of the processes used in working gold ores, in the United States, beyond the immediate vicinity of the mines. They are, in general, very rude, and perhaps for this reason, have excited but little attention, and have received less improvement. With a view of supplying this deficiency I have prepared sketches of the principal implements in actual use, in the hope of directing the attention of the ingenious inventors of machinery to the subject. The value of gold is so great that a very slight diminution of the waste would soon repay an immense cost in the machinery producing the saving. It is proper, however, to state that the loss is quite as much due to rude construction and bad management, as to any inherent defect in the machines used.

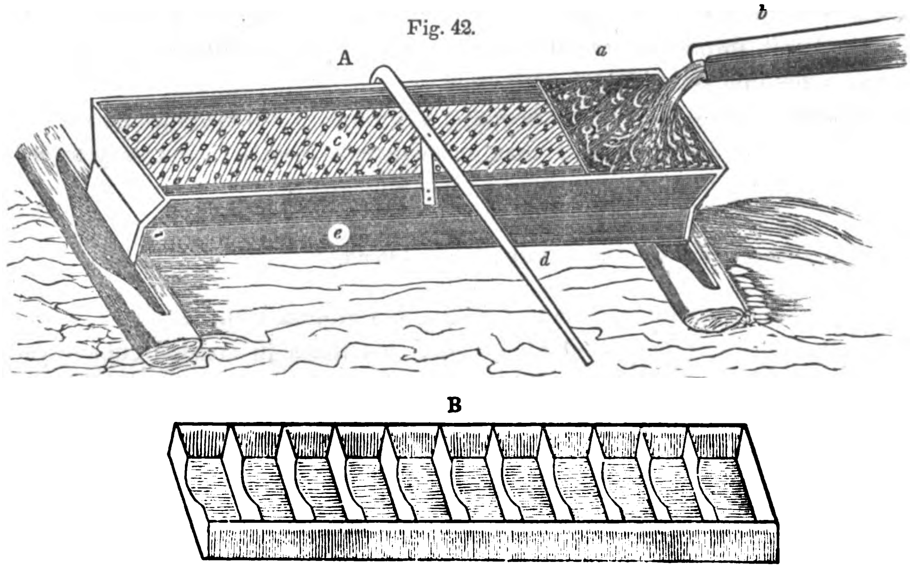
In deposit mines no grinding is resorted to: the gold is collected by separating it from the gravel, &c. The grains are larger than in the gold from the veins, probably because the finer particles have been carried away by the water. The simplest instrument in use for separating the gold is the common frying-pan, without handle. It is filled with the gravel, sand, &c. containing the gold, placed in water, and, by a peculiar circular and alternating motion, the gravel, &c. is thrown out, whilst the precious metal sinks to the bottom, by its greater specific gravity; and this is continued till all but the gold passes off. Excepting in very rich deposits, this method is not practiced to any extent. But as a means of testing the richness of a deposit, or the value of an ore, in the hands of a skilful manipulator, there is no test more reliable than that furnished by this simple instrument; and hence it is always in the hands of the gold-miner, whether he would trace up a vein, or know its value, when found.

Fig. 41.



Next to this, in simplicity, is the common rocker, (Fig. 41.) A portion of the auriferous matter, with some water, is placed in this, with one or two pounds of mercury; the machine is rocked backwards and forwards, until it is supposed that all the gold is taken by the mercury, when the other materials are thrown off, by a peculiar motion, not easily described, leaving the amalgam in the rocker. The amalgam is strained through a closely woven cloth, and well squeezed; this leaves the gold combined with some mercury, which is driven off by heat. About 20 bushels of ore may be washed, with such an implement as this, in a day.

Fig. 42.



The Burke rocker, (Fig. 42,) is an improvement on this. *a* is an iron plate, on which the ore to be washed is placed; *b* is a spout of water, pouring on, with considerable velocity; *c* is a perforated plate of sheet iron, the holes about half an inch in diameter, through which the finer parts fall into the riffle-box, below. B is the riffle-box, with shallow compartments, five inches apart. In the rocker its position is seen at *e*.

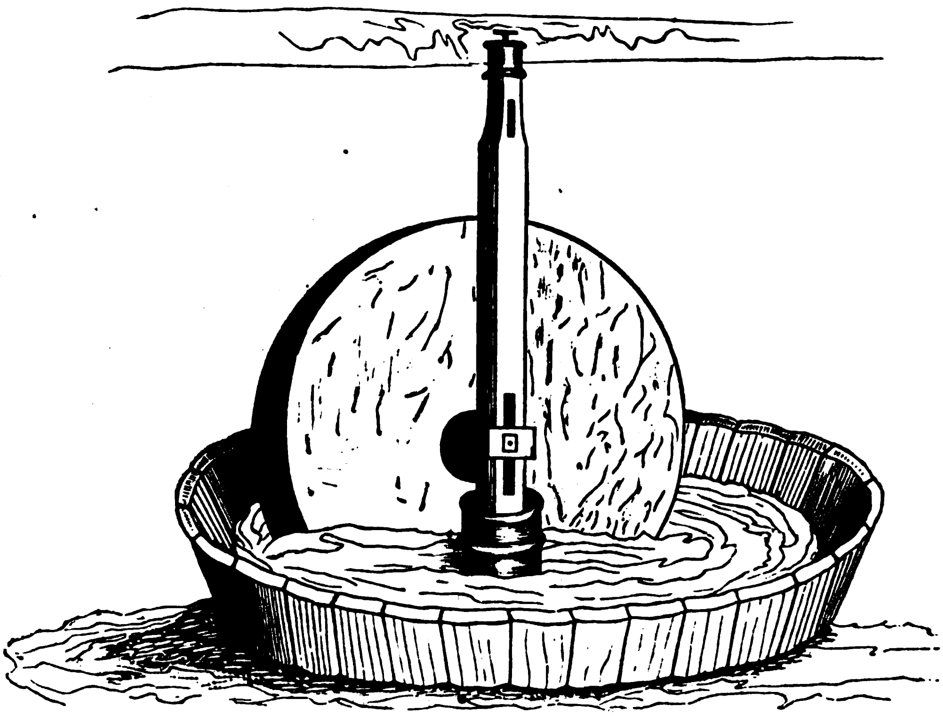
Mercury is placed in the compartments, and as the particles of gold pass over it, they are taken up. This machine, placed in an inclined position, is rocked by means of a lever, attached to the side, and is manipulated by a boy or girl; a second person being employed to throw on the ore, and remove the coarser gravel, &c. More than double the work of the preceding, can be accomplished by this machine.

There are some modifications of these, that scarcely deserve notice: such as a long simi-cylindric trough, with transverse grooves, in which the mercury is placed, and a stationary rocker, where the ore is washed by the force of a stream of water, and pushed along by the shovel. These are all the means used at the deposit mines.

The practice of working deposits over, after the lapse of some time, is common; and it does not follow that the previous working was imperfect, because gold is found. The iron pyrites which the beds contain, by exposure becomes oxydized, and gold is liberated.

The gangue in the veins requires crushing, and often a high degree of levigation, in order to liberate the gold. To accomplish this there are two or three machines in common use. Fig. 43 is the Chilian mill, which consists of a stone wheel, about five feet in diameter, and shaped like a millstone. This is fixed upon an axis, upon which it turns, very close to a vertical shaft, which also revolves. The floor is composed of hard stone, enclosed by staves, so as to retain the water and ore placed under the wheel. It is obvious that when this passes over the ore, an enormous crushing and grinding force is exerted; and, for very refractory ores, it is an excellent contrivance. Mercury is placed with the ore, in the mill, or the amalgamation takes place as the ground ore and water passes off.

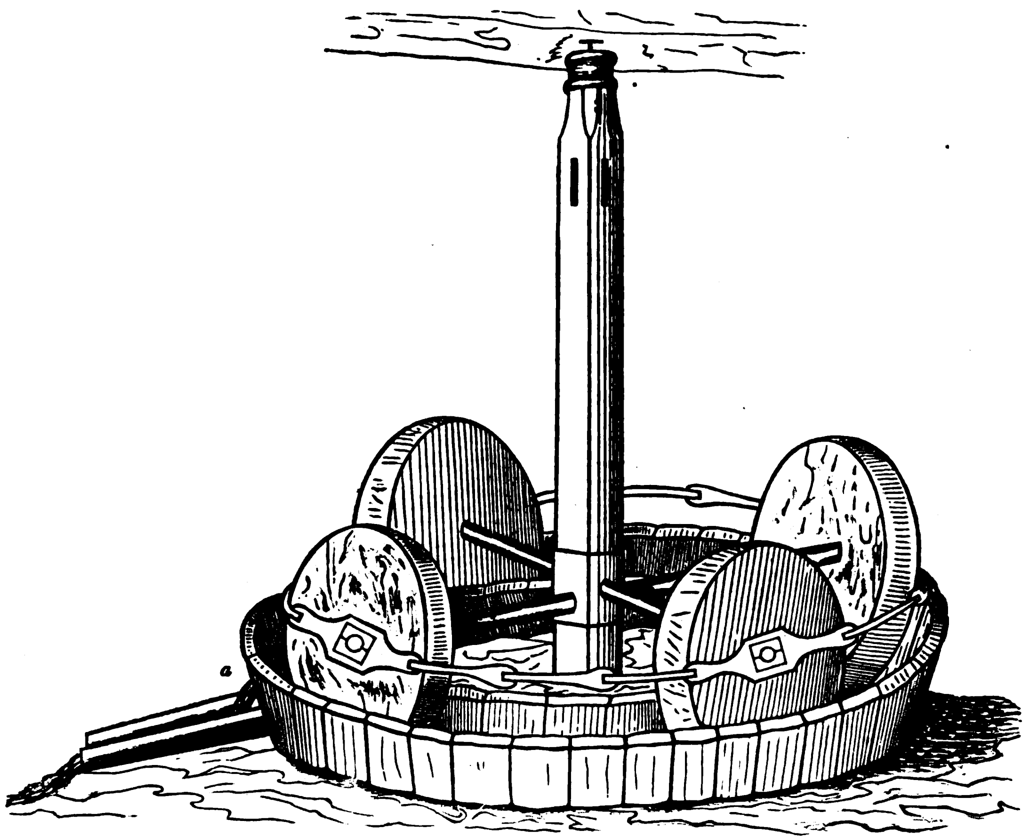
Fig. 43.



In this State what is supposed to be an improvement on this, is used.

Fig. 44 is a sketch of this machine, which consists of four cast-iron wheels, each weighing about 1500 pounds. They revolve in a circular trough, composed of four segments, weighing 3600 pounds. The wheels make from six to eight revolutions round the circle per minute, and grind, of ordinary ore, from fifty to seventy bushels a day. Six to eight pounds of mercury are used at a time, in the mill; a small stream of water flows into the trough, which carries off the fine matter, as the ore is ground. The ore is fed in by a man with a shovel. Some care is requisite to regulate the quantity admitted, and the velocity of the wheels. The water, as it escapes, passes over mercury, placed in the riffle-box, *a*, so as to catch any gold not taken up in the mill. Notwithstanding this, I have rarely examined the water, as it escapes from the riffle, without finding both mercury and gold.

Fig. 44.



In North Carolina I saw another contrivance appended to the mill: it consisted of an inclined table, with numerous grooves, containing mercury, over which the ground ore and water were made to meander; and finally, to pass over a sheepskin, which detained the last atom.

A scraper in front of the wheels, to stir up the ore, is a great improvement; for there is considerable difficulty in grinding some of the ores of Lancaster, in consequence of the fine quartz sand packing so closely as to allow the wheels to run over it, as on a road, without effect. An addition of this sort would do something towards removing this difficulty.

The gold is taken from the mills at the end of each day's work. The amalgam is placed in an iron retort, and the mercury driven off and collected, by placing the beak of the retort in water. The amalgam loses nearly one half in weight, by this process.

Fig. 45.

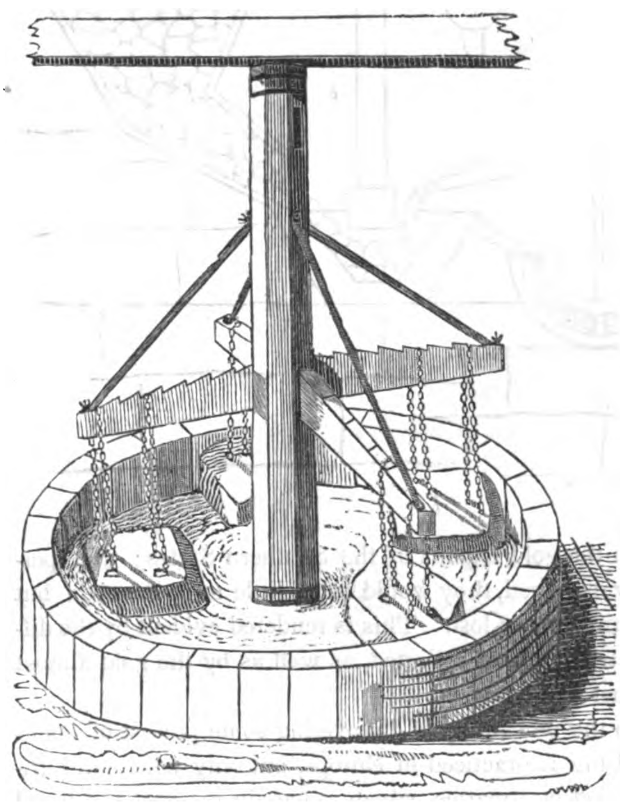
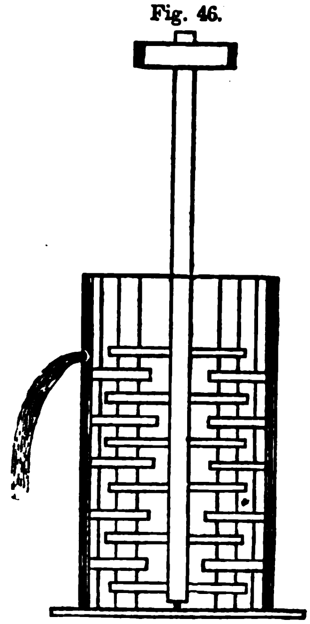


Fig. 45 is the Arastre. The principal parts of this machine consist of heavy blocks of hard stone, and a bed of the same material. The stones are attached to the arms by chains, as represented in the cut; and when drawn round imitate, very exactly, the force produced by the painter's muller and flag, used in grinding colors.

It is obvious that such a machine as this is best adapted to the grinding of rich pyritous ores, where the gold exists in minute particles, and is completely mixed with the gangue. The tenacious, slaty ores, in which the gold exists in a finely divided state, are also best managed in such a mill. Poor ores are best treated by other processes, where a large quantity can be ground in a short time.

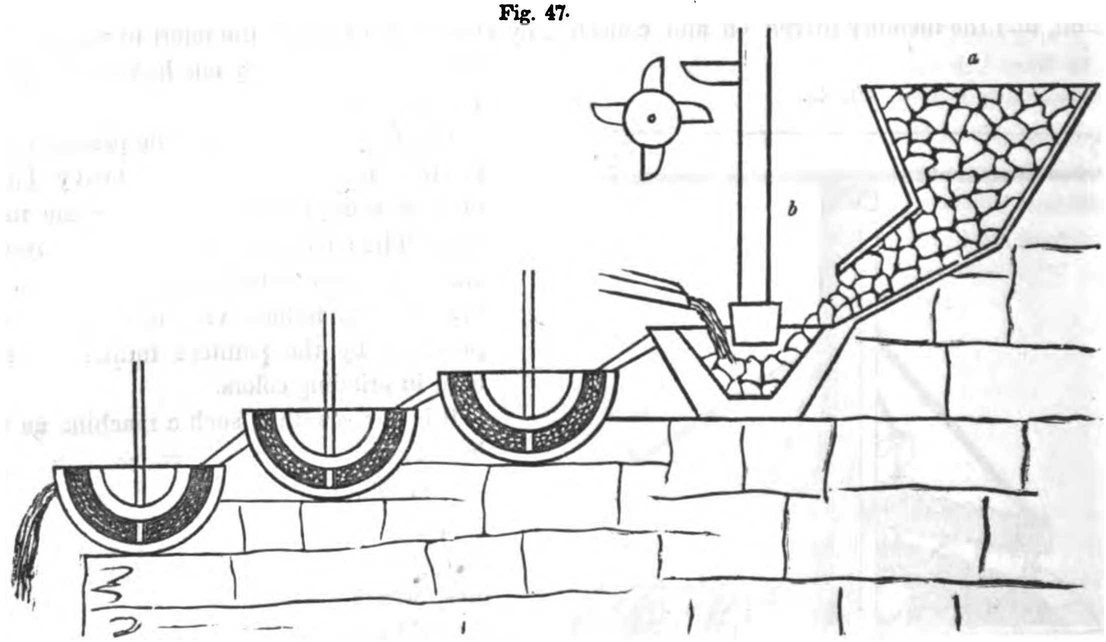
Fig. 46.



For amalgamating the gold, after grinding in the Arastre, a contrivance, represented in Fig. 46, was used in St. Catharine's Mill, North Carolina. The levigated ore was placed in the barrel, and a stream of water allowed to flow in. The central axle, with its arms, were made to revolve, by which means the whole is agitated. The finer particles pass off, and the gold falls down and is taken up by the mercury placed in the barrel.

Another machine remains to be examined, which was once in use in South Carolina, but now abandoned: I mean the Tyrolese Mill, (Fig. 47.) The ore was placed in the hopper, *a*, from which it passed to the stamps, *b*. After being crushed by the stamps, in contact with water, it passed into a series of bowls, one revolving within the other, and placed so that the ore could pass from one pair of bowls to the next, until the grinding and amalgamation was completed.

Fig. 47.



These are all the machines that are in use in the gold regions of the Southern States; and perhaps if they were well constructed and properly managed, they would leave little to be desired; but it is quite certain that a considerable portion of the gold is lost. This is rendered evident by the difference between all the assays made and the actual amount collected, as well as by the gold almost invariably found below the mill, and which must have escaped.

This has led some to direct their attention to the probability of discovering some process of smelting, which might obviate this difficulty. Smelting is practiced in Europe, but only with rich auriferous sulphurets. Those are roasted and melted into mattes, which are again roasted, and fused with lead; the gold is taken up by the lead, from which it is separated by cupellation. But even this is considered uncertain, and but little practiced. Poor iron ores, containing gold, have been smelted in the ordinary way, and the iron got rid of by conversion into sulphate of iron, which has a commercial value, and the gold remains.

Now there is no mine in the State where a pyritous ore, sufficiently rich or abundant, occurs to render this process at all available. There is, indeed, an iron ore in York District, which contains gold, where an experiment may be tried. But the proposition to smelt the ordinary ores of the State, consisting for the most part of quartz and talcose slates, and containing about fifty cents in the bushel, of the precious metal, need not occupy much space in the discussion.

It is not very easy to form a correct estimate of the productive value of the gold mines of the State, for assays of gold ores, in the small way, are not at all reliable, as every one knows, who has had any experience in the matter—and the specimens generally exhibited, give as fair a view of the mine as the single brick did of the city. I have, however, obtained from two mines statistics of some value in this relation.

From my own investigations I set the workable ores of the State down as containing from the 720,000th to the 60,000th part of gold. The former can only be worked where little mining and no grinding is necessary. The poorest ores worked at Brewer's mine are about equal to this. At many of the mines ore is worked that does not contain over the 200,000th part of gold.

Copper and silver are the only alloys found in the gold. Bismuth occurs native at Brewer's mine, and is taken up in the process of amalgamation, and fused with the gold; it is not, however, a native alloy. The fineness of the gold, at some of the principal mines, is presented in the following table—fine gold being 1000.

Gold from Hale's mine,	.929
" " Bogan mine,	.950
" " Blackman's mine,	.990
" " Fair Forest mine,	.818
" " Nott's mine,	.930

The force employed at the mines is very fluctuating, and somewhat dependent upon the prices of the staple crops of the State. At the Fair Forest mine there were, at my last visit, in operation two mills, employing eight hands and five mules. At Nott's mine a steam engine of 25-horse power is the moving force, and the grinding machinery consists of six stamps and four mills, that grind from 200 to 240 bushels of ore a day—employing thirty hands and sixteen horses. The product of this mine is about 50 dwts. of gold a day, on an average. 50 dwts. of gold, distributed among 200 bushels of ore, does not quite amount to twenty-five cents per bushel. I am satisfied that the ore contains more than this amount of gold, and that the waste sands will be worked over at some future time: still I believe that this represents pretty correctly the product of many of the mines.

The following statistics of Brewer's mine were politely furnished by Mr. Craig, the superintendent.

Force employed for six months, in 1844.

Hands,	170	Carts,	43	Rockers,	62
Horses and mules,	49	Wagons,	3		

Product in that time, $13,130.

Force employed from January 1*st to October* 18*th*, 1845.*

	January.	April.	July.	October.
Hands,	123	192	131	101
Horses and mules,	37	55	34	27
Carts,	33	46	30	25
Wagons,	2	2	—	—
Rockers,	29	48	29	21

The product for that time was $15,087. The total product of this interesting mine, from its discovery, in 1843, to October 18th 1845, was $53,580 71.

When I first saw it, in the Spring of 1844, ground was fairly broken, and there were about 200

* The force at the mine was reckoned up at the times here given.

hands employed; at my next visit, in 1846, it had been so torn up by the misapplied force of these men, that it was scarcely to be recognized. The system of letting portions of the mine to any one that applies is a most deplorable one—a fact of which the intelligent superintendent is fully aware, but can do no better. Twelve feet square of the mine is rented by one or two persons, who pay one fourth of what they make, as a rent. The consequence is, that there is no system, much less any concert, in the working—and certainly no view to future operations. It is easy to imagine the rest, where so many men are employed under such a system.

With regard to mining operations, some improvement has taken place, within the last two years, but they are yet very defective. Many suppose that mining, in the proper sense, must be expensive; the preliminary operations appear more so than sinking into the ore at once, but it soon becomes evident, that mining has for its object the production of the greatest useful effect with the least labor and expense.

In conclusion, the statistics here given of two important mines will give a more correct view of the economic value of the gold mines of the State, than any general representations that I could present. Between speculation, and consequent exaggeration, on one side, and disappointment and disgust on the other, it is difficult to arrive at the truth.

I think it may now be fairly stated, that while as industrial resources they will yield a fair remuneration, when worked with industry, perseverance and skill, it is folly to resort to them with a view of getting suddenly rich, and still worse to purchase them at an enormous price. A rich pocket is indeed sometimes found, as was the case at Nott's mine, where $3000 were extracted from 11 bushels of ore, but such an instance did not occur again in the State.

Employments where the remuneration is uncertain, exert an injurious influence on the habits of those so employed, but the State presents one example of a mine worked steadily, and for a series of years, as any other ordinary employment; I allude to Hale's mine, which has been explored, I believe, with profit, and without any bad effects on the operatives.

Of the other Metals found in the State.

Manganese.—I have pointed out the localities of this mineral, which is used in the arts, for removing the tint imparted to glass by iron, but most extensively in the preparation of chlorine of lime, or bleaching-powder. For this purpose, a mixture of salt, sulphuric acid and manganese, is placed in a large retort, to which heat is applied. Chlorine is liberated and conveyed into a chamber provided with shelves, that are covered with a few inches in thickness of lime. The chlorine is absorbed by the lime, which is now put up in barrels for use. The price of oxide of manganese is from $25 to $30 per ton.

Lead.—This metal occurs in the form of galena or sulphuret of lead in Cheochee valley, but only in sufficient quantity to be mentioned among the minerals of the State. It is also found at Parson's Mountain, as a phosphate, in small quantities.

Copper.—The most prominent indications of this metal occur at the Harman mine: it forms, by the spontaneous decomposition of copper pyrites sulphate of copper, which is seen in the refuse of the heaps at the mine. I have marked on the map the other localities.

Bismuth.—Both native, and in the form of ochre, is found at Brewer's mine.

Graphite or Black Lead.—I have met with but one locality of this substance, and that is in Spartanburg, in the N. E. corner of the District. It has been used at the iron works, on the machinery, and is said to answer well. No excavation has been made, and it is difficult to say of what extent it may be.

Oxide of Titanium.—This mineral occurs in considerable quantity in Cheochee valley, and may be collected where gold deposits are worked; it is used in the manufacture of artificial teeth, for imitating the natural color.

Sulphuret of Iron.—This mineral is found at many of the gold mines; at Hale's it is thrown out in heaps, and forms by decomposition, sulphate of iron, or copperas. On Brass Town creek, Pickens district, it is also found in this last state, mixed with sulphate of alumina.

Building Materials.

In building materials, durability and strength, combined with a certain facility of being formed into requisite shapes, are the principal requisites.

In these respects, limestone and granite stand pre-eminent. Limestone is very durable, and resists external agencies remarkably well.

The white crystalline limestones of Laurens and Spartanburg, if they were more accessible, would be prized for ornamental purposes. At the Limestone Springs some blocks have been saved, that prove the excellence of the stone at that locality. The color is white, with reddish streaks. In choosing granite, the tendency to decay should be examined closely. Where it has been long exposed to the weather, if the felspar has lost its lustre and become dull, it should be rejected, especially if it absorbs moisture, or contains pyrites. The fine grained granite of uniform appearance and structure is to be preferred, where strength and durability are prominent objects. The granites around Columbia are of this character. There is a granite in Newberry that possesses all the requisites of an excellent building material. In color and appearance it resembles, when dressed, a coarse gray marble; it may be split with ease into prisms of any dimensions, and it is worked with great facility. This beautiful granite cannot surely remain long unknown.

There is little or no expense incurred in quarrying, for immense masses appear above the surface, from which slabs are split off by means of wedges.

The sienites of Abbeville, Fairfield, and Lexington, would make excellent building materials. The Abbeville sienite can scarcely be distinguished from the Quincy granite.

The porphyritic granite, near Camden, is the most beautiful that I have seen, and if a cheap means of sawing and polishing it could be devised, it would make an elegant ornamental stone.

Gneiss, also, furnishes a good building stone, and the coarse soap stones have also been employed with success; they are durable and easily worked. The silicious rock into which clay slate passes, on Stevens' creek, is broken into cubic blocks, and would furnish a good material. The tertiary formation also furnishes some beds that may be used in construction.

The white felspathic sand stone, and grits of the Buhrstone formation, have been long known, in Columbia, as a building stone. It has been quarried to some extent at Platte's springs, and it occurs in abundance on Little Horse creek, Edgefield. It is, however, but a poor material, as it is subject to crumble and exfoliate, especially when the finer varieties are chosen. A coat of paint or oil would protect it very much, but in all cases the coarser silicious stones should be used, as they are far more durable.

There is a fine silicious clay also in the buhrstone, which becomes quite hard and cherty, and for durability is unsurpassed. It is very light, and generally, when taken from the quarry, so soft as to be readily cut with the axe. I have seen chimnies, in Lexington, that have stood for 20 years, and the angles are now as sharp, and the impressions left by the chissel as fresh, as when they were put up. To stand great pressure, this rock would require accurate dressing, as it is not very strong.

From an analysis by Professor Shepard, its composition appears to be:

Water,	9.00
Silica,	77.50
Alumina,	2.30
Protoxide of iron,	9.90
Carbonate of lime,	1.30
	100.00

I am inclined to think that the moderately hard marls of the Tertiary would also answer very well for certain architectural purposes, and I mentioned, in another place, that they had been applied.

In Clarke county, Alabama, a white marl, much softer than that on the banks of the Ashley, is used for the construction of chimnies very generally. It resembles exactly the white Eocene marls of this State. It is so soft when first quarried, as to be cut with the drawing knife, and even planed; and what is more remarkable, it stands fire admirably, provided that no water be thrown upon it while hot.

As the mode of quarrying it is peculiar, it may be worth while to describe it. The face of the bluff, selected for the quarry, is cut into vertical pannels; the projecting portions being of the proper thickness for the blocks required, and as long as can be conveniently cut with a cross-cut saw. A small stream of water, from a barrel, is allowed to trickle down on the saw, which keeps it from clogging. When the slab is sawed, it is laid flat on the ground and cut, in the same manner, into blocks of the requisite size. The length should not exceed double the thickness. The blocks are now dressed, and piled up loosely, and protected from rain, by a temporary covering; after a partial drying of this sort, they are ready for the mason. Any of the marls of the State, that are free from hard fossil shells, and sufficiently coherent to remain together, will answer for an experiment, which I trust some one will try.

There is found in the sand hills a bed of ferruginous sand stone, which is very durable, because the iron is all peroxidised; it is rough in appearance, but when dressed, forms a good material. In Fayetteville, N. Carolina, it is used extensively, and is even ornamental.

Flagstones.

Good flagstones are, in cities, of considerable value; I observed, in the Charleston Market House, flags that were imported from Yorkshire, England. These were transported by land, and canal, before they were shipped, a distance nearly as great as that from Charleston to Edgefield, where flagstones equally good may be found. Flagstones, besides being durable, must split so as to leave smooth surfaces, that need little, if any, dressing. I have pointed out numerous localities, where the rocks present these conditions. The slaty gneiss of Edgefield; the talcose slates of Ruff's Mountain, if they should be found sufficiently silicious; the mica slates of York, near the Catawba; and those in Fairfield, on Dutchman's creek, may be mentioned as favorable and accessible localities.

There is a slaty rock passing into soapstone, along the King's Mountain range, that can be procured in large slabs; specimens may be seen in the church yards of the upper part of York, where it is used for tablets, and its dark gray and sombre color renders it conspicuous.

Although there has not been a quarry opened in the State, for procuring flagstones, with a single exception, in Greenville, I am persuaded that any demand could be supplied.

Fire Proof Materials.

Those acquainted with the manufacture of iron, know the importance of a supply of materials that resist the destructive influence of intense heat. For furnace hearths, there is no material equal to granular quartz, and the more granular the better. The King's Mountain range furnishes the best specimens of this rock, in the State, and localities are well known at the Iron Works. Next to this, in refractory properties, stands fire clay, which is found side by side with the quartz rock and iron ore, in a bed of some thickness; it is derived from the decomposition of felspar. It has been made into brick, in York, and although formed in the ordinary way, I was told that they answered very well for the lining of the furnaces at the Iron Works.

Fire bricks, however, require another operation; they are first made and burned in the ordinary way; these are pulverised, and sifted so as the largest particles may not exceed buckshot in size; this is mixed with the clay, and some clean quartz sand; and from it the bricks are moulded and burned.

Soapstone, talcose and mica slates, answer very well for resisting ordinary degrees of heat, and may be used for the lining of limekilns, &c. The less silicious they are the better.

Soapstone has, of late years, assumed considerable importance in the arts. It is used in lining stoves, fire-grates, culinary furnaces, &c., and is sent from N. England, to every part of the country, The soapstone of this State, as I have shown, is abundant and of fine quality, yet it has no where been explored.

There is a peculiar rock in the lower part of Edgefield, which stands fire very well; it resembles soapstone, but is evidently altered trap; it is of a reddish color, and when sawed, presents a handsome appearance.

Materials for Pottery.

I have in the body of this report mentioned particularly the localities of porcelain clay, which abounds in the buhrstone formation. The manufacture of fine porcelain requires the highest degree of skill, and considerable capital; but stone ware, and the better sorts of common pottery, could be manufactured profitably at any of these localities; and I deem it quite a favorable circumstance, that some of the best deposits of this clay occur on the lands of the Graniteville Manufacturing Company, and in the vicinity of their works.

A fine bed, entirely free from iron, is found north of Hamburg; the same may be said of the beds on Congaree creek. Enormous quantities occur in the sand hills near Graniteville; and what is very interesting, there are also beds of pure white quartz sand, that will be valuable, should the clay ever be used for pottery. The less pure varieties will make fire bricks and if the finer porcelain clay be not used, it may be exported, as it is but a few miles from the Savannah.

In Cornwall and Devon, where, according to De la Beche, a vast amount of this clay is annually exported, it is known in two forms, that in which it requires no preparation, being the fine clay without quartz grains, and deposited from suspension in water, this is called natural china clay; and the other, which is prepared as I am about to describe, is called artificial china clay. Near the deposit of clay, 2 or 3 broad shallow tanks are arranged, so that the water from one may flow into the next. Above the first, a short inclined plane is placed, and a trench leads from it to the tanks, which are called catch-pits. A portion of the clay is placed on the plane, and a stream of water conducted to the spot, is made to fall on it, which washes it down to the trench and into the tank, where the quartz grains subside, the finer particles being carried forward to the next pit. The clay, however, is not allowed to rest, till it reaches the last pit, when it has parted with all the quartz. The water, when clear, is drawn off, at plug-holes. When the tank, by repetition of this process, becomes filled, all the water is drawn off, and when the clay is so dry as to be cut into cubic blocks, it is taken out and dryed in sheds, and is then ready for the market.

When the clay is free from sand and impurities, all that is necessary, is to excavate and dry it. Of the artificial variety, seven or eight thousand tons are exported annually, from these works. It appears that from the south-west of England, materials used in the potteries are exported annually, to the value of $250,000.

The process that I have described is simple and not expensive. The decomposing grits of Platte's Springs could be washed in this way, if better sources of the clay did not occur.

Fire bricks are sold in Boston at from $5 to $6 per hundred. Would it not be worth while to attempt the manufacture here?

For glazing pottery, there are abundant materials in the felspar of the coarse granites, and even in the eurite of the slate.

The bed of silicious clay of the buhrstone, will furnish a material of value in the manufacture of pottery.

Materials for Millstones.

The beds of silicified shells, of Barnwell, will furnish an excellent material for this purpose. Pieces may be found that agree exactly with the French buhrstone, but those who have attempted to procure millstones at this locality, have committed a great mistake in trying to get them in one piece. Every one knows that French burr mill stones are made up of from 16 to 20 pieces, cemented and bound together with iron hoops.

By properly selecting the pieces, very excellent millstones may be procured at this place. The principal locality occurs on Cedar creek, within a few miles of the rail road.

There is above Dean Swamp, Orangeburg, a bed of close grained silicious rock, also belonging to this formation, which is explored for millstones, but nearly all those that are not imported are procured from the coarse granites.

Materials for Paints.

A very fine yellow ochre of a rich color and fine quality is found in a deep ravine at Lang Syne, in Orangeburg. I showed this to several artists, who pronounced it equal, if not superior, to the best English or French ochres. Red and yellow ochres are abundant in Chesterfield, and localities are known throughout the lower beds of the Eocene. The Orangeburg ochre needs no preparation, but ochres, in general, require to be separated from the sand with which they are mixed. For this purpose the best process is that I described for the preparatian of China clay.

Soapstone is often ground with whale oil, as a paint for common purposes, and especially for the roofs of houses, it is said to answer well. The fine soapstone associated with the magnetic ores, and that at Brewer's mine, furnish all that can be desired for this purpose.

Materials for Glass Making.

The white, arenaceous quartz, found associated with the talcose slates, will serve for this purpose; but the auriferous decomposed hornstone of Brewer's mine, presents the most convenient material, as it is already pulverized. There are also very pure sands in the Tertiary beds, near Aiken, that would answer well.

Materials for Whetstones and Grindstones.

In the clay slates there are many localities, in Edgefield, where good whetstones are found. Among the talco-micaceous slates coarser stones occur, approaching scythe-stones. The fine grits of the New Red sandstone, of Chesterfield, are sometimes used for grindstones; and there are beds of fine grit, in the Fork of Saluda, that would answer the same purpose. The South is every where supplied with all these things from the North.

As a general rule, it is better for the industrial pursuits of a people to be confined to the production of those things that are best suited to their soil, climate or circumstances; but there are some things that can be as well produced in one place as another, and I apprehend that there are hundreds of persons in the State, whose industry would be quite as productive, if engaged in lime burning, in the preparation of porcelain clay, or the manufacture of fire-brick, as it is in planting.

Mineral Springs.

The geological character of the State is unfavorable to the existence of springs of very prominent mineral properties; nevertheless there are some that have acquired considerable notoriety for medicinal virtues: among these the most noted are Glenn's Springs, in Spartanburg District. The water of these springs is strongly charged with salts of lime. Their location is a pleasant and salubrious one, and the springs are much resorted to by visitors from the lower parts of the State. Not far from this there is a chalybeate spring, known as West's Springs.

Chick's Springs, a few miles above the village of Greenville, are pleasantly situated, in sight of the mountains, and within a pleasant ride of the village. The water resembles that at Glenn's Springs, but is not so strongly impregnated.

There are, in Abbeville District, in the Flat-woods, and near Parson's Mountain, saline and chalybeate springs, but they are not places of resort. There is another spring in the eastern side of the District, at Pinson's Ford, near Dr. Jones's, which is also chalybeate and saline, and deserves a trial.

In Laurens there are three or four highly chalybeate and sulphureous springs. They occur in the hornblende slates that extend from the Saluda to the Enoree, north of the village, and are worthy of notice.

A few miles above the village of Spartanburg a spring occurs that has some reputation, and is a place of some resort.

Another spring of similar character, is found at the foot of the Estatoe mountains, in the upper part of Greenville, at Mr. Barton's. This is a pleasant spot for the ramblers among the mountains to rest, as it is an easy ride to Table-rock.

There are few places where persons in search of health or pleasure could spend a month or two more pleasantly than among the mountains of the State. They commit a great mistake who imagine that, by skipping to the top of Table-rock, with the aid of Mr. Sunderland's steps, and from thence run across to Cæsar's Head, they have exhausted the beauties of this region.

Let them commence at the Limestone Springs, where a day or two may be pleasantly spent in visiting Gilkey's Mountain, from the top of which there is a fine view, and in examining the iron works. Some of the islands in the river must also be examined. Crossing the river, and proceeding up the mountain, on the York side, till they reach its peak, just over the North Carolina line; where, looking from the ruggid top of that fearful escarpment, a scene will present itself, not readily to be forgotten. Returning by way of the Battle-ground, a simple stone will be found, recording the names and marking the resting places of the brave, who fell on the side of Liberty. From this, Broad River must be re-crossed, to the Cowpens, where relics of the strife of that field may yet be picked up. At and near the furnace there are many picturesque spots, as well as a chalybeate spring. Proceeding westward, till Hog-back, Glassy, and some of the peaks of the Saluda mountains are seen lifting their sublime forms above the horizon, in the gray distance, no better guides will be wanted till the base of Glassy is reached. Taking an obscure path from the road, if the tourists have sure-footed horses they may ride to the top; if not, it must be accomplished on foot. This should be early in the morning, for many a temptation to linger will be presented, in the shady dells and other beautiful spots on the way upwards. Many a sparkling, playful little stream will beckon them from their path, to witness its daring leap, as it starts on its downward journey to its great home, the ocean.

In the midst of the pleasant thoughts that will occupy them here, they must not startle that the first sign of man's presence, in this lonely place, should be a distillery; for the next person they meet will demonstrate that it was the only means of condensing the crop, so that it may be sufficiently portable to be carried to market, where there are no roads.

From the top of the mountain the view is beautiful. The distance to Hodge's is but short; and here a week or a fortnight must be spent. The falls of the Saluda, three or four hundred feet in height, are almost in sight, and scarcely a rivulet that meanders among the Rododendrons that does not present a little picture of its own, well worth the finding. After they have examined this place to the right and left, if they do not heartily pity those who pass, with rail-road speed, through this wonderful gap, I am greatly mistaken.

Our ramblers will next ascend to Poinsett's Spring, where I am sure they will admire the good taste and simple beauty of that fountain; and if they have walked up, they will bless the man that was thus mindful of the way-worn traveller. Mr. Burton, at the toll-gate, will conduct them to the top of Walnut Mountain. Of the scene that presents itself here, I can only say that if, after beholding it, they do not return more humble and better men, they need proceed no farther.

After spending a few days here, the base of the Saluda Mountains must been circled, to the south prong of Saluda, where, at an old mill, close to the mountain side, they will be repaid for the journey across, by the sight of a water fall of great beauty, brought out against the dark shadows of the hemlocks that overhang the banks. The journey, between this and Cæsar's Head, is not wanting in interest and beautiful views. From the top of the Head, every one knows how magnificent is the scene, but it is at sunset, when Table Rock stands out against its glorious back ground of mountains, that it is most impressive.

The distance to Table Rock is but a few hours' ride. On the way, our travellers may amuse themselves with reflections on the stupenduous force that severed at this point the mountain, leaving Cæsar's Head and Table Rock, fit monuments to attest the event.

At Table Rock, they will be in the hands of the veteran guide, Mr. Sunderland, with whom I will leave them, with the assurance, that however high conceptions they may have formed of this noble rock, they will not be disappointed. From the rock to Mr. Barton's hospitable abode, is but a short distance, and from this point, the wild scenery of the Estatoe Mountains must be visited. After this they will receive a hearty welcome from the Kennys, who will conduct them to the celebrated Jocassa valley. They will see here, on the tops of the mountains, forming vast walls, an extension of the stratum seen at Table Rock. The White water, meeting with this in its course, and tired of the slow process of cutting a channel through it, fairly clears it at a bound, forming one of the finest water falls of the South. Tomassie, and the quiet scenery of Pickens, may close the ramble, as they turn their faces homeward, their minds, I trust, filled with pleasant remembrances of this most beautiful region.

APPENDIX.

CATALOGUE

OF THE

FAUNA OF SOUTH CAROLINA.

I. DIVISION. VERTEBRATED ANIMALS.

An internal osseous skeleton. Organs of the functions of relation symmetrically placed about a vertical median plane. Nervous system, composed of a cerebo-spinal axis, and nerves.

I. SUBDIVISION. VIVIPAROUS.

Young brought forth alive, and suckled. Lower jaw articulated directly with the skull. Occiput articulated with first vertebra, by two distinct condyles. Diaphragm complete.

I. CLASS. MAMMIFERA.

Breathe by lungs, respiration simple. Temperature constant, not depending on that of surrounding medium, warm-blooded. Circulation complete, heart with four cavities. Vertebræ with anterior and posterior surfaces flat or slightly concave. Body generally clothed with hair.

I. ORDER. QUADRUMANA.

Limbs four, terminating in hands, with nails. Frugivorous, teeth of three kinds, incisors, canines, and molars. Monkeys, &c. None of this order in South Carolina.

II. ORDER. CARNIVORA.

Limbs four, terminating in feet, with nails. Carnivorous, teeth of three kinds, molars trenchant.

1. Ursus	Lin.	
1. americánus	Pall.	Black Bear.
2. Prócyon	Storr.	
2 lótor	Lin.	Raccoon.
3. Mephítis	Cuv.	
3. chinga	Tied.	Skunk.
4. Mustéla	Lin.	
4 ermínea	Lin.	Weasel.
5. Putórius	Cuv.	
5. víson	Lin.	Mink.
6. Lûtra	Storr.	
6 canadénsis	Sab.	Otter.
7. Cânis	Lin.	
7 lûpus	Lin.	Wolf.
8. Vûlpes	Cuv.	
8 virginiánus	Schr.	Fox.
9. Lynx	Raf.	
9 rûfus	Guld	Wild Cat.
10. díscolor	Lin.	Panther.

III. ORDER. AMPHIBIA.

Limbs four, short, formed for swimming, with nails. Carnivorous, teeth of three kinds, molars trenchant. Seals, &c. None in South Carolina.

IV. ORDER. CHEIROPTERA.

Limbs four, formed for flying, by a membranous expansion of skin between the limbs, and between the fingers, with nails. Insectivorous (in So. Ca.) or frugivorous (not in So. Ca.) Teeth of three kinds, molars not trenchant.

8. Vespertílio	Lin.		9. Nyctíceus	Raf.	
11. carolinénsis	Geof.	Leather wing Bat.	17. pruinósus	Say.	
12. subulátus	Say.		18. noveboracénsis	Penn.	Red Bat.
13. montícola	Bach.		19. crepusculáris	Lec.	
14. virginiánus	Bach.		20. Molóssus	Geof.	
15. nigréscens	Bach.		20. carolinénsis	Geof.	
16 noctívagans	Lec.		11. Plecótis	Geof.	
			21. macrótis	Lec.	Long-eared Bat.

V. ORDER. INSECTIVORA.

Limbs four, terminating in feet, with nails. Insectivorous, teeth of three kinds, molars not trenchant, but studded with conical points. Animals fossorial.

12. Sórex.	Lin.	Shrews,	13. Condylúra	Ill.	
22. brevicáudis	Say.	generally but improperly, called Field-Mice.	26. cristáta	Lin.	Starnosed Mole.
23. cinéreus	Bach.		14. Scálops	Cuv.	
24. carolinénsis	Bach.		27. aquáticus	Lin.	Common Mole.
25. longiróstris	Bach.				

VI. ORDER. RODENTIA.

Limbs four, terminating in feet, with nails. Food generally fruits, roots, bark, &c. teeth of two kinds only, incisors and molars, the last with flat crowns.

15. Sciúrus	Lin.		19. Arctomys	Gm	
28. capistrátus	Bosc.	Fox Squirrel.	40. mónax	Lin.	Woodchuck.
29. carolinénsis	Gm.	Grey Squirrel.	20. Meríones	F. Cuv.	
16. Támias	Ill.		41. canadénsis	Penn.	Jumping Mouse.
30. Lísteri	Ray.	Ground Squirrel.	21. Arvícola	Lac.	
17. Ptéromys	Cuv.		42. pinetórum	Lec.	Pine Mouse.
31. volucélla	Gm.	Flying Squirrel.	22. Sígmodon	S. & O.	
18. Mus.	Lin.		43. híspidum	S. & O.	Cotton Rat.
32. ráttus	Lin.	Black Rat.	23. Neótoma	S. & O.	
33. decumánus	Lin.	Norway Rat.	44. floridána	S. & O.	Wood Rat.
34. músculus	Lin.	House Mouse.	24. Fíber	Ill.	
35. húmilis	Bach.		45. zibéthicus	Lin.	Musk Rat.
36. oryzívora	Bach.		25. Lépus	Lin.	
37. carolinénsis	Bach.		46. palústris	Bach.	Swamp Rabbit.
38. leúcopus	Raf.		47. sylváticus	Bach.	Common Rabbit.
39. auréolus	Bach.				

VII. ORDER. EDENTATA.

Limbs four, terminating in feet, with large nails. Insectivorous or herbivorous; teeth incomplete, incisors always wanting; in some, the canines and molars also. Armadillo, Anteater, &c. None in South Carolina.

VIII. ORDER. PACHYDERMATA.

Limbs four, terminating with feet, with hoofs. Herbivorous generally, not ruminating, teeth variable. Elephant, Hog, Horse, &c. None in South Carolina.

IX. ORDER. RUMINANTIA.

Limbs four, terminating with feet, with hoofs. Herbivorous, ruminating, stomachs four. Teeth incomplete, incisors wanting in upper jaw, canines generally wanting. Head generally with horns.

26. Cérvus	Lin.	
48. virginiánus	Gm.	Deer.

X. ORDER. CETACEA.

Limbs two, the anterior only existing, formed for swimming, finlike. Tail forming a horizontal fin. Body pisciform.

27. Delphînus	Lin.	
49. phocoéna.	Lin.	Porpoise.

XI. ORDER. MARSUPIALIA.

Limbs four, terminating in feet, with nails. Young born very imperfect, and received into an external abdominal pouch, where they attain the perfect state. Pelvis furnished with marsupial bones.

28. Didélphis	Lin.	
50. virginiánus	Penn.	Opossum.

The following Mammifera formerly existed in South Carolina, but have become extinct.

Cástor fîber	Buff.	Beaver	now found west of Alleghany Mountains.
Cérvus strongylóceros	Schr.	Elk	" " M'ts. from Penns. to Pacific.
Bos americánus	Gm.	Bison	" in plains of Rocky Mountains.

2. *SUBDIVISION. OVIPAROUS.*

Young produced from an egg, not suckled. Lower jaw articulated indirectly with the skull by means of an intermediate bone. Occipital bone never articulated with first vertebra by two distinct condyles. Diaphragm rudimentary.

2. CLASS. BIRDS.

Breathe by lungs, respiration double, the air permeating not only the lungs, but all parts of the body. Temperature constant, not depending on that of the surrounding medium, warmblooded. Circulation complete, heart with four cavities. Vertebræ with anterior or superior surface concave, posterior convex. Occipital bone with a single condyle. Body clothed with feathers.

I. ORDER. RAPACES.

Terrestrial. Beak and claws powerful, hooked. Carnivorous.

1. *Family Diurnal.* Eyes lateral.

1. Cathártes	Ill.	Turkey Buzzard.	
1. aúra	Lin.	Red headed	Res.
2. atrátus	Wils.	Black headed	Res.
2. Búteo	Bech.		
3. boreális	Gm.	Hen Hawk.	Res.
4. lineátus	Gm.	Chicken Hawk	Res.
3. Haliætus	Sav.		
5. Washingtoni	Aud.		
6. leucocéphalus	Lin.	Bald Eagle	Res.
4. Pándion	Sav.		
7. haliætus	Lin.	Fish Hawk	Res.

5. Elanus	Sav.		
8. díspar	Tem.		
6. Ictínia	Viel.		
9. plûmbea	Gm.		
7. Nauclérus	Vig.		
10. furcâtus	Lin.	Swallowtailed H.	
8. Fálco	Lin.		
11. peregrínus	Gm.		Win.
12. columbárius	Lin.	Pigeon Hawk	Win.
13. sparvérius	Lin.	Sparrow Hawk	Res.
9. Astur	Cuv.		Win.
14. Coóperi	Bon.		
15. fûscus	Gm.		
10. Círcus	Bech		Res.
16. cyáneus	Lin.		

2. *Family Nocturnal.* Eyes looking forward.

11. Sûrnia	Dum.		
17. nyctea	Lin.	White Owl	Win.
12. Strix	Lin.		
18. americána	Aud.	Barn Owl.	Sum.
13. Syrnium	Sav.		
19. nebulósum	Lin.	Hooting Owl.	Res.
14. Bûbo	Cuv.		
20. virginiánus.	Gm.	Horned Owl	Res.
21. ásio	Lin.	Screech Owl	Res.
15. Otus	Cuv.		
22. brachyótus	Flem.	Shorteared Owl.	Win.

II. ORDER. PASSERINÆ.

Terrestrial. Birds not possessing the characters assigned to the other orders, insectivorous, frugivorous or granivorous.

1. *Family.* *Dentirostres.* Beak notched near the tip, variable in form.

16. Lánius	Lin.		
23. ludoviciánus	Lin.	Loggerhead	Res.
17. Muscícapa	Lin.		
24. tyránnus	Lin.	King-bird	Sum.
25. crinita	Lin.		
26. Coóperi	Nutt.		
27. acádica	Gm.		
28. fúsca	Gm.		
29. vírens	Lin.		
30. ruticílla	Lin.		
18. Culecívora	Swa.		
31. cærûlea	Lath.		
19. Víreo	Viel.		
32. flávifrons	Viel.		
33. solitárius	Viel.		
34. noveboracénsis	Gm.		
35. gílvus	Viel.		
36. Bártrami	Swa.		
37. oliváceus	Lin.		
20. Ictéria	Viel.		
38. víridis	Gm.		
21. Bombycílla	Bris.		
39. carolinénsis	Bris.	Sealing Wax Bird.	
22. Myiodióctes	Aud.		
40. mitrátus	Lath.		
41. Wílsoni	Bon.		
23. Sylvícola	Swa.		
42. coronáta	Lath.		
43. striâta	Lath.		
44. pénsilis	Lath.		
45. castánea	Wíls.		
46. ícterocéphalus	Lath.		
47. pínus	Lath.		Res.
48. vírens	Lath.		
49. cærûlea	Wils.		
50. Blackbûrniæ	Lath.		
51. æstiva	Gm.		
52. petéchia	Lath.		Win.
53. americána	Lath.		
54. canadénsis	Lin.		
55. maculósa	Lath.		
56. díscolor	Viel.		
24. Tríchas	Swa.		
57. marylándica	Lin.		
25. Mniotílta	Viel.		
58. vária	Lin.		
26. Helináia	Aud.		
59. Swaínsoni	Aud.		
60. vermívora	Lath.		
61. protonotárius	Lath.		
62. chrysóptera	Lin.		
63. Báchmani	Aud.		
64. peregrína	Wils.		
65. solitária	Wils.		
66. celáta	Say.		Win.
67. rubricapílla	Wils.		
27. Régulus	Cuv.		
68. sátrapa	Lich.		Win.
69. caléndula	Lin.		Win.
28. Siália	Swa.		
70. siális	Wils.	Bluebird	Win.

29. Orpheus	Swa.		
71. polyglóttus	Lin.	Mockingbird.	Res.
72. carolinénsis	Lin.	Catbird.	Res.
73. rúfus	Lin.	Thrush.	Res.
30. Túrdus	Lin.		
74. migratórius	Lin.	Robin.	Win.
75. mustelinus	Gm.		
76. Wilsoni	Bon.		
77. solitárius	Wils.		Win.
31. Anthus	Bech.		
78. ludovíciánus	Lich.		Win.
32. Seiúrus.	Swa.		
79. auricapíllus	Lin.		
80. noveboracénsis	Gm.		
33. Troglódytes	Cuv.		
81. ludovíciánus	Gm.		Res.
82. Béwicki	Aud.		
83. americánus	Aud.		Win.
84. hyemális	Viel.		Win.
85. palústris	Wils.		Res.
86. brevirόstris	Nutt.		Win.

2. *Family.* *Fissirostres.* Beak, short, broad, flat, opening wide.

34. Hirúndo	Lin.		
87. purpúrea	Lin.	Purple Martin	Sum.
88. bicolor	Viel.	Whitebellied Swallow	Sum.
89. rústica	Lin.		Sum.
90. ripária	Lin.	Sand Martin	Sum.
91. serripénnis	Aud.		Sum.
35. Chætúra	Steph.		
92. pelásgica	Lin.	Chimney Swallow	Sum.
36. Caprimúlgus	Lin.		
93. carolinénsis	Gm.	Chuck-Wills-Widow	Sum.
94. vocíferus	Wils.	Whippoorwill	Sum
37. Chordéiles	Swa.		
95. virginiánus		Night Hawk	Sum.

3. *Family.* *Conirostres.* Beak, conical, strong, without notches.

38. Alaúda	Lin.		
96. alpéstris	Lin.		
39. Párus	Lin.		
97. bicolor	Lin.	Chicadee	Res.
98. carolinénsis	Aud.		Res.
40. Emberíza	Lin.		
99. americána	Gm.		Sum.
100. graminea	Gm.		Wint.
101. savána	Wils.		Win.
102. passerína	Wils.		
103. Hénslowi	Aud.		Win.
104. pusílla	Wils.		Win.
105. sociális	Wils.		Win.
41. Niphœa	Aud.		
106. hyemális	Lin.	Snowbird	Win.
42. Spíza	Bon.		
107. círis	Tem.	Nonpareil	Sum.
108. cyánea	Wils.	Indigo-bird	Sum.
43. Ammódramus	Swa.		
109. marítima	Wils.		Res.
110. Macgillivrai	Aud.		Sum.
111. caudacútus	Gm.		Res.
112. palústris.	Wils.		Win.
44. Peucæa	Aud.		
113. Báchmani	Aud.		Sum.
45. Linária	Ray.		
114. pínus	Wils.		Win.
46. Carduélis	Cuv.		
115. trístis	Lin.	May bird Goldfinch	Sum.
47. Fringílla	Lin.		
116. iliaca	Mer.		Win.
117. melódia*	Wils.		Win.
118. pennsylvánica	Lath.		Win.
119. leúcophrys	Gm.		
48. Pípilo	Viel.		
120. erythrophthálmus	Lin.		
49. Eythrospíza	Bon.		
121. purpúrea	Gm.		Win.
50. Coccóborus	Swa.		
122. cærúleus	Lin.		
123. ludoviciánus	Lin.		
51. Pítylus	Cuv.		
124. cardinális	Lin.	Redbird.	Res.
52. Pyránga	Viel.		
125. æstiva	Gm.	Summer Red-bird	Sum.
126. rúbra	Lin.		Sum.
53. Dolíchonyx	Swa.		
127. oryzívora	Lin.	Ricebird.	
54. Molóthrus	Swa.		
128. pécoris	Gm.	Cowbird	Win.
55. Ageláius	Swa.		
129. phæníceus	Lin.	Redwing Blackbird	Res.
56. Icterus	Bris.		
130. baltimóre	Lin.	Fire bird Hangnest	Sum.
131. spúrius	Gm.		
57. Quíscalus	Viel.		
132. májor	Viel.	Jackdaw	Res.
133. versícolor	Viel.		Res.
134. ferrugineus	Lath.		Win.
58. Sturnélla	Viel.		
135. ludoviciána	Lin.	Lark	Res.
59. Córvus	Lin.		
136. córax.	Lin.	Raven	Res.

B

137. americánus	Aud.	Crow	Res.
138. ossífragus	Wils.	Fish Crow	Res.
60. Gárrulus	Bris.		
139. cristátus	Lin.	Bluejay	Res.

4. *Family*. *Tenuirostres*. Beak, slender, elongated, sometimes arcuated.

61. Sítta	Lin.		
140. carolinénsis	Lin.		Res.
141. pusílla	Lath.		Res.
62. Cérthia	Lin.		
142. familiáris	Lin.		Win.
63. Tróchilus	Lin.		
143. cólubris	Lin.	Hummingbird	Sum.

5. *Family*. *Syndactylæ*. Outer toe united to the middle one as far as the last joint.

64. Alcedo	Lin.		
144. álcyon	Lin.	Kingfisher	Res.

III. ORDER. SCANSORES.

Terrestrial. Toes two, directed forwards and two backwards. Insectivorous, frugivorous, or granivorous.

65. Pícus	Lin.	Woodpeckers	
145. principális	Lin.	Ivorybilled W.	Res.
146. pileátus	Lin.	Log-cock	Res.
147. villósus	Lin.		Res.
148. pubéscens	Lin.		Res.
149. quérulus	Wils.		Res.
150. várius	Lin.	Yellow bellied Woodpecker	
151. erythrocéphalus	Lin.	Red headed W.	Res.
152. carolínus	Lin.	Redbellied W.	Win.
153. aurátus	Lin.	Lark W.	Res.
66. Centúrus	Kuhl.		
154. carolinénsis	Lin.	Carolina Parrokeet.	
67. Coccyzus	Viel.		
155. americánus	Lin.	Yellowbilled Rain Crow.	Sum.
156. erythrophthálmus.	Wils.	Blackbilled Rain Crow.	Sum.

IV. ORDER. GALLINACEÆ.

Terrestrial. Beak moderate, arched above. Wings generally short and power of flight moderate. Granivorous, with very muscular stomach.

68. Colúmba	Lin.		
157. passerína	Lin.	Ground Dove	Res.
69. Ectopístes	Swa.		
158. migratórius	Lin.	Wild Pigeon	
159. carolinénsis	Lin.	Turtle Dove	Res.
70. Meleágris	Lin.		
160. gallopávo	Lin.	Wild Turkey.	Res.
71. Ortyx	Steph.		
161. virginiána	Lin.	Partridge	Res.
72. Tétrao	Lin.		
162. umbéllus	Lin.	Pheasant	Res.

V. ORDER. BREVIPENNES.

Terrestrial. Wings rudimentary, flight impossible. Toes three, in some but two; legs long, powerful. Graminivorous generally. Ostriches, Cassowaries, &c. None in South Carolina.

VI. ORDER. GRALLATORIÆ.

Aquatic, waders. Wings generally long, flight good. Legs long, naked, extended behind during flight; toes generally separate. Piscivorous or insectivorous.

1. *Family*. *Pressirostres*. Bill of Moderate length. Hind toe not touching the ground.

73. Charádrius	Lin.		
163. helvéticus	Lin.		Wint.
164. marmorátus	Wagl.	Plover	Win.
165. vocíferus	Lin.	Kildeer	
166. Wilsoni	Ord.		Res.
167. semipalmátus	Bon.		Win.
168. mélodus	Ord.		Win.
74. Strépsilas	Ill.		
169. intérpres	Lin.		Win.
75. Hæmátopus	Lin.		
170. palliátus	Tem.		Win.

2. *Family.* *Cultrirostres.* Bill, large, long, powerful, generally trenchant and pointed.

76. Grus	Lin.		
171. americána	For.	Whooping Crane	Win.
77. Tántalus	Lin.		
172. loculátor	Lin.		Res.
78. Platálea	Lin.		
173. aiáia	Lin.	Spoonbill	Sum.
79. Ardea	Lin.		
174. nyctícorax	Lin.	Quow	
175. violácea	Lin.		
176. lentiginósa	Sab.		
177. exílis	Wils.	Poorjoe	
178. viréscens	Lin.		
179. heródias	Lin.	Blue Crane	Res.
180. egrétta	Gm.		
181. cærúlea	Lin.		
182. ludoviciána	Wils.		
183. candidíssima	Gm.	White Crane	

3. *Family.* *Longirostres.* Bill, long, slender, feeble.

80. Ibis	Cuv.		
184. falcinéllus	Lin.		Sum.
185. álba	Lin.		Sum.
81. Trínga	Lin.		
186. Bartrámia	Wils.		
187. islándica	Lin.		
188. pectorális	Bon.		Win.
189. alpína	Lin.		
190. subarquáta	Tem.		
191. himántopus	Bon.		
192. Schínzii	Bre.		
193. semipalmáta	Wils.		Win.
194. pusilla	Wils.		
195. arenária	Lin.		
82. Micróptera	Nutt.		
196. americána	Aud.	Woodcock	Win.
83. Limósa	Bris.		
197. fédoa	Lin.		
198. hudsonica	Lath.		
84. Tótanus	Bech.		
199. maculátus	Wils.		Res.
200. solitárius	Wils.		Res.
201. flávipes	Lath.		
202. vocíferus	Wils.		Win.
203. semipalmátus	Lath.	Stone Curlew	Res.
85. Scólopax	Lin.		
204. Wilsoni	Tem.	Snipe	Win.
205. noveboracénsis	Gm.		
86. Recurviróstra	Lin.		
206. americána	Gm.		
87. Himántopus	Bris.		
207. nigricóllis	Viel.		Sum.
88. Numénius	Bris.		
208. longiróstris	Wils.	Curlew	Res.
209. hudsónicus	Lath.		
210. boreális	Lath.		

4. *Family.* *Macródactyli.* Toes long, spreading. Bill rather long, stronger than in last.

89. Rállus	Lin.	Marsh Hen	
211. élegans	Aud.	Freshwater do.	Res.
212. crépitans	Gm.	Saltwater do.	Res.
213. virginiánus	Lin.		Res.
90. Ortygómetra	Leach		
214. carolínus	Lin.		
215. noveboracénsis	Lath		
216. jamaicénsis	Bris.		
91. Fúlica	Lin.		
217. americánus	Gm.		Win.
92. Gallínula	Bris.		
218. martínica	Lin.		Res.
219. chlóropus	Lin.		Res.

5. *Family.* *Phænicopteri.* Neck and legs excessively long, bill bent down at middle.

93. Phænicópterus	Lin.	
220. rúber	Lin.	Flamingo.

VII. ORDER. PALMIPEDES.

Aquatic, swimmers. Legs of moderate length, placed far back on the body, terminated with webbed feet. Plumage dense, oily.

1. *Family.* *Brachypteræ.* Wings short, flight feeble. Walk with difficulty.

94. Mórmon	Ill.		
221. árcticus	Lin.		Win.
95. Colymbus	Lin.		
222. glaciális	Lin.		Win.
223. árcticus	Lin.		Win.
96. Pódiceps	Lath.		
224. cristátus	Lath.		
225. cornútus	Lin.		
226. carolinénsis	Lath.	Diver	Win.

2. *Family.* *Longipennes.* Wings very long, flight powerful. Hind toe free or wanting.

97. Thalassídroma	Vig.			234. marínus	Lin.		Win.
227. Wílsoni	Bon.	Mother Carey's Chicken.		100. Léstris	Ill.		
				235. parasíticus	Lin.		Win.
98. Púffinus	Bris.			101. Stérna	Lin.		
228. cinéreus	Lath.			236. ánglica	Monta		Sum.
229. obscúrus	Lath.		Sum.	237. hirúndo	Lin.		Sum.
99. Lárus	Lin.			238. háveli	Aud.		Sum.
230. Bonapártii	Rich.		Sum.	239. nígra	Lin.		Sum.
231. atricílla	Lin.		Sum.	240. minúta	Lin.		Sum.
232. zonorhyncus	Rich.		Win.	102. Rhyncops	Lin.		
233. argentátus	Brun.		Win.	241. nígra	Lin.	Shearwater	Sum.

3. *Family.* *Totipalmatæ.* Wings long; hind toe united to the others, by web.

103. Pelecánus	Lin.			105. Súla	Bris.		
242. americánus	Aud.	White Pelican	Win.	245. bassána	Lin.	Gannet	
243. fúscus	Lin.	Brown Pelican	Res.	106. Plótus	Lin.		
104. Tachypetes	Viel.			246. anhínga	Lin.	Cormorant.	Sum.
244. áquilus	Lin.		Sum.				

4. *Family.* *Lamellirostres.* Wings moderate; bill thick, broad, denticulate on edges.

107. Anæs	Lin.			259. albéola	Lin.		Win.
247. bóschas	Lin.		Win.	260. glacialis	Lin.		Win.
248. obscúra	Gm.	Black Duck	Win.	261. rúbida	Wils.		
249. strépera	Lin.			262. fúsca	Lin.		Win.
250. americána	Gm.	Widgeon.	Win.	263. clángula	Lin.		Win.
251. acúta	Lin.		Win.	109. Cygnus	Meyer		
252. spónsa	Lin.	Summer Duck	Res.	264. buccinátor	Rich.		Sum.
253. carolinénsis	Steph.	Greenwinged Teal	Win.	265. americánus	Shar.		Win.
				110. Anser	Bris.		
254. díscors	Lin.	Bluewinged Teal.	Win.	266. canadénsis	Lin.	Wild Goose	Sum.
				267. álbifrons	Bech.		Win.
255. clypeáta	Lin.			268. hyperbóreus	Gm.		Win.
108. Fulígula	Leach.			111. Méigus	Lin.		
256. valisnéria	Wils.	Canvassback	Win.	269. mergánser	Lin.		Win.
257. ferína	Lin.			270. serrátor	Lin.		
258. americána	Swa.		Win.	271. cucullátus	Lin.		Win.

3. CLASS. REPTILES.

Breathe by lungs, at least in the adult state, respiration simple. Temperature variable, depending on that of surrounding medium, cold blooded. Circulation incomplete, all the blood in the heart not passing through the lungs before entering the arterial system; heart generally with three cavities, one ventricle and two auricles. Vertebræ generally concave anteriorly, posteriorly in some concave, in others, Ophidia and Sauria, with a hemispherical head for articulating with posterior one. Occipital bone with a single condyle, or none. Body naked or clothed with scales of a greater or less degree of hardness.

I. ORDER. CHELONIA.

Body protected by a solid covering, formed above by the coalescence of the ribs with each other and with the dorsal vertebræ, beneath by the enlargement of the sternum. Teeth none. Limbs four.

1. Testúdo	Brong.	
1. polyphémus	Daud.	Gopher
2. Cistúda	Flem.	
2. carolína	Edw.	Box Cooter
3. Kinostérnon	Spix	
3. pennsylvánicum	Edw.	Mud Cooter
4. Sternothærus	Bell	
4. odorátus	Bosc.	Musk Cooter
5. Emys	Brong.	Terrapin
5. serráta	Daud.	Yellowbelly T.
6. reticuláta	Bosc.	Chicken T.
7. pícta	Schn.	Checkered T.
8. guttáta	Schn.	Speckled T.
9. térrapin	Schoepf	Saltwater T.
10. concínna	Lec.	
6. Chelonúra	Flem.	
11. serpentina	Lin.	Alligator Cooter
7. Tríonyx	G. st. H.	
12. férox	Schn.	Softshelled Ter.
8. Chelónia	Brong.	
13. mydas	Lin.	Green Turtle
14. carétta	Lin.	Loggerhead Tur.
9. Sphárgis	Mer.	
15. coriácea	Lin.	Leatherbacked Tur.

II. ORDER. SAURIA.

Ribs and vertebræ moveable. Jaws with teeth, rarely implanted in sockets, and then always by a single root. Limbs generally four. Body clothed with scales.

10. Alligátor	Cuv.	
16. mississipiénsis	Daud.	Alligator
11. Anólius	Cuv.	
17. carolinénsis	Cuv.	Green Lizard
12. Tropidólepis	Cuv.	
18. undulátus	Bosc.	Brown Lizard
13. Ameíva	Cuv.	
19. sexlineáta	Lin.	Six-striped Lizard
14. Plestíodon	D. & B.	
20. erythrocéphalus	Gil.	Scorpion.
15. Scíncus	Daud.	
21. quinquelineátus	Lin.	Five-striped Lizard
22. fasciátus	Lin.	Bluetailed Lizard
16. Lygosóma	Gray	
23. laterális	Say.	Ground Lizard

III. ORDER. OPHIDIA.

Body elongated without limbs, clothed with scales. Jaws with teeth.

a. Not venomous.

17. Ophisaúrus	Daud.	
24. ventrális	Lin.	Glass Snake
18. Cóluber	Lin.	
24. constríctor	Lin.	Black Snake
25. guttátus	Lin.	Corn Snake
26. punctátus	Lin.	
27. alleghaniénsis	Holb.	
28. quadrivittátus	Holb.	Chicken Snake
19. Coronélla	Laur.	
29. getúla	Lin.	Chain Snake
30. doliáta	Lin.	
20. Hélicops	Wagl.	
31. erythrográmmus	Daud.	
32. abacúrus	Holb.	
21. Brachyórros	Kuhl.	
33. amænus	Say.	
22. Calamária	Boié.	
34. elapsoídea	Holb.	
35. striátula	Lin.	
23. Rhinóstoma	Fitz.	
36. coccínea	Blum.	Scarlet Snake
24. Pitúophis	Holb.	
37. melanoleúcus	Daud.	Pine Snake
25. Psámmophis	Boié.	
38. flagellifórmis	Cat.	Coachwhip Snake
26. Léptophis	Bell	
39. æstívus	Lin.	Green Snake
40. saurítus	Lin.	Ribbon Snake
27. Tropidonótus	Kuhl.	
41. fasciátus	Lin.	
42. erythrogáster	Shaw	Copperbelly
43. taxispilótus	Holb.	
44. rígidus	Say.	
45. sirtális	Lin.	Striped Snake
46. ordinátus	Lin.	Grass Snake
28. Hetérodon	P. de B.	
47. símus	Lin.	
48. níger	Cat.	Black Viper
49. platyrhínos	Lat.	Hognose Viper

C

b. Venomous.

29. Elaps	Schn.	
50. fûlvius	Lin.	Bead Skake
30. Trigonocéphalus	Oppel.	
51. piscívorous	Lac.	Water Mokeson
52. contórtrix	Lin.	Copperhead
31. Crotalóphorus	Gray	
53. miliárius	Lin.	Ground Rattle S.
32. Crótalus	Lin.	
54. duríssus	Lin.	Banded Rattle S.
55. adamânteus	P. de B.	Water Rattle S.

IV. ORDER. BATRACHIA.

Body naked, not covered with scales; with fôur limbs, without nails. Jaws generâlly with teeth. Heart with two cavities. In early life breath by gills.

a. Without tails.

33. Râna	Lin.	
56. pípiens	Lat.	Bull Frog
57. clámitans	Bosc.	
58. halecína	Kalm.	
34. Cystígnathus	Wagl.	
59. ornâtus	Holb.	
60. nigrítus	Lec.	
34. Scaphíopus	Holb.	
61. solitárius	Holb.	
35. Hylódes	Fitz.	
62. gryllus	Lec.	
63. oculáris	Holb.	
36. Hyla	Laur.	
64. víridis	Laur.	Tree Frog.
65. squirélla	Bosc.	
66. femorâlis	Daud.	
67. delitéscens	Lec.	
37. Bûfo		
68. lentiginósus	Shaw.	
69. erythronótus	Holb.	
70. quércicus	Holb.	Oak Frog.
71. americânus	Lec.	Common Toad.
38. Engystoma	Fitz.	
72. carolinênse	Holb.	

b. With tails.

39. Salamândra	Laur.	The Salamanders
73. guttolineáta	Holb.	are generally known
74. salmónea	Storer	as Soft Skinned or
75. rúbra	Daud.	Smooth Skinned
76. glutinósa	Green	Lizards.
77. erythronóta	Green	
78. quadrimaculâta	Holb.	
79. bilineâta	Green	
80. symmétrica	Harl.	
81. quadridigitâta	Holb.	
82. melanostícta	L. Gibbes	
83. venenósa	Bart.	
84. fasciâta	Green	
85. talpoídea	Holb.	
40. Tríton	Laur.	
86. dorsâlis	Harl.	Spring Lizard.
87. níger	Green	
41. Amphiúma	Gard.	
88. méans	Gard.	Congo Snake
42. Síren	Lin.	
89. lacertína	Lin.	Mud Eel
90. intermédia	Lec.	

4. CLASS. FISHES.

Breathe by gills. Temperature variable, cold blooded. Circulation complete, heart with two cavities, one auricle and one ventricle, propelling venous blood to the gills. Vertebræ with conical depression on anterior and posterior surfaces, and deep grooves or apertures on the sides Occipital bone without condyles. Body either clothed with scales or naked.

I. ORDER. ACANTHOPTERYGII.

Skeleton osseous. Fins with spiny rays, most numerous in the dorsal.

1. Lábrax	Cuv.	
1. lineátus	Block.	Rockfish.
2. rúfus	Mitch.	
2. Serrânus	Cuv.	

3. erythrogáster	Dek.	Grouper
4. acutiróstris	Cuv.	
5. fasciculáris	Cuv.	
6. mório	Cuv.	
3. Centroprístis	Cuv.	
7. nígricans	Cuv.	Blackfish.
8. trifúrca	Cuv.	
4. Grystes	Cuv.	
9. salmoídes	Cuv.	Trout. Fr. Water
5. Centrárchus	Cuv.	
10. sparoídes	Cuv.	
11. irídeus	Cuv.	
12. gulósus	Cuv.	Mawmouth
13. víridis	Val.	The species of this genus and of the two following, belong to fresh water, and are generally called Perch and Chub.
14. hexacánthus	Val.	
6. Pomótis	Cuv.	
15. vulgáris	Cuv.	
16. Ravenélii	Val.	
17. Hólbrooki	Val.	
18. gibbósus	Val.	
7. Bryttus	Val.	
19. punctátus	Cuv.	
20. reticulátus	Val.	
21. unícolor	Val.	
8. Holocéntrum	Art.	
22. longipínne	Cuv.	
9. Uranóscopus	Lin.	
23. ánoplos	Cuv.	
10. Prionótus	Lac.	
24. carolínus	Cuv.	
25. tríbulus	Cuv.	
11. Dactylópterus	Lac.	
26. vólitans	Lin.	Flying Fish
12. Scorpæna	Lin.	
27. búfo	Cuv.	
13. Otólithus	Cuv.	
28. regális	Schn.	
29. carolinénsis	Cuv.	
14. Leióstomus	Cuv.	
30. oblíquus	Mitch.	
31. xanthúrus	Cuv.	Yellowtail
15. Corvína	Cuv.	
32. ocelláta	Lin.	Bass
33. argyroleúca	Mitch.	
16. Umbrína	Cuv.	
34. albúrnus	Lin.	Whiting
35. coroídes	Cuv.	
17. Hæmulon	Cuv.	
36. formósum	Lin.	
37. chrysópteron	Lin.	
38. arcuátum	Cuv.	
18. Pogónias	Lac.	
39. chrómis	Lin.	Drum

40. fasciátus	Lac.	Young Drum.
19. Micropógon	Cuv.	
41. undulátus	Cuv.	Croker
42. costátus	Mitch.	
20. Lobótes.	Cuv.	
43. surinaménsis	Bloch.	
21. Pristipóma	Cuv.	
44. ródo	Cuv.	
22. Sárgus	Cuv.	
45. óvis	Mitch.	Sheephead
46. rhomboídes	Lin.	
23. Págrus	Cuv.	
47. árgyrops	Lin.	Porgee
24. Gérres	Cuv.	
48. apríon	Cuv.	
25. Pimelépterus	Lac.	
49. Bósci	Lac.	
26. Ephíppus	Cuv.	
50. fáber	Bloch.	Angelfish
51. gígas	Park.	
27. Holacánthus	Lac.	
52. ciliáris	Lac.	
28. Scómber	Cuv.	
53. cólias	Gm.	Span. Mackerel
54. vernális	Mitch.	Spring Mackerel
55. grex	Mitch.	
29. Pélamys	Cuv.	
56. sárda	Bloch.	
30. Cybium	Cuv.	
57. maculátum	Mitch.	
31. Líchia	Cuv.	
58. carolína	Dek.	
32 Elácate	Cuv.	
59. atlántica	Cuv.	
33. Cáranx	Cuv.	
60. defénsor	Dek.	Crevalle
61. punctátus	Cuv.	
34. Seríola	Cuv.	
62. Bósci	Cuv.	
63. fasciáta	Cuv.	
64. cosmopólita	Cuv.	
35. Rhómbus	Lac.	
65 longipínnis	Mitch.	Rudderfish
36. Ptéraclis	Cuv.	
66. carolínus	Cuv.	
37. Trichiúrus	Lin.	
67. leptúrus	Lin.	
38. Trachinótus	Cuv.	
68. pampánus	Cuv.	Pompeynose
69. argénteus	Cuv.	
39. Vómer	Cuv.	
70. Brówni	Cuv.	
40. Témnodon	Cuv.	

71. saltátor	Lin.	Skipjack
41. Lampúgus	Cuv.	
72. punctulátus	Cuv.	
42. Argyreiósus	Lac.	
73. vómer	Lin.	
43. Coryphæna	Lin.	
74. Sueúri	Cuv.	
44. Acanthúrus	Lac.	
75. phlebótomus	Cuv.	
76. cærúleus	Cuv.	
45. Atherína	Lin.	
77. menídia	Lin.	Silverfish
78. notáta	Mitch.	
79. carolína	Cuv.	
46. Múgil	Lin.	
80. álbula	Lin.	Mullet.
81. petrósus	Cuv.	
82. lineátus	Mitch.	
83. Plumiéri	Cuv.	
47. Bléennius	Cuv.	
84. geminátus	Wood	
85. punctátus	Wood	
48. Chasmódes	Cuv.	
86. novemlineátus	Wood	
87. Bosciánus	Cuv.	
49. Phólis	Flem.	
88. carolínus	Cuv.	
50. Góbius	Lin.	
89. alepidótus	Bosc.	
51. Chironéctes	Cuv.	
90. lævigátus	Cuv.	
52. Bátrachus	Schn.	
91. tau	Lin.	Toadfish
53. Málthea	Cuv.	
92. nasúta	Cuv.	
93. vespertílio	Cuv.	
54. Xirícthys	Cuv.	
94. lineátus	Lin.	
55. Tautóga	Mitch.	
95. americána	Bloch.	Tautog

II. ORDER. MALACOPTERYGII ABDOMINALES.

Skeleton osseous. Fins with soft cartilaginous rays, excepting occasionally the first ray of the dorsals and pectorals. Ventral fins behind the pectorals.

56. Galeícthys	Cuv.	
96. marínus	Mitch.	Catfish. Salt Water
57. Arius	Cuv.	
97. Mílberti	Cuv.	
58. Pimelódus	Cuv.	
98. cátus	Lin.	Catfish. Fresh W.
99. lemniscátus	Les.	
59. Catóstomus	Les.	
100. Sucéti	Lac.	Sucker
101. oblóngus	Mitch.	
60. Cyprínodon	Lac.	
102. variegátus	Lac.	
61. Leucíscus	Klein.	
103. americánus	Lac.	Minnows
104. gardóneus	Val.	Minnows
105. vandoísulus	Val.	Minnows
106. roténgulus	Val.	Minnows
62. Hydrárgyra	Lac.	
107. fasciáta	Schn.	
63. Lébias	Cuv.	
108. ellipsoídes	Les.	
64. Exocætus	Lin.	
109. furcátus	Mitch.	Flyingfish
65. Hemirámphus	Cuv.	
110. (species not determined.)		
66. Fistulária	Lac.	
111. serráta	Bloch.	
67. Alósa	Cuv.	
112. præstábilis	Dek.	Shad
68. Amia	Lin.	
113. cálva	Lin.	Mudfish
69. Butirínus	Com.	
114. vúlpes	Lin.	
70. Lepisósteus	Lac.	
115. ósseus	Lin.	Garfish.

III. ORDER. MALACOPTERYGII SUBBRACHIATI.

Skeleton osseous. Fins with soft rays. Ventral fins under the pectorals.

71. Platéssa	Cuv.	
116. oblónga	Mitch.	Plaice
117. (species not determined)		Flounder
72. Achírus	Lac.	
118. móllis	Mitch.	
73. Echinéis	Lin.	
119. (species not determined)	Lin.	Suckingfish

IV. ORDER. MALACOPTERYGII APODES.

Skeleton osseous. Fins with soft rays. Ventrals wanting.

74. Muræna	Lin.	
120. (species not determined)		Salt water Eel.
121. (species not determined)		Fresh water Eel

V. ORDER. LOPHOBRANCHIATI.

Skeleton osseous. Gills in tufts, not arranged like the teeth of a comb, as in the preceding orders.

75. Syngnathus	Lin.	
122. (species not determined)		
76. Hippocámpus	Cuv.	
123. (species not determined)		Seahorse

VI. ORDER. PLECTOGNATHI.

Skeleton osseous. Jaws soldered to the adjacent bones, immoveable, not free and moveable, as in the preceding orders.

77. Tetráodon	Lin.
124. lævigátus	Lin.
125. túrgidus	Mitch.
78. Díodon	Lin.
126. maculostriátus	Mitch.
127. pilósus	Mitch.
79. Balístes	Cuv.
128. (species not determined)	

VII. ORDER. STURIONES.

Skeleton cartilaginous. Gills with one external opening, as in the preceding orders.

80. Acipénser	Lin.	
129. (species not determined)		Sturgeon

VIII. ORDER. PLAGIOSTOMI.

Skeleton cartilaginous. Gills with several external openings. Jaws moveable, formed for mastication.

81. Zygæna	Cuv.	Hammerhead Shark
130. málleus	Val.	
82. Prístis	Lath.	
131. antiquórum	Lin.	Sawfish
83. Squátina	Dum.	
132. Dumerílii	Les.	Sharks
84. Sélachus	Cuv.	Sharks
133. máximus	Lin.	Sharks
85. Lámna	Cuv.	Sharks
134. punctáta		Sharks
86. Ráia	Lin.	
135. eglantiera	Bosc.	Skate.
136. Desmaréstia	Les.	
87. Trygon	Adan.	
137. sabína	Les.	Stingray.
88. Cephalóptera		
138. vampyrus	Mitch.	Devil-fish.
89. Aetóbatis	M. & H.	
139. guttáta	Shaw	

IX. ORDER. CYCLOSTOMI.

Skeleton cartilaginous. Gills with several external openings. Jaws united together in a ring, formed for suction.

90. Petromyzon	Lin.	
140. (species not determined)		Lamprey.

D

II. DIVISION. ANNULATED ANIMALS.

No internal osseous skeleton, but generally a tegumentary one, composed of moveable rings. Organs symmetrically placed about a vertical median plane. No cerebro-spinal axis. Nervous system central, generally a series of ganglia.

I. SUBDIVISION. ARTICULATA.

Organs of locomotion composed of several segments articulated with each other. Nervous system highly developed.

1. CLASS. INSECTA.

Respiration aerial. Body composed of a head, thorax and abdomen, distinct from each other. Three pairs of feet, attached to the thorax.

A class abounding in species, probably not less than 5000 in South Carolina. We have not been able to procure an authentic list of the more common or most important species.

II. CLASS. MYRIAPODA.

Respiration aerial. Body composed of a head and a series of thoraco-abdominal rings. Numerous pairs of feet. Centipede, Fortyleg, &c.

III. CLASS. ARACHNIDA.

Respiration aerial. Head and thorax in one piece, to which are attached four pairs of feet. Spiders, &c.

We have not been able to procure authentic lists of species in these two classes.

IV. CLASS. CRUSTACEA.

Respiration aquatic, effected generally by gills or branchiæ. Circulatory system highly developed. Generally five or seven pairs of feet. Sexes distinct.

I. ORDER. DECAPODA.

Mouth formed for mastication (as also in the eight following orders) and furnished with six pairs of members, one pair mandibles, two pair jaws, and three pair foot-jaws, the last of these covering the mouth externally. Eyes on moveable peduncles. Head not distinct from the thorax, both protected by a continuous shell, not separable into segments. Five pairs of feet, prehensile, ambulatory or natatory. Gills enclosed in cavities on the side of the thorax.

A. BRACHYURA.

Abdomen but slightly developed, folded under the body.

1. *Family. Oxyrhincha.*

Shell triangular in form, tapering anteriorly to a beak, sometimes much prolonged. Mouth-frame nearly square, remote from the front.

1. Leptopódia	Leach.	2. Libínia	Leach.
1. calcaráta*	Say.	2. canaliculáta	Say. Spider Crab

3. dúbia	M. Ed.	
3. Míthrax	Leach	
4. híspidus	Herbst	
4. Cryptopódia	M. Ed.	
5. granuláta	L. Gibbes.	Not yet described.

2. *Family. Cyclometopa.*

Shell broad, regularly curved on anterior border, narrowed posteriorly. Mouth frame nearly square, remote from front.

5. Panopéus	M. Ed.	
6. Hérbstii	M. Ed.	
7. limósus	Say.	
6. Pseudocárcinus	M. Ed.	
8. mercenária	Say.	Stone Crab.
7. Platycárcinus	Lat.	
9. Sáyi	Gould.	
8. Pilúmnus	Leach.	
10. aculeátus	Say.	
9. Platyónichus	Lat.	
11. ocellátus	Herbst	Sand Crab.
10. Lúpa	Leach.	
12. dicántha	Lat.	Sea Crab.
13. cribrária	Lam.	
14. Sáyi	L. Gibbes.	L. pelagica of Say.

3. *Family. Catometopa.*

Shell quadulateral or ovoid. Mouth-frame nearly square, not reaching the front.

11. Pinnothéres	Lat.	
15. óstreum	Say.	Oyster Crab.
16. maculátum	Say.	
12. Ocypoda	Fab.	
17. arenária	Cat.	Sand Crab or Land Crab
13. Gelásimus	Lat.	
18. vócans	Lin.	Fiddler.
14. Sesárma	Say.	
19. cinérea	Bosc.	Square back Fiddlers.
20. reticulátus	Say.	Square back Fiddlers.
15. Plagúsia	Lat.	
21. squamósa	Herbst.	

4. *Family. Oxystoma.*

Shell generally orbicular or arched on anterior border. Mouth-frame triangular, reaching nearly, or quite, to the front.

16. Caláppa	Fab.	
22. marmoráta	Fab.	
17. Hépatus	Lat.	
23. decórus	Herbst.	Spotted Crab.
18. Guáia	M. Ed.	
24. punctáta	Brown.	

B. ANOMOURA.

Abdomen but moderately developed, either extended or folded under the body, and almost always with appendages on the penultimate segment.

19. Albúnea	Fab.	
25. symnísta	Fab.	
20. Híppa	Fab.	
26. eméritus	Lin.	
21. Monólepis	Say.	
27. spinitársus*	Say.	
22. Pagúrus	Fab.	
28. villátus	Bosc.	Soldier Crabs or Hermit Crabs.
29. pollicáris	Say.	Soldier Crabs or Hermit Crabs.
30. longicárpus	Say.	Soldier Crabs or Hermit Crabs.
23. Porcellána	Lam.	
31. pilósa	M. Ed.	
32. macrochéles	L. Gibbes	Not yet described.
33. ocelláta	L. Gibbes	Not yet described.

C. Macroura.

Abdomen highly developed, extended behind the thorax, furnished with appendages on the penultemate segment, which with the last segment form a fanlike caudal fin, a powerful organ of locomotion.

24. Callianássa	Leach.	
34. májor	Say.	
25. Gébia	Leach.	
35. affínis	Say.	
26. Astacus	Fab.	
36. Bártoni	Fab.	Crawfish.
37. Blándingi	Harl.	Crawfish.
27. Alpheus	Fab.	
38. heterochélis	Say.	
28. Pontónia	Lat.	
39. occidentális	L. Gibbes.	
29. Hippólyte	Leach.	Freshwater Shrimp.
40. caroliniána	Gibbes.	
30. Palæmon	Fab.	
41. vulgáris	Say.	Hardbacks.
31. Penéus	Fab.	
42. setíferus	Lin.	Shrimps.
43. caramóte	Rond.	Shrimps.

II. ORDER. STOMAPODA.

Eyes on moveable peduncles. Gills not enclosed in thoracic cavity, generally attached to the false feet of the abdomen, which part of body is in general highly developed. Feet in seven or eight pair generally.

32. Squílla	Fab.	
44. scabricaúda	Lat.	
45. empúsa	Say.	
46. neglécta	L. Gibbes.	Not yet described.
47. dúbia	M. Ed.	

III. ORDER. AMPHIPODA.

Eyes sessile. Head, thorax and abdomen distinct, composed of separate rings. No proper gills, but vesicles supplying their place. Abdomen highly developed. Body frequently compressed. Seven pairs of feet.

33. Orchéstia	Leach
48. longicórnis	Say.
34. Amphíthoe	Leach
49. dentáta	Say.
50. not determined.	
35. Gámmarus	Fab.
51. mucronátus	Say.
52. fasciátus	Say.

IV. ORDER. LÆMIPODA.

Eyes sessile. Head, thorax and abdomen distinct, the latter rudimentary. Branchial vesicles in place of branchiæ. Feet in seven or five pair.

36. Caprélla	Lam.
53. equilíbra	Say.
44. geométrica	Say.

V. ORDER. ISOPODA.

Eyes, head, thorax and abdomen as in Amphipoda. No branchiæ or branchial vesicles, the abdominal feet supplying their place. Body depressed. Seven pairs of feet.

37. Idotéa	Fab.		41. Armadillídium	Brandt.	
55. cæca	Say.		60. piluláris	Say.	Pillbugs
38. Aséllus	Geof.		42. Sphæróma	Lat.	
56. commûnis	Say.		61. quadridentâta	Say.	
57. lineâtus	Say.		43. Nesæa	Leach.	
39. Lygia	Fab.		62. caudâta	Say.	
58. Gaudichaûdii	M. Ed.	Wharf louse	44. Neròcila	Leach.	
40. Oníscus	Lin.		63. variábilis	L. Gibbes.	Fishlouse
59. (not determined)			45. Livóneca	Leach.	
			64. ovális	Say.	Fishlouse

VI. ORDER. PHYLLOPODA.

Thoracic limbs foliaceous, adapted not to locomotion but to respiration, in eight or more pair. Animals minute.

No species of this order observed in South Carolina, though, doubtless, several exist.

VII. ORDER. CLADOCERA.

Thoracic limbs as in Phyllopoda, in five pair. Body enclosed between two valves. Animals minute.

46. Dáphnia — Mull.
65. angulâta — Say.

VIII. ORDER. OSTRAPODA.

Thoracic limbs not foliaceous, natatory, two or three pair. Body not divided into rings, enclosed between two valves. Animals minute.

47. Cythére — Lat.
66. bifasciâta — Say.

IX. ORDER. COPEPODA.

Thoracic limbs not foliaceous, natatory, four or five pair. Body divided into rings, not enclosed between two valves. Animals minute.

48. Cyclops — Mul.
67. navículus — Say.

X. ORDER. SIPHONOSTOMA.

Mouth formed for suction, not for mastication. Feet natatory, three or four pair.

XI. ORDER. LERNEIDA.

Mouth as in Siphonostoma. Feet wanting or rudimentary. No species of these two orders yet observed in South Carolina.

XII. ORDER. ARANEIFORMIA.

Mouth formed for suction. Feet ambulatory, long, in four pair.

49. Nymphum — Fab.
68. carolinénse — Leach.

XIII. ORDER. XIPHOSURA.

Mouth not formed for suction nor furnished with organs of mastication, but surrounded by the feet, the first joint of each of which is armed with spines or teeth for performing that function. Tail, long, bayonet form.

50. Límulus	Mul.	
69. polyphémus	Lin.	King-crab.

5. CLASS. CIRRIPEDES.

Respiration aquatic. No organs of locomotion in the adult state, animal fixed on other bodies.

1. Anátifa	Brug.
1. dentáta	Brug.
2. striáta*	Brug.
2. Bálanus	Lam.
3. ebúrneus	Gould.
4. (not determined.)	
3. Conópea	Say.
5. elongáta*	Say.
4. Corónula	Lam.
6. dentuláta	Say.
5. Acásta	Leach.
7. montagúi*	Leach.

2. *SUBDIVISION. VERMES.*

No articulated organs of locomotion. Nervous systems slightly developed.

VI. CLASS. ANNELIDES.

Respiration branchial. Blood generally red. In most, tufts of bristles serving as feet.

1. Spío	Lam.	
1. caudátus*	Lam.	
2. Pectinária	Lam.	
2. bélgica	Pall.	
3. Sabellária	Lam.	
3. two species		
4. not determined		
4. Terebélla	Cuv.	
5. conchílega	Pall.	
6. ventricósa	Bosc.	
5. Spirórbis	Lam.	
7. two species		
8. not determined		
6. Sérpula	Lin.	
9. fasciculáris	Lam.	
7. Lúmbricus	Lin.	
10. two species		Earthworms
11. not determined		
8. Hírúdo		
12. two or more species		Leeches
13. not determined.		

VII. CLASS. ROTIFERA.

Respiration cutaneous, blood white. Vibratile organs at anterior extremity. Microscopic animals which have not yet attracted much attention in this State.

VIII. ENTOZOA.

Respiration cutaneous, blood white. No vibratile organs, nor special organs of locomotion. Parsasitic, inhabiting the internal organs of animals.

We have not been able to procure a list of the species observed in this State.

III. DIVISION. MOLLUSCOUS ANIMALS.

No proper skeleton, internal or tegumentary, body sometimes naked, sometimes protected by a shell. Organs symmetrically placed about a median plane, in general curved. No cerebro-spinal axis. Nervous system ganglionary, but not forming a series.

1. *SUBDIVISION. MOLLUSCA.*

Animals oviparous. Ganglia, several, forming a collar round the esophagus. Circulatory system highly developed.

1. CLASS. CEPHALOPODA.

Body in the form of a sac, furnished with a distinct head, around which are placed the organs of locomotion or prehension, in the form of tentacula.

1. Octopus	Lan.	3. Spirûla	Lam.
1. granulátus	Lam. v. 11, p. 362.	3. Perónii	Lam. Sow. Gen.
2. Loligo	Lam.		
2. brevipínna	Les. J. A. N. S. v. 3, pl. 10.		

2. CLASS. GASTEROPODA.

Body with a distinct head, and a fleshy disk on under side by means of which the animal crawls; in most cases the animal is protected by a shell, which is univalve.

A. Terrestrial, respiration aerial.

1. Tebennóphorus	Bin.		15. perspectíva	Say.	J. A. N. S. v. 1, p. 18
1. carolinénsis	Bosc.	Fer. Moll. pl. 6, f. 3*	16. guláris	Say.	J. A. N. S. v. 2, p. 156
2. Límax	Lin.		17. pulchélla	Mul.	Gould In. Mass. f. 102
2. flávus	Lin.	Fer. Moll. pl. 5, f. 1*	4. Pûpa	Lam.	
3. Hélix	Lin.		18. rupícola	Say.	J. A. N. S. v. 2, p. 163
3. albílabris	Say.	Am. Con. pl. 13, f. 1	19. fállax	Say.	Gould In. Mass. f. 123
4. májor	Bin.	B. J. N. H. v. 1, pl. 12*	29. ováta*	Say.	J. A. N. S. v. 2, p. 375
5. aspérsa	Mul.	Wood I. pl. 34, f. 126	21. péntodon*	Say.	J. A. N. S. v. 2, p. 376
6. thyroídus	Say.	Am. Con. pl. 13, f. 2	5. Bulímus	Brug.	
7. tridentáta	Say.	Wood Sup. pl. 7, f. 11	22. decollátus	Lin.	Wood In. pl. 34, f. 135
8. fállax	Say.	J. A. N. S. v 5, p. 119	23. (not determined)		
9. appréssa	Say.	J. A. N. S. v 2, p. 119	6. Glandína	Schu.	
10. auriculáta	Say.	J. A. N. S. v 1. p. 277	24. truncáta.	Gm.	Am. Con. pl. 20
11. carolinénsis*	Lea.	T. A. P. S. v. 4, pl 15. f. 33.	7. Succínea	Drap.	
			25. ovális	Say.	Gould In. Mass. f. 125
12. inornáta	Say.	J. A. N. S. v. 2, p. 371	26. campéstris	Say.	Gould In. Mass. f. 126
13. concáva	Say.	J. A. N. S. v. 2, p. 159	8. Aurícula	Lam.	
14. alternáta	Say.	Gould In. Mass. f. 114.	27. bidentáta	Say.	Gould In. Mass. f. 130
			28. oblíquus*	Say.	J. A. N. S. v. 2, p. 277

B. Aquatic, fluviatile, respiration aerial.

9. Planórbis	Mul.	31. glabrátus*	Say. J. A. N. S. v. 1. p. 280
29. lentus	Say. Am. Con. pl. 54, 61	10. Physa	Drap.
30. párvus	Say. Gould In. Mass. f. 139	32. gyrina	Say. J. A. N. S. v. 2 p. 271

11. Limnæus	Lam.	
33. columélla	Say.	Gould In. Moss. f. 144
34. macróstoma	Say.	Gould In. Mass. f. 148
35. húmilis	Say.	J. A. N. S. v. 2, p. 378

C. Aquatic, fluviatile, respiration aquatic.

12. Paludína	Lam.	
36. decísa	Say.	Am. Con. pl. 30, f. 34
37. íntegra	Say.	Hald. Mon. pl. 3
38. intertéxta	Say.	Am. Con. pl. 30, f. 3, 4
13. Melánia	Lam.	
39. próxima	Say.	J. A. N. S. v. 5, p. 127
40. catenária	Say.	J. A. N. S. v. 2, p. 379
41. áltilis	Lea.	T. A. P. S. v. 8, pl. 5. f. 23
14. Ancylus	Mul.	
42. (species not determined)		

D. Aquatic, marine, respiration acquatic, shell without notch or canal.

15. Fissurélla	Brug.	
43. alternáta	Say.	J. A. N. S. v. 2, p. 245
16. Crepídula	Lam.	
44. fornicáta	Lin.	Sow. Gen. f. 1.
45. plána	Say.	J. A. N. S. v. 2, p. 226
46. aculeáta	Gm.	Sow. Gen. f. 4
17. Chíton	Lin.	
47. apiculátus	Say.	Gould. In. Mass. f. 20
18. Búlla	Lin.	
48. solitária	Say.	J. A. N. S. v. 2, f. 245
49. canaliculáta	Say.	Am. Con. pl. 39
19. Aplysia	Lin.	
50. (species not determined)		
20. Sigarétus	Lam.	
51. perspectívus	Say.	Am. Con. pl. 25
21. Nática	Brug.	
52. duplicáta	Say.	Gould In. Mass. f. 163
53. pusílla	Say.	Gould In. Mass. f. 166
22. Scalária	Lam.	
54. cláthrus	Lin.	Am. Con. pl. 27
55. multistriáta	Say.	Am. Con. pl. 27
56. lineáta.	Say.	Am. Con. pl. 27
23. Littorína	Fer.	
57. irroráta	Say.	J. A. N. S. v. 2, p. 239
24. Turritélla	Lam.	
58. (species not determined)		

E. Aquatic, marine, respiration aquatic, shell with a notch, groove or canal for the passage of the siphon.

25. Cancellária	Lam.	
59. reticuláta	Lin.	Sow. Gen. f. 1.
26. Pleurótoma	Lam.	
60. pusílla*	Rav.	(not yet described)
27. Fúsus	Lam.	
61. cinéreus	Say.	Am. Con. pl. 29
28. Fasciolária	Lam.	
62. túlipa	Lin.	Kiener pl. 1
63. dístans	Lam.	Kiener pl. 3
64. gigántea	Kiener	Kiener pl. 10 & 11
29. Pyrúla	Lam.	
65. canaliculáta	Lin.	Wood Ind. pl. 26, f. 82
66. cárica	Lam.	Wood Ind. pl. 26, f. 83
67. pervérsa	Lin.	Wood Ind. pl. 26, f. 88
68. pyrum	Dill.	Say. Am. Con. pl. 19
30. Ranélla	Lam.	
69. caudáta	Say.	Am. Con. pl. 48
31. Murex	Lin.	
70. (species not determined)		
32. Strómbus	Lam.	
71. alátus	Gm.	Lam. v. 9, p. 696.
33. Cássis	Lam.	
72. sulcósa?	Lam.	Wood In. pl. 22, f. 25
34. Purpura	Lam.	
73. catarácta	Chem.	Kiener pl. 36, f. 85
35. Dólium	Lam.	
74. gálea	Lin.	Kiener pl. 2, f. 2
36. Nássa	Lam.	
75. obsoléta	Say.	Wood Sup. pl. 4, f. 26
76. unicíncta*	Say.	Am. Con. pl. 57
77. víbex	Say.	Am. Con. pl. 57
78. trivittáta	Say.	Gould In. Mass. f. 211
37. Terébra	Brug.	
79. claváta	Rav.	(not yet described)
80. dislocáta	Say.	J. A. N. S. v. 2, p. 235
81. concáva	Say.	
38. Columbélla	Lam.	
82. avára	Say.	Gould In. Mass. f. 197
83. lunáta	Say.	Gould In. Mass. f. 196
39. Volúta	Lam.	
84. junóniá	Chem.	Wood Ind. pl. 2, f. 170.
40. Marginélla	Lam.	
85. spilóta*	Rav.	(not yet described)
86. guttáta?	Dill.	Kien. pl. 3, f. 12

41. Ovula	Brug.	
87. aciculáris	Lam.	Wood In. pl. 18. f. 7
42. Olíva	Brug.	
88. literáta	Lam.	Say. Am. Con. pl. 3
89. mûtica	Say.	J. A. N. S. v. 2, p. 228

III. CLASS. ACEPHALA.

Body without a distinct head, and in almost every case, is protected by a shell, which is bivalve.

A. Fluviatile.

1. Unio		
1. complanátus*	Sol.	Gould In. Mass. f. 68
2. confértus*	Lea.	T. A. P. S. v. 5, pl. 16 f. 47.
3. congaræus*	Lea.	T. A. P. S. v. 4, pl. 6. f. 4
4. fûlvus*	Lea.	T. A. P. S. v. 5, pl. 13. f. 39
5. Geddingsiánus*	Lea.	T. A. P. S. v. 8, pl. 11. f. 15
6. Griffithiánus*	Lea.	T. A. P. S. v. 5, pl. 15. f. 46
7. jejúnus*	Rav.	T. A. P. S. v. 6, pl. 4. f. 9
8. palliátus*	Lea.	(not yet described)
9. watereénsis*	Lea.	(U. Raveneli Con.)
10. angustátus*	Lea.	T. A. P. S. v. 4, pl. 17. f. 43
11. folliculátus*	Lea.	T. A. P. S. v. 6, pl. 11. f. 33
12. Vaughaniánus*	Lea.	T. A. P. S. v. 6, pl. 3. f. 5.
13. modioliformis*	Lea.	T. A. P. S. v. 5. pl. 13. f. 40.
14. ténerus*	Rav.	
15. crocátus*	Lea.	T. A. P. S. v. 8, pl. 22. f. 52
16. tæniátus*	Con.	
2. Margaritána	Schu.	
17. margináta	Say.	Gould In. Mass. f. 77
3. Anodon	Brug.	
18. fluviatilis	Sol.	(cataracta Say.)
19. Dunlapiána	Lea.	T. A. P. S. v. 8, pl. 27. f. 65
20. incérta	Lea.	T. A. P. S. v. 5, pl. 6. f. 16
4. Cyclas	Lam.	
21. partuméia	Say.	Gould In. Mass. f. 54
5. Cyréna	Lam.	
22. caroliniénsis	Bosc.	Lam. v. 6, p. 276.

B. Marine.

6. Vénus	Lin.	
23. mercenária	Lin.	Lam. v. 6, p. 346
24. notáta	Say.	J. A. N. S. v. 2, p. 271
25. páphia*	Lin.	Lam. v. 6, p. 371
26. elevâta*	Say.	J. A. N. S. v. 2, p. 272
7. Artemis	Poli.	
27. concéntrica	Born.	Sow. Gen. f. 4
8. Astárte	Sow.	
28. lunuláta*	Con.	
9. Lucína	Brug.	
29. tigerína*	Lin.	(Cytherea of Lam.)
30. divaricáta	Lin.	Lam. v. 6, p. 226
31. edéntula	Lin.	Lam. v. 6, p. 224
10. Cardíta	Lam.	
32. tridentáta*	Say.	Am. Con. pl. 40
11. Cárdium	Lin.	
33. isocárdia*	Lin.	Lam. v. 6, p. 398
34. muricátum	Lin.	Lam. v. 6, p. 398
35. marmóreum	Lam.	Lam. v. 6, p. 399
36. ventricósum	Brug.	Lam. v. 6, p. 400
12. Arca	Lam.	
37. incóngrua	Say.	J. A. N. S. v. 2, p. 268
38. pexáta	Say.	J. A. N. S. v. 2, p. 268
39. ponderósa	Say.	J. A. N. S. v. 2, p. 267
40. transvérsa	Say.	J. A. N. S. v. 2, p. 269
13. Núcula	Lam.	
41. próxima	Say.	Con. Mar. Con. pl. 6, f. 2
42. acûta	Con.	Am. Mar. Con. pl. 6, f. 3
14. Sanguinolária	Lam.	
43. fúsca	Say.	Con. Mar. Con. pl. 7
44. lusória	Say.	Con. Mar. Con. pl. 7
15. Psammóbia	Lam.	
45. cayennénsis	Lam.	v. 6, p. 177
16. Tellína	Lin.	
46. maculósa*	Lam.	Wood G. Con. pl. 36, f. 3
47. alternáta	Say.	J. A. N. S. v. 2, p. 275.
48. polita	Say.	J. A. N. S. v. 2, p. 276
49. íris	Say.	J. A. N. S. v. 2, p. 302.
50. ténera	Say.	Gould. In. Mass. f. 44.
51. flexuósa	Say.	J. A. N. S. v. 2, p. 303.
52. brévifrons	Say.	
17. Donax	Lin.	
53. variábilis	Say.	J. A. N. S. v. 2, p. 305
18. Saxícava	Lam.	

54. distórta	Say.	Gould. In Mass. f. 40
19. Petrícola		
55. pholadifór-mis	Lam.	Say. Am. Con. pl. 60, f. 1
56. dáctylus	Sow.	Say. Am. Con. pl. 60, f. 2
20. Lutrária	Lam.	
57. canaliculáta	Say.	J. A. N. S. v. 2, p. 311
58. lineáta	Say.	Am. Con. pl. 9
21. Máctra	Lam.	
59. símilis	Say.	J. A. N. S. v. 2, p. 309
60. laterális	Say.	Gould. In. Mass. f. 34
61. oblongáta	Say.	J. A. N. S. v. 2, p. 310
62. tellinoídes	Con.	J. A. N. S. v. 6, pl. 11, f. 3
22. Amphidésma	Lam.	
63. orbiculáta	Say.	J. A. N. S. v. 2, .p 307
64. equális	Say.	Am. Con. pl. 28
65. lépida	Say.	J. A. N. S. v. 5, p. 221
66. punctáta	Say.	J. A. N. S. v. 2, p. 308
23. Mya	Lin.	
67. arenária	Lin.	Sow. Gen.
24. Córbula	Brug.	
68. contrácta	Say.	Gould. In. Mass. f. 37
25. Sólen	Lam.	
69. énsis	Lin.	Con. Mar. Con. pl. 5
70. víridis	Say.	Con. Mar. Con. pl. 5
26. Solecúrtus	Blain.	
71. caribæus	Lam.	Con. Mar. Con. pl. 4
72. frágilis	Pult.	Con. Mar. Con. pl. 4
27. Phólas	Lin.	
73. costáta	Lin.	Sow. Gen.
74. oblongáta	Say.	J. A. N. S. v. 2, p. 320
75. truncáta	Say.	J. A. N. S. v. 2, p. 321
76. semicostata*	Lea.	
77. cuneíformis	Say.	J. A. N. S. v. 2, p. 322
28. Terédo	Lin.	
78. palmúlatus?		Lam. v. 6, p. 38
29. Cháma	Lin.	
79. arcinélla*	Lin.	Sow. Gen. f. 2
30. Mytilus	Lin.	
80. túlipa	Lam.	Sow. Gen.
81. plicátula	Lam.	under Modiola
82. cúbitus	Say.	J. A. N. S. v. 2, p. 263
83. domingénsis	Lam.	v. 7, p. 40
84. laterális	Say.	J. A. N. S. v. 2, p. 264
85. castánea	Say.	J. A. N. S. v. 2, p. 266
86. lithóphaga	Lin.	Sow. Genera.
87. caudígera	Lam.	under Litho-
88. attenuáta	Desh.	domus.
89. leucopheá-tus*	Con.	J. A. N. S. v. 6, pl. 11, f. 13
31. Pínna	Lin.	
90. muricáta	Lin.	Lam. v. 7, p. 64
91. seminúda	Lam.	v. 7, p. 61
32. Avícula	Lam.	
92. atlántica	Lam.	v. 7, p. 99
33. Pécten	Lam.	
93. dislocátus	Say.	Am. Con. pl. 56
34. Plicátula	Lam.	
94. cristáta*	Lam.	v. 7, p. 177
35. Anómia	Lin.	
95. ephíppium	Lin.	Sow. Gen.
36. Ostræa	Brug.	
96. virginiána	List.	Sow. Gen. f. 2
97. fundáta	Say.	
98. equéstris	Say.	Am. Con. pl. 58

2. *SUBDIVISION. MOLLUSCOIDEA.*

Reproduction by buds as well as by eggs. Circulatory and nervous systems rudimentary.

IV. CLASS. TUNICATA.

Respire by internal branchiæ ; no tentacula about the mouth. One or more undetermined species of Ascidia exist on the cost.

V. CLASS. BRYOZOARIA.

Respire by external branchiæ, which form about the mouth a crown of ciliated and protractile tentacula. No heart.

Several marine species are found, and there are no doubt several fluviatile species also, but none have been satisfactorily determined.

IV. DIVISION. ZOOPHYTIC ANIMALS.

In general no skeleton interior or exterior. Organs symmetrically placed, rather about a central point or axis than about a plane. Nervous system rudimentary or null.

1. *SUBDIVISION. RADIATA.*

Body and organs presenting an arrangement decidedly radiated.

1. CLASS. ECHINODERMATA.

Teguments generally hard, and often armed with spines. Annimals formed for creeping.

1. Astérias	Lin.
1. spinósus	Link. J. A. N. S. v. 5, p. 142
2. articuláta	Say. J. A. N. S. v. 5, p. 141
3. clathráta	Say. J. A. N. S. v. 5, p. 142
2. Ophiúra	Lam.
4. anguláta	Say. J. A. N. S. v. 5, p. 145
5. elongáta	Say. J. A. N. S. v. 5, p. 146
6. brevispína	Say. J. A. N. S. v. 5, p. 149
3. Echínus	Lin.
7. punctulátus	Lam. v. 3, p. 363
8. variegátus	Leske.Lam. v. 3, p. 365
4. Cidárites	Lam.
9. metulária	Lam. v. 3, p. 381
5. Spatángus	Lam.
10. átropos	Lam. v. 3. p. 327
6. Scutélla	Lam.
11. quinquéfora	Lam. v. 3, p. 280
12. gibbósa	Rav. J. A. N. S. v.

II. CLASS. ACALEPHA.

Body gelatinous, in form of a disc or sac, formed for swimming.

1. Céphea	Lam.
1. rhizóstoma?	Lam.
(one or more	species not determined.)
2. Physália	
2. pelágica	

III. CLASS. POLYPI.

Animals sedentary, without special organs of locomotion, generally living in groups or communities, united by a common envelope corneous or calcareous.

1. Actínia	Lin.
1. cavernáta	Bosc. Lam. v. 3, p. 411
2. Astræa	
2. species not	determined
3. Gorgónia	Lin.
3. virguláta	Lam. v. 2, p. 495
4. Antípathes	
4. Bóscii	Lamx.Lam. v. 2, p. 484
5. alopecuroídes	Ellis. Zooph. p. 102
5. Renílla	
6. renifórmis	Ellis. Zooph. p. 65
6. Tubulária	
7. (species not	determined)

2. *SUBDIVISION. GLOBULOSA.*

Arrangement of parts not decidedly radiated, but rather irregular or even globular.

IV. CLASS. INFUSORIA.

Microscopic animals which have not yet received attention sufficient for their determination or arrangement.

V. CLASS. SPONGIA.

Several species of Sponges and allied forms, in this lowest class of the animal kingdom, exist on our coast, but have received even less attention than those of the last class.

REMARKS.

It is proper that the sources, whence the materials for the preceding catalogue have been drawn, should be indicated.

The list of Mammalia has been drawn up from the published volume of the "Quadrupeds of North America," by Audubon and Bachman, and from the manuscript notes of the latter gentleman.

The "Synopsis of the Birds of North America," by Audubon, and the "Herpetology of North America," by Dr. Holbrook, have furnished the list of Birds and Reptiles.

The list of Fishes was sent two years ago, by Dr. Storer of Boston, and has been compared with his "Synopsis of the Fishes of North America," published last year, but no doubt many additions to it will be made by Dr. Holbrook, in his Ichthyology of the Southern States, now in course of publication. With the exception of this class, the list of vertebrated animals may be considered complete.

Among the Annulated animals, the Insecta, Myriapoda, Arachnida, Rotifera, and Entozoa, have been entirely omitted, for reasons given in the catalogue. The lists of Crustacea, Cirripedes and Annelides, have been drawn up in great part from the writer's own observations, and partly, also, from the writings of Say, and of Milne Edwards.

The catalogue of Molluscous animals has been made out from the "Catalogue of Shells in the Cabinet of Dr. Ravenel," from manuscript communications of the same gentleman, from articles in various journals, and from the writer's own observations. This list may be regarded as tolerably complete, the Bryozoaria excepted, which have not been sufficiently examined.

The catalogue of Zoophytic annimals, made out chiefly from the writer's own observations, is very incomplete, this division not having attracted much attention, with the exception of the Echinodermata.

In the construction of the catalogue, the rule has been to admit those species only, which have actually been found within the limits of the State. The only cases in which it has not been strictly observed, are in the Birds, whose known habits render it almost certain, that if found both north and south of the State, they may be regarded as belonging to its Fauna—and in the Fishes, whose similar habits require a similar admission.

In the three last divisions, the Invertebral annimals, specimens collected within the State, of each of the species named, has passed under the eye and examination of the writer, except a few admitted on good authority, and indicated by a *; and the references given in the last two divisions have also been examined by him, with a few exceptions, indicated in a like manner. He is indebted to Prof. Tuomey, to Dr. E. Ravenel, Dr. Ogier, Rev. Dr. Bachman, Mr. F. S. Holmes, and Mr. J. H. Richard, of this city, to Dr. T. L. Burden, of John's Island, and to Dr. Barrett, of Abbeville, for the transmission to him of specimens of species that would otherwise have escaped his notice. Nearly all the species named, are in his cabinet; for the remainder he must refer to those of his friends.

To add to the value of the catalogue, the scientific names have been accented throughout, except in a few cases where the accent falls on the letter *y* in a word, or upon the first letter, a capital, for which the fount did not supply accented letters.

In the two first divisions, the vulgar names applied to the animals in this State have been given, as far as known. In the two last, not many having received common names, it was thought more useful to give references to a figure or description.

LEWIS R. GIBBES.
Prof. Math. Ast. &c. College Charleston.

Charleston, July, 1847.

Fort Johnson, 27th January, 1847.

My Dear Sir:—I send you herewith six Meteorological Tables, lettered from A to F inclusive. I have drawn largely from the published journal of the Surgeon General, as you will perceive; also, from a private diary kept by Mr. Perreneau in the city of Charleston, who noted his observation at 10 o'clock p. m. Table C from the records of Fort Moultrie, also table F. These observations were taken by the Medical Officers, and from 1840 by myself in a great measure. This last table was prepared in part (i. e. to 1841) by order of the Chief Engineer of the Harbour to ascertain what influence the prevailing winds might have upon the cutting away of Sullivan's Island—a period of thirty years shows the prevailing wind to be S. W. in this Harbour—next N. E. I have therefore recorded S. W. and N. E.

Very truly yours,

ROBERT LEBBY.

M. Tuomey, Esq.

Table A.

Showing the highest and lowest degrees, and range of Thermometer—course of Wind and Weather—Quarterly, from 1st *January* 1816, *to* 31st *December* 1820, *in Charleston.*

	Thermometer.						Winds.									Weather.				Remarks,
	Highest Deg.	Lowest Deg.	Mean.	Range.	Hottest Day.	Coldest Day.	North.	North West.	North East.	East	South East.	South.	South West.	West.	Prevailing.	Fair.	Cloudy.	Rain or Snow	Prevailing.	
1816.																				
1st Qr. January to 31st March...	69	40	54	29	24th March	9th January	4	13	25	2	5	4	31	6	S. W.	69	9	12	Fair.	Note.—This table was collected from the Diary of the venerable Wm. Perrenneau, Esq., of Charleston, and the observations recorded at 10 o'clock p. m.
2d " April to 30th June.......	78	65	71	13	15th June	7th April	0	6	12	9	10	15	39	0	"	62	9	20	"	
3d " July to 30th September...	84	68	77	16	23d July	28th Sept.	5	0	16	2	20	4	43	2	"	55	8	29	"	
4th " October to 31st December.	72	52	63	20	28th Oct.	30th Dec.	1	17	30	9	2	4	26	3	N. E.	57	20	15	"	
Mean of the year..............	76	56	66	19	23d July	9th January	10	36	83	22	37	27	139	11	S. W.	243	46	76	Fair.	
1817.																				
1st Qr. January to 31st March....	64	36	50	28	24th March	18th Jan'y	2	28	4	1	6	1	47	1	S. W.	69	5	16	Fair.	June was a wet month; July and August were rainy; Yellow Fever prevailed to an alarming extent during August and September: aggregate number of cloudy and rainy days in July and August were 40—Prevailing wind in Aug. and Sept. S. E. for the Qr. and Yr. S. W.
2d " April to 30th June......	79	65	72	14	30th June	1st April.	5	2	7	13	6	4	53	1	"	59	8	24	"	
3d " July to 30th September..	83	71	79	12	10th Aug.	25th Sept.	8	2	5	6	30	0	41	0	"	84	7	37	"	
4th " October to 31st December.	74	43	60	30	13th Oct.	21st Dec	8	16	13	5	27	3	18	2	S. E.	53	15	24	"	
Mean of the year..............	75	54	65	21	10th Aug.	18th Jan'y	23	48	29	25	69	8	159	4	S. W.	229	35	101	Fair.	
1818.																				
1st Qr. January to 31st March....	66	37	52	29	1st March	13th Jan'y	7	16	8	12	6	2	38	1	S. W.	53	5	32	Fair.	13th January sleet and snow; July frequent showers with severe thunder; August very dry; white frost 5th October; ice at Rantowl's, 13 miles from Charleston, on the 23d October; 8th November thick ice in City; December 17th and 18th snow and sleet.
2d " April to 30th June......	78	60	70	18	7th June	20th April	2	11	17	4	18	2	47	0	"	68	7	16	"	
3d " July to 30th September...	85	74	79	11	28th July	30th Sept.	14	0	4	7	13	5	49	0	"	67	7	18	"	
4th " October to 31st December.	71	46	58	25	26th Oct.	17th Dec.	21	19	13	9	5	1	24	0	"	73	8	11	"	
Mean of the year..............	75	54	64	21	28th July	13th Jan'y	44	46	42	32	42	10	158	1	S. W.	261	27	77	Fair.	
1819.																				
1st Qr. January to 31st March...	67	47	57	20	29th March	4th January	18	11	11	6	13	4	24	3	S. W.	69	9	12	Fair.	Ice on 2d and 16th March; 40 days of this qr. wind N. N W. N E.
2d " April to 30th June.......	78	64	72	14	29th June	1st April	6	3	6	10	20	7	35	4	"	59	13	19	"	
3d " July to 30th September...	84	73	79	11	2d July	29th Sept.	5	1	18	7	10	8	41	2	"	60	5	27	"	
4th " October to 31st December.	73	49	61	24	8th Oct.	31st Dec.	2	27	23	2	9	0	29	0	"	71	5	16	"	Very dense fogs 6 days in November.
Mean of the year..............	75	58	67	17	2d Aug.	31st Dec.	31	42	58	25	52	19	129	9	S. W.	259	32	74	Fair.	
1820.																				
1st Qr. January to 31st March...	68	46	58	22	8th March	24th Jan'y	2	25	18	2	7	3	28	6	S. W.	48	14	29	Fair.	April 2d. and 16, violent hail storms. September 10th, severe storm from S. E.
2d " April to 30th June.......	78	59	68	19	15th June	3d April	4	9	5	7	7	4	55	0	"	59	8	24	"	
3d " July to 30th September...	85	73	79	12	17th Aug.	20th Sept.	4	5	19	6	18	2	38	0	"	54	11	27	"	
4th " October to 31st December.	75	48	62	27	6th Oct.	1st Dec.	6	36	16	5	6	2	21	0	N.W.	58	15	19	"	
Mean of the year..............	76	58	67	18	17th Aug.	24th Jan'y	16	75	58	20	38	11	142	6	S. W.	219	48	99	Fair.	

Table B.

Exhibiting the hottest and coldest days in each year from 1820 *to* 1830, *inclusive, as observed at the several Military Posts of the United States Army. Those marked with an asterisk are remote from Lakes and Oceans—whilst those on Lakes or the Seaboard are without any sign.*

1820.	Lat.	Low'st Deg.	High't D.
*Fort Snelling, Iowa...	44°53	30	93
Portsmouth, N. H.....	43 04	3	94
*Prairie du Chien, Wi..	43 03	23	99
Boston Harbour.......	42 22	1	98
*Council Bluffs........	41 25	22	105
New London, Con.....	41 22	8	88
Fort Johnston, N. C...	34 00	28	90
New Orleans, La......	29 57	35	92
1824.			
Fort Brady...........		33	84
*Fort Snelling.........		27	
East Port, Me.........		19	86
*Prairie du Chien......		28	96
Boston Harbour........		8	90
*Council Bluffs........		21	103
New York Harbour....		2	96
Charleston Harbour....		24	91
Cant Clinch, Florida...		24	95
1828.			
Fort Brady...........		20	91
*Fort Snelling.		22	92
East Port............		10	85
*Prairie du Chien.		11	97
Boston Harbour.		3	94
*Jefferson Barracks, Mo.	38 28	100	100
New York Harbour. ..		9	90
Fort Gibson, Arkansas.	35 30	19	101
Fort Johnston.........		42	86
Tampa Bay, Florida...		50	94

1821.	Lat.	Low'st Deg.	High't Deg.
*Fort Snelling.........	44°53	32	92
Portland, Me..........	43 38	18	94
Portsmouth, N. H......	43 04	12	90
Prairie du Chien, Wi...	43 03	36	91
Boston Harbour........	42 22	10	99
*Fort Armstrong, Ill....	41 28	28	94
*Council Bluffs........	41 25	13	100
Fort Johnston, N. C....	34 00	30	89
Fort St. Philip, La.....	29 29	32	92
1825.			
Fort Brady............		21	89
East Port, Me..........		5	94
*Fort Howard, Wis....		25	100
Boston Harbour.......		5	98
*Council Bluffs........		11	102
New York Harbour....		3	104
Charleston Harbour....		28	94
St. Augustine, Florida..	29 50	42	94
1829.			
*Hancock Barracks, Me	46 10	24	92
*Fort Snelling.........		30	90
East Port............		16	82
*Fort Howard.........		32	92
Boston Harbour.......		4	88
*Fort Armstrong.......		16	96
New York Harbour....		7	95
*Fort Levenworth, Mo.	39 25	22	95
*Jefferson Barracks.....		1	97
*Fort Gibson.........		0	106

1822.	Lat.	Low'st Deg.	High't Deg.
*Fort Snelling.......		29	92
Portland, Me.........		10	96
Portsmouth, N. H....		7	86
Prairie du Chien....		22	94
Boston Harbour.....		7	92
*Council Bluffs......		17	108
Fort Johnson, N. C..		26	90
Cant Clinch, Florida.		20	93
*Fort Armstrong, Ill..		15	94
1826.			
Fort Brady..........		37	
Fort Mackinac, Mich.	45°51	31	82
East Port, Me........		24	98
*Fort Snelling.......		23	92
*Fort Howard.......		30	100
Boston Harbour.....		10	98
*Fort Armstrong.....		18	90
*Council Bluffs......		16	104
New York Harbour...		1	97
Fort Johnston, N. C..		28	86
Tampa Bay, Florida..		28	92
1829 (continued)			
Fort Johnston, N. C..		21	86
Charleston Harbour..		22	100
Tampa Bay, Florida.	27°57	28	92
1830.			
Fort Brady..........		26	93
*Fort Snelling.......		26	94
East Port...........		14	93
*Fort Howard.......		26	100
Prairie du Chien.....		23	94

1823.	Lat.	Low'st Deg.	High't Deg.
Fort Brady, Michigan...	46°39	30	90
*Fort Howard, Wis....	44 40	38	100
East Port, Me.........	44 44	10	90
Boston Harbour.......		3	97
*Council Bluffs........		16	102
New York Harbour....	40 42	3	91
Charleston Harbor, S. C.	32 42	19	89
Cant Clinch, Fla.......		11	94
1827.			
*Fort Snelling.........		22	96
East Port.............		4	89
Sacketts Harbour, N. Y.	43 57	27	82
Boston Harbour.......		7	94
*Fort Armstrong.......		6	94
*Council Bluffs........		12	
*West Point		10	101
New York Harbour.....		0	96
*Augusta, Ga..........	33 28	26	102
Charleston Harbour....		16	89
Tampa Bay...........		26	94
1830. (continued)			
Boston Harbour.......		4	93
*Fort Armstrong.......		24	98
New York Harbour....		5	98
*Council Bluffs........			105
Fort Severn, Md.......	38 58	10	100
*Jefferson Barracks.....	38 28	5	98
*Fort Gibson..........	35 30	3	107
Charleston Harbour....	32 42	20	94
Tampa Bay...........	27 57	30	92

Table C.

Shewing the state of the Thermometer, Winds, and Weather, at Fort Moultrie, Charleston Harbor, South Carolina, and the Mean of each month in the City of Charleston, for the year 1835.—*Also Abstract for the year* 1845.

1845. Months.	Fort Moultrie. Thermometer. Highest Degree. 7 A M	2 P M	9 P M	Lowest Degree. 7	2	9	Mean Temp. 7	2	9	Hottest Day.	Coldest Day.	Charleston. Mean Ther. 7 A. M.	2 P. M.	9 P. M.	Winds. North.	N. West	N. East.	East.	S. East.	South.	S. West.	West.	Prevailing.	Weather. Fair.	Cloudy.	Rain.	Snow.	Prevailing
January	58	66	60	26	29	30	43	51	47	28th	4th	43	54	47	4	4	5	0	1	7	8	2	S. W.	15	12	4		Cl'y
February	56	67	60	6	21	18	38	46	42	22d	8th	38	53	43	3	4	7	0	1	6	5	2	N. W.	17	7	4		Fair
March	62	69	63	26	35	31	47	55	52	19th	4th	57	61	53	0	2	10	2	2	3	9	3	S. W.	20	8	3		Do.
April	65	73	72	48	60	49	59	64	62	30th	5th	62	68	65	1	1	1	5	7	8	5	2	S.	19	8	3		Do.
May	79	82	79	60	70	68	71	77	73	31st	12th	74	81	81	1	1	1	7	7	8	6	0	S.	28	3	0		Do.
June	81	88	84	75	75	73	77	82	79	20th	21st	78	85	82	3	0	2	2	4	12	5	2	S.	22	4	4		Do.
July	84	87	84	71	68	69	77	82	79	31st	1st	79	85	82	2	0	3	3	5	9	5	4	S.	14	15	2		Cl'y
August	82	90	85	73	74	74	77	82	79	1st	9th	80	87	83	1	1	7	4	2	10	5	1	S.	19	9	3		Fair
September	78	81	80	61	67	63	75	75	73	7th	30th	71	78	75	2	0	14	7	1	1	4	1	S. E.	13	14	3		Cl'y
October	74	77	77	53	57	60	65	69	70	2d	8th	63	71	67	3	2	13	5	1	0	4	3	N. E.	16	11	4		Fair
November	70	75	73	44	48	48	60	63	63	9th	29th	62	68	64	4	4	3	3	2	7	6	1	S.	16	11	3		Do.
December	59	62	61	35	45	50	48	54	52	20th	24th	45	57	50	6	3	8	1	2	2	5	4	N. E.	20	10	1		Do.
Mean of the Y'r.	71	76	73	48	54	52	61	66	64	A'g 1	F'y 8	62	70	66	30	22	74	39	35	73	67	25	N. E.	219	112	34		Fair

REMARKS.

4th January: Thermometer at m. 29 1-2°
5th January, Sleet; 7th, High Wind;
8th do Boisterous Weather, and on
9th do Sleet; 15th, Rain, with Thunder and Lightning. 8th February, Thermometer in the City at 2 above 0.—A Thermometer belonging to the (late) Cashier of the Union Bank, graduated to 6' below Zero; the Mercury retired within the bulb, and did not flow when the *instrumente was inverted* on the morning of 8th. Orange Trees destroyed in Carolina and Florida.

Abstract for the year 1845, *of the Thermometer, Barometer, Dew Point, Winds and Weather, at Charleston, S. C.*

Months.	Barometer. Max.	Min.	Range	Thermometer Attached. Mean 7 A M	Mean 2 P M	Mean 9 P M	Hottest Days	Coldest Days	Thermometer Detached. Max'm. 7 A. M.	2 P. M.	9 P. M.	Mini'm. 7 A. M.	2 P. M.	9 P. M.	Mean Temp'ture. 7 A M	2 P M	9 P M	Register Thermometer. Mean Day.	Tem. Night	Hi'h Deg. day.	Low Deg. Night	Dew Point MEAN
January	30.47	29.80	0.67	50.51	58.93	54.21	17	31	64	68	67	35	42	42	48.61	54.37	52.41	57.96	47.32	67	36	44.41
February	30.50	29.60	0.90	49.57	58.25	53.92	23	5	64	73	64	31	41	39	43.89	58.28	52.96	59.60	46.53	71	32	42.07
March	30.58	29.74	0.84	55.35	63.45	59.77	31	20	66	78	69	40	54	47	53.64	64.32	59.03	64.12	51.32	76	40	47.41
April	30.45	30.00	0.45	65.80	72.86	68.50	18	9	72	85	75	43	54	52	64.46	75.26	67.46	75.60	62.80	85	41	57.70
May	30.50	29.80	0.70	67.97	75.03	69.77	5	16	74	80	74	53	57	55	67.35	73.45	69.41	77.66	66.58	85	50	62.93
June	30.45	29.94	0.51	74.03	85.00	78.86	23	1	81	94	84	62	70	65	75.00	84.03	73.46	86.86	74.30	96	63	69.46
July	30.36	29.92	0.44	74.00	82.25	82.49	22	1	81	92	86	72	75	75	77.42	83.80	79.39	86.54	74.25	93	69	72.77
August	30.34	30.02	0.32	77.32	83.00	79.67	15	3	80	89	84	65	68	67	74.48	80.74	76.67	83.66	73.22	91	65	71.96
September	30.33	29.81	0.52	73.70	80.50	76.60	5	25	79	88	82	56	68	62	71.20	79.06	73.30	80.50	68.40	90	55	66.10
October	30.50	29.75	0.75	62.93	69.90	66.54	10	22	76	82	76	43	54	51	59.61	68.70	63.03	69.67	55.38	84	43	54.61
November	30.45	29.74	0.41	52.70	61.16	56.26	1	28	68	76	68	38	44	41	49.40	60.50	54.33	61.63	46.50	75	36	41.00
December	30.54	29.50	1.04	41.93	47.89	44.64	9	21	58	62	59	20	30	25	40.16	45.54	41.19	47.96	36.93	62	20	32.26

Months.	Course of Winds at Sunrise. N.	N. E.	N. W.	E.	S.	S. E.	S. W.	W.	Prevailing.	Course of Winds at 4 P. M. N.	N. E.	N. W.	E.	S.	S. E.	S. W.	W.	Prevailing.	Weather. F.	C.	R.	Prevailing.	Quantity Rain.
January	1	6	11	2	0	0	10	1	N W	2	3	8	5	0	0	8	5	S W	25	2	4	Fair	3.65
February	1	5	10	2	0	3	7	0	do	0	7	6	3	1	2	7	2	N E	21	4	3	do	1.20
March	3	9	4	1	0	4	10	0	S W	2	7	3	1	4	4	5	5	do	20	3	8	do	2.72
April	1	4	4	2	0	2	14	3	do	0	1	2	7	1	2	15	2	S W	25	1	4	do	0.10
May	2	3	4	4	2	6	9	1	do	1	1	2	6	3	6	11	1	do	17	7	7	do	7.62
June	1	0	2	2	5	4	14	2	do	0	0	2	2	7	5	13	1	do	22	3	5	do	1.69
July	1	6	1	3	2	3	14	1	do	0	2	0	2	3	8	16	0	do	15	3	13	R'in	8.02
August	4	9	1	1	1	2	12	1	do	3	4	1	4	2	4	11	2	do	16	5	10	Fair	9.42
September	6	10	1	3	1	1	7	1	N E	2	10	1	7	1	3	5	1	N E	21	5	4	do	2.27
October	3	19	2	1	1	3	2	0	do	2	17	2	3	2	3	1	1	do	16	6	9	do	5.51
November	1	4	11	0	1	2	8	3	N W	3	3	17	0	0	2	12	3	S W	17	7	6	do	0.62
December	0	7	14	0	0	0	5	5	do	0	[illegible]	4	0	0	1	5	2	[illegible]	15	5	11	[illegible]	[illegible]

Table D.

Shewing the difference of Temperature, more especially as regards its distribution among the Seasons, between the Seaboard and the interior remote from large bodies of Water.

Places of Observation.	Latitude	Mean an. Tem.	Range of Thermomter.	Winter.* Dec.	Jan.	Feb.	Spring. March.	April.	May.	Summer. June.	July.	Aug.	Autumn. Sept.	Oct.	Nov.
				31 22	28 17	28 17	35 07	41 82	56 77	62 15	69 61	69 39	62 76	52 18	40 38
				24 98	17 57	19 89	32 15	42 86	69 24	74 22	75 40	72 49	59 08	53 17	38 94
Atlantic	43 06	4 18	98 24 212	29 19			44 55			67 05			51 92		
Interior remote from Lakes.	43 09	48 83	104 23 127	20 81			48 08			74 04			50 38		

See Meteorological Abstract of Medical Bureau U. S. Army, 1840.

Winds and Weather.

Abstract Shewing the course of the Wind and state of Weather.

Place of Observation.	Mean Latitude	N. Days.	N. W. Days.	N. E. Days.	E. Days.	S. E. Days.	S. Days.	S. W. Days.	W. Days.	Prevailing	Fair. Days.	Cloudy Days.	Rain. Days.	Snow. Days.	Prevailing
Sea Coasts.	43 18	1 71	5 46	3 47	1 69	2 35	6 36	5 23	4 25	S.	16 89	9 09	3 77	0 79	Fair.
Region beyond the Lakes.	43 10	3 89	3 30	1 51	2 00	2 88	7 16	4 19	6 07	S.	20 04	6 46	2 60	1 36	Fair.
*Charleston Harbour.	32 42	1 25	0 66	6 58	5 50	3 91	5 25	4 41	2 91	N. E.	23 33	2 50	4 66	—	Fair.

See Meteorological Abstract of Medical Bureau U. S. Army.

*Added by the Collator.

Table E.

Shewing the mean temperature of each month, each season, and the whole year.

Years of Observation.	Place of Observation.	Lat.	Mean annual Temperature.	Mean Temperature of the Seasons. Winter,	Spring,	Summer,	Autumn.	Mean Temperature of each Month. Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1826, 7, 8.	Fort Brady, Mn.	46°39′	41.84	21.67	39.36	62.54	45.46	18.24	20.24	26.90	37.20	53.91	57.87	65.85	63.91	56.19	46.43	33.75	22.49	Michigan.
Do.	" Sneeling, Ia.	44.53	45.77	17.29	45.67	72.80	47.35	13.59	19.27	31.19	42.49	63.32	71.94	74.77	71.68	58.12	49.50	34.15	15.08	Iowa.
1828, 9, 30.	" Preble, Me.	43.38	46.92	26.71	44.27	67.45	49.29	22.54	25.07	33.24	45.01	54.57	64.75	69.59	68.00	58.12	49.20	40.28	32.52	Maine.
29,30	" Niagara, N. Y.	43.15	51.69	30.46	47.23	72.19	56.98	26.86	25.20	34.39	47.52	59.77	68.90	74.60	73.06	63.85	58.94	48.12	39.32	New York.
1828, 29, 30.	" Woolscot, Ct.	41.30	50.10	33.21	48.66	67.93	53.21	30.77	30.39	36.96	45.38	55.75	64.84	69.45	69.50	61.69	53.10	44.84	38.45	Connecticut.
Do.	" Armstrong.	41.28	51.57	26.86	50.53	76.06	52.60	24.49	24.59	36.48	51.29	63.83	74.01	77.77	76.06	62.22	55.36	40.22	31.49	
Do.	West Point, N. Y.	41.22	52.74	32.81	50.44	73.28	54.51	29.52	29.74	38.88	50.54	61.90	70.88	74.53	74.42	65.33	52.66	45.55	39.15	New York.
Do.	Washington.	38.41	55.68	37.85	54.70	76.83	56.97	35.90	36.53	44.50	53.71	65.88	75.48	78.02	76.98	66.99	56.41	47.50	41.12	District Columbia.
Do.	Jefferson Barracks.	38.28	57.77	37.37	58.63	78.54	56.53	35.42	33.63	46.68	59.18	70.04	77.90	78.67	79.09	67.11	56.12	46.36	43.07	Missouri.
Do.	Fort Monroe.	37.02	61.57	45.51	58.25	78.50	64.01	44.67	43.40	49.13	57.58	68.04	76.49	79.69	79.32	71.85	64.33	55.84	48.45	Old Point, Virginia.
Do.	Cant. Gibson.	35.30	62.90	44.31	62.49	81.14	64.90	45.47	41.25	53.51	61.28	72.69	78.65	81.49	83.28	74.61	65.95	54.12	46.20	Arkansas.
Do.	Augusta Arsenal.	33.28	65.24	50.66	64.30	81.21	64.49	50.00	49.44	55.90	64.29	72.72	81.06	81.55	81.02	72.73	64.76	55.97	52.55	Georgia.
1830,	Charleston Harbour.	32.42	64.31	46.92	71.83	77.83	60.67	47.08	42.22	51.48	61.89	73.81	79.79	79.44	79.58	74.47	68.19	62.27	51.55	South Carolina.
1828, 9, 30.	Petites Coguilles.	30.10	71.40	59.05	70.13	83.44	72.98	57.71	58.47	63.86	69.28	77.41	82.73	83.77	83.83	80.56	73.10	61.95	61.32	Louisiana.
1825, 8, 30.	St. Augustine.	29.48	72.24	62.83	70.55	82.05	73.56	62.15	64.97	66.53	68.68	76.44	81.12	82.36	82.68	79.56	73.61	67.47	61.38	Florida.
Do.	Cant Brooke.	27.57	73.19	65.02	71.71	81.04	74.59	63.75	66.56	66.48	71.27	77.39	80.90	81.43	80.79	79.01	75.04	69.71	64.76	Tampa Bay, Fla.
	Fort Vancouver.	45.37	51.75	41.33	48.00	65.00	52.67	38.00	43.00	44.00	46.00	54.00	63.00	66.00	66.00	61.00	54.00	43.00	43.00	Oregon Territory.
	North Cape.	71.00	32.00	23.72	29.66	43.34	32.08													
	Ulea (Lap.)	65.03	35.08	11.84	27.14	57.74	35.96													
	Edinburgh.	55.58	47.31	39.40	44.70	57.30	47.86	40.17	39.54	39.60	45.84	48.67	54.85	59.31	57.74	55.61	48.37	39.60	38.50	Vide Meteorological Register, published in 1840 by the Surgeon General U. S. A.
	Moscow, Russia.	55.45	40.10	10.78	44.06	67.10	38.30													
	London.	51.31	50.39	39.12	48.76	62.32	51.35	37.36	40.44	42.64	48.00	55.64	60.00	63.43	63.52	58.80	51.78	43.47	39.58	
	Penzance.	50.07	52.16	44.66	49.66	60.50	53.83	43.00	44.50	46.50	48.50	54.00	59.00	61.00	61.50	58.00	54.50	49.00	46.50	
	Paris.	48.50	51.50	38.43	50.40	64.47	52.30	35.60	40.50	43 50	49.60	58.10	62.50	65.70	65.20	60.40	52 40	44.20	39.20	
	Nice.	43.41	59.48	47.82	56.23	72.26	61.63	45.85	49.00	51.45	57.00	63.00	69.00	73.50	74.30	69.35	61.85	53.70	48.60	
	Montpelier.	43.36	57.60	44.60	53.33	71.30	61.30	42.00	45.00	47.00	53.00	60.00	67.00	72.00	75.00	71.00	61.00	52.00	46.00	
	Rome.	41.54	60.70	48.90	57.65	72.16	63.96	47.65	49.45	52.05	56.40	64.50	69.17	73.30	74.02	69.50	63.60	58.80	49.62	
	Naples.	40.50	61.40	48.50	58.50	70.83	64.50	46.50	48.50	52.00	57.00	66.50	71.00	75.00	76.50	72.50	65.00	54.50	50.50	
	Madeira.	32.37	64.56	59.50	62.20	69.33	67.23	59.50	58.50	61.06	62.50	63.00	65.00	70.00	73.00	71.50	67.50	62.70	60.50	
	Cairo.	30.02	72.12	58.52	73.58	85.10	71.48	58.10	56.12	64.58	77.90	78.26	83.66	85.82	85.82	79.16	72.32	62.96	61.34	
	Cumana, S. A.	10.27	81.86	80.24	83.66	82.04	80.24													

Table F.

Shewing the Prevailing Winds each Year, in the City and Harbour of Charleston, from 1829 *to* 1846, *inclusive, and quantity of Rain from* 1840 *to* 1846.

1829	1830	1831	1832	1833	1834	1835	1836	1837	1838	1839	1840	1841	1842	1843	1844	1845	1846	Prevailing.
E.	N. E.	S. W.	N. E.	S. E.	N. E.	S. W.	S.	S.	N. E.	S.	S.	S. W.	S. W.	N. W.	S. W.	S. W.	S. W.	S. W.
									Quantity of Rain.			Ft. in. 4.50	Ft. in. 3.50	Ft. in. 4.64	Ft. in. 3.03	Ft. in. 3.87	Ft. in. 3.69	Average. 3.86.

RECAPITULATION.

N.	N. W.	N. E.	E.	S. E.	S.	S. W.	W.	Prevailing.
0	1	4	1	1	4	7	0	NE & SW.

Average in 6 years, 3 feet 86 Rain.

Note.—We find from 1816, a period of 30 years, the prevailing winds to be S. W. and N. E. Observations on Rain Guage were made in the City of Charleston by the City Register—the difference is so slight, with those of the Harbour, we have substituted the City Observations.

VANUXEM'S REPORT.

(*From "Mills' Statistics of South Carolina.*")

Of the minerals collected, there are *thirty species*, and of the rocks *ten species*. The most important are two species of iron ore; also marble or limestone, pyrites, gold, and oil stones. The two species of iron ore, are the magnetic, or gray ore, and the hydrate, or brown ore. The only furnace in the upper country now in operation, which uses the brown ore, is the one belonging to Col. Nesbitt, in Spartanburg District. Two furnaces make use of the gray ore; they are in the Districts of York and Spartanburg. It is also carried from York to North Carolina, where it is reduced to iron.

The gray ore makes the best iron, either for bar iron or castings. This ore is found in abundance in York and Spartanburg; in both these Districts it is connected with the same rocks and minerals, and pursues the same direction. The brown ore, though inferior to the gray in the quality of the metal produced, yet is more generally distributed, and more abundant than the other kind.

In the upper country there are two ranges of limestone having the same direction to each other, and parallel to the great mass of rocks which covers the State, so far as the examination has extended. The general direction of all these rocks is nearly North East and South West. The western range of limestone is in the upper part of Pendleton, whilst the eastern one is met with in Spartanburg and York. They produce excellent lime when burnt. In Spartanburg the limestone furnishes very beautiful granular marble, consisting of the white, blue, and brown varieties; this latter is new in the arts.

The mineral called pyrites is very abundant in Spartanburg and York. It will be of great value to the State, whenever the United States is deprived of her foreign commerce, as it is a raw material in the making of copperas and allum.

To this mineral also, in such an event, must we look for our supply of sulphur, essential to the manufacture of gunpowder. A variety of pyrites containing gold, is found in Spartanburg, at three different points. This same mineral is worked for gold in two or three places in Europe. Gold has been found in Abbeville and in Spartanburg Districts. A lump of gold was picked up last spring on the plantation of Mr. John E. Norris, in the Calhoun settlement. It weighed thirty-two penny weights. A part of it is in the collection of the College. No doubt exists as to the fact of the discovery, and the spot where found.

That portion of Spartanburg District which contains gold, is on middle Tiger River, near the Greenville line. The gold owes its appearance to the decomposition of the pyrites before mentioned. When this gold is considered in connexion with the products which pyrites is capable of yielding, it will, at no distant period, be of importance to the section of country where found, and probably to the State generally.

In Abbeville District, oil stones are met with in abundance; they are considered by the workmen as being equal, if not superior, to those from Turkey, which rarely sell for less than seventy-five cents a pound.

So far as information has been obtained of the upper country, there is no likelihood of gypsum being discovered in any part of it. If found in the State, it will be met with in the region of country which lies between Columbia and the sea-board. Besides gypsum, we may also expect to find, in that part of the State, the same kind of marl which has so greatly contributed to enhance the value of the poor lands of New Jersey, by the fertility which it imparts to the soil.

The collection of minerals and rocks consists of upwards of five hundred specimens.

MINERALS FROM ABBEVILLE DISTRICT.

Gold. Iron, (two species) magnet or gray ore, both massive and in the form of sand—titaniferous iron. Copper pyrites. Lead ore, (galena) in small quantity. Kaolin. Quartz crystals, common and amethyst, abundant. Garnet, greenish yellow, for the first time discovered in the United States. Epidote. Amphiboles variety hornblende. Lithomarge.

ROCKS FROM THE SAME.

Granite, (common and hornblende granite,) predominant rock. Sciente, very abundant and beautiful. Gneiss. Leptinite, a variety of this rock forms excellent oil stone—a fraud was put upon the State by using a disentegrated variety of this rock as a cement in building the Court House; it has no adhesive property whatever.

Diabase, (green stone.)

MINERALS FROM PENDLETON DISTRICT.

Iron, magnetic or gray ore. Lead ore. Plumbago. Kaolin. Carb. lime. Talc, (lamilar.) Asbestus. Quartz crystals. Amphibole. Epidote. Tourmaline, (variety, schorl.)

ROCKS FROM THE SAME.

Gneiss, predominant rock. Mica, schiste. Limestone. Granite; serpentine, mixed with talc or actinolite.

MINERALS FROM GREENVILLE DISTRICT.

Iron, oligiste or red oxide, same as Elba. Lead ore in small quantity. Yttro-columbite, contains the columbium and earth yttria. Titianium, oxide, silico calcareous oxide. Emerald. Tourmaline. Sulphate of barytes. Feldspar. Kaolin. Lithomarge. Quartz crystals. Sulphur in small particles, arising from decomposition of pyrites.

ROCKS FROM THE SAME.

Gneiss. Granite. Green stone.

MINERALS FROM SPARTANBURG DISTRICT.

Gold. Pyrites. Do. white. Iron. Titanium, oxide. Plumbago. Garnet, (common and precious.) Tourmaline. Staurotide. Disthene. Feldspar. Talc, (scaly and schistose.) Phos. lime. Asbestus. Epidote. Quartz crystals. Amphibole, the sub species hornblende, tremolite and actinolite.

ROCKS FROM THE SAME.

Gneiss predominant. Granite, common and graphic. Mica schiste. Talco—Mica—Schiste. Marble or granular limestone. Diabase. Leptinite. Quartz, granular. Hyalomicte, graisen.

MINERALS FROM YORK DISTRICT.

Iron. Magnetic or gray ore, very abundant, being worked for iron, black oxide with chrome-hydrate. Pyrites, common, magnetic. Lead ore, galena; it is found in the rock, but in small quantity.

Sulphate of barytes, two localaties, and in great masses. Corundrum, adamantine spar. Asbestus. Talc, French chalk. Garnet.

Hyalin quartz, very transparent; in large pieces and fit for jewelry.

ROCKS FROM THE SAME.

Granite, common, porphyritic, hornblende. Mica—Schiste. Gneiss. Leptinite. Diabase. Quartz, schistose. Chlorite—Schiste.

INDIGO.

October 3d, 1845.
ORANGEBURG.

My Dear Sir:—In fulfilment of the promise I made to you, I herewith send a brief statement of the method of cultivating and manufacturing Indigo, together with a few specimens of such as is made in this District. I am, Sir, very respectfully, your ob'dt. serv't.,

THOMAS W. GLOVER.

Indigo was planted in South Carolina at an early period, and was extensively cultivated, and constituted an important item in the exports of the Colony, till rice, in the lower country, and cotton, almost every where, superceded it.

In Orangeburg District it has never been abandoned, and the following exhibit will shew the number of acres planted and the amount made in three several years:

Years.	*Acres planted.*	*Amount made.*
1831	953	27,700 lbs.
1841	1091	34,150 lbs.
1842	1337	35,935 lbs.

The average production per acre, therefore, was, 29 lbs. in 1831, 31 lbs. in 1841, and 26 lbs. in 1842. Some planters, however, in 1842, made upwards of 60 lbs. per acre.

The price of Carolina Indigo varies from 40 to 80 cents, and much of it is vended in the interior or in the neighboring States.

Light and sandy land, which will not yield more than 500 lbs. seed cotton per acre, is generally appropriated to this culture, the better soils being reserved for cotton.

Two species of Indigo have been cultivated here—the tame, which is an annual plant, and the wild, which is septenial. The latter, re-producing seven years successively, and affording a better and finer dye, has almost entirely supplanted the former.

The seed is planted about the 15th of April, in trenches 18 inches asunder, made sometimes with the plough, and it is afterwards worked with the hoe. The wild Indigo may be cut once during the first year; but it is frequently not touched till the second. The ground is hoed over every subsequent year, about the last of March, and before the plant appears. One bushel of seed is enough and is used for four acres planted in drill. The weed is cut (after the first year,) twice annually—early in June, and again in September; and the hoe is used, even after the second cutting, that the land may be left free of grass.

MANUFACTURE.

Three vats or tanks, made of wood, and water tight, are employed in the manufacture of Indigo. First, the *Steeper*, which is sixteen feet square and twenty-six inches deep; second, the *Beater*, sixteen feet by twelve, and four feet deep, and third the Lime Vat, which is ten feet square and three feet deep, into which is put two bushels of lime, and, in the process of manufacturing, one half of a bushel is added to each subsequent vat made. When the plant begins to bloom, it is cut with hooks, early in the morning, and two wagon loads are put in the *Steeper*, which is filled with water by pumps, or, if the locality admits, by troughs from a hill-side. Laths are placed over the weed, which is entirely immersed under the water, where it remains till sufficiently steeped. The indications by which the sufficiency of the steeping is judged, are various, and mainly depend on experience. If the fermentation stops, or the leaves cease to be brittle, or the water subside, it is drawn from the *Steeper* into the *Beater*, the former being elevated above the latter to admit the free passage of the liquid through troughs. When in the Beater a wheel, with arms placed on a shaft, is used to stir and agitate the liquid for about fifteen minutes. Lime water is then added from the lime vat till a cloudy hue appears; with an addition of lime water, it is again agitated thirty or forty minutes, until granulation begins. After beating, or this process of agitation, the liquor remains at rest about four hours, when, from its affinity for and combination with the lime, and from its greater specific gravity, the dye stuff is precipitated and the liquid is drawn off. The drug deposited at the bottom of the Beater is then collected and removed into a box five feet square and fourteen inches deep, called the Drainer, which is placed on a bed of sand, and inside of which, and in contact with the sand, is a coarse cloth, (cotton osnaburghs.) From the Drainer the Indigo is placed in a box three feet long and fourteen inches wide, called the Press, in which a stout cloth is also put and folded over the Indigo. It is then pressed till sufficiently dry, and cut into pieces about two inches square, which are placed separately for several days, and then put into barrels for market.

ANALYSIS OF MARLS FROM THE VICINITY OF CHARLESTON.

By Charles Upham Shepard, *Professor of Chemistry in the Medical College of the State of South Carolina.*

In connexion with my lately completed course on Chemistry applied to agriculture, the following results were obtained, which, as they were in some respects novel to myself, may not prove wholly uninteresting to others.

The specimens examiued may be conveniently referred to, under the following names:

1. *Yellowish gray chalk-marl*; 2. *Greyish white chalk-marl*; 3. *Agillaceous chalk-marl*; 4. *Marly limestone.*

1. *Yellowish grey chalk-marl.* (*Green marl.*)

This is a loose, slightly cohering stone, much freckled with brown and blackish grains. It easily crumbles down when wetted, at the same time assuming a dark, greenish grey color. When the crumbling particles are thoroughly washed with water, so as to float off the finer powder, we discover, with the aid of a common microscope, little fragments of shells, zoophytes and echinoderms, as well as of bones, mingled with fine grains of sand, and occasionally with particles of green earth. Dry lumps of this marl do not emit the argillaceous odor on being moistened.

(*a.*) From Mr. J. P. Clement's plantation, on the west bank of Ashley River, fourteen miles above Charleston. The bank is 30 feet above the bed of the river, and directly contiguous to navigable water.

Silica,	28.00
Carbonate of lime, with traces of carb. magnesia,	58.00
Phosphate of lime and magnesia, with traces of peroxide of iron,	8.80
Alumina,	0.80
Water,	4.00
	99.60

Water boiled on this marl, takes up an abundance of sulphate of lime and of chloride of calcium. The stone gives off fumes of ammonia on being wetted with solution of potassa. It is also slightly impregnated with bitumen, or mineral-tar.

(*b*) From the Rev. Dr. Hanckel's place, at Church Creek, St. Andrews. In connection with this locality, I noticed various fragments of fish-remains, and casts of a small *Cardium*, about ¾ of an inch in diameter.

Silica,	29.08
Carbonate of lime,	44.40
Carbonate of magnesia,	9.58
Phosphate of lime and magnesia, with traces of peroxide of iron,	7.00
Alumina,	.80
Water,	4.00
	94.86

Soluble ingredients and bitumen, the same as in (*a.*)

(*c.*) From Pon Pon on the Ashepoo. This fragment was handed me by Dr. Holbrook.

Silica,	34.41
Carbonate of lime,	58.56
Carbonate of magnesia,	2.12
Phosphate of lime and magnesia, with traces of peroxide of iron,	2.47
Alumina,	0.40
Water,	4.00
	101.96

Contains bitumen. Soluble ingredients not tested.

Mean result for the three foregoing localities.

Silica,	30.43
Carbonate of lime and magnesia,	57.55
Phosphate of lime and magnesia,	6.09
Alumina,	0.66
Water,	4.08
	98.73

With traces of peroxide of iron, ammonia, sulphate of lime, chloride of calcium, bitumen, and very feeble indications of some compound of potassium.

2. *Greyish white chalk-marl.*

This is a fine grained, porous, easily pulverized stone, strikingly analogous in its lithological properties to the chalk-marls of Westphalia. Its color is greyish white, sometimes tinged brown by iron, and rarely having a pale yellow hue, mingled with the grey. It is easily crushed to powder, even with the strength of the hands, especially if it is wetted. It is richer in fossil remains and impressions, than the variety first described. The most conspicuous of these fossils are an anthophyllum of a conical form, and one inch or more long, a slender jointed coralline, a caryophyllia, stem of a pentacrinites? spines and plates of echini, a cast of a small belemnites, of a natica, a fulgur, a ranella, a scalaria, a mytilus, a venus (2 inches across) and cytherea (of about one inch,) a cardium and shells of a balanus (1 inch across and ¾ high.) In addition to these, are noticed frequent fish remains, as teeth, bones, and scales, as well as irregular fragments of bones, which must have belonged to larger animals.

(*a.*) From Drayton-Hall. Specimen from Dr. Drayton.

Silica,	10.20
Carbonate of lime,	66.04
Carbonate of magnesia,	2.56
Phosphate of lime and magnesia, with traces of peroxide of iron,	8.60
Alumina,	1.00
Water,	4.00
	92.40

Rich in ammonia, sulphate of lime, chloride of calcium, with distinct traces of bitumen.

(*b.*) From Dr. Gedding's plantation, called "Elms," on Goose Creek, a branch of Cooper River, and fifteen miles from Charleston. It has a pale buff color, and is less fossiliferous than the variety from Drayton Hall.

Silica,	18.60
Carbonate of lime,	68.00
Carbonate of magnesia,	1.20
Phosphate of lime and magnesia, with traces of peroxide of iron,	9.20
Alumina,	40
Water,	4.00
	101.04

Bitumen and soluble matter as in (*a.*)

(*c.*) From Mr. T. Harleston's plantation, called Elwood, on Cooper River.

Silica,	16.200
Carbonate of lime,	76.880
Carbonate of magnesia,	1.406
Phosphate of lime and magnesia,	2.600
Alumina,	traces.
Water,	4.00
	101.086

Soluble matter and bitumen, only in traces.

Mean of the three results.

Silica,	15.00
Carbonate of lime and magnesia,	72.06
Phosphate of lime and magnesia,	6.80
Alumina,	46
Water,	4.00
	98.32

3. *Argillaceous chalk-marl. From Mr. Dixon's Plantation.*

This is a light, porous, fine grained, clayey looking marl, which emits a strong argillaceous odor when moistened, and easily falls to pieces in water. Its color is dark grey, with a tinge of yellow. It embraces small white fragments of shells, and strikingly resembles certain fresh-water marls. Among its particles, when well washed, are noticed grains of sand and of bone; but the latter in much smaller quantity than in either of the foregoing varieties.

Silica,	16.00
Carbonate of lime,	63.50
Carbonate of magnesia,	7.00
Phosphate of lime and magnesia, with traces of peroxide of iron,	2.00
Alumina,	4.75
Water,	5.00
	98.25

Soluble salts, only in traces.

4. *Marly limestone, from Wilmington, N. C. Found in thick beds, contiguous to the Steam Boat Landing.*

This is rather a firm rock, often sub-crystaline and rich in fossils, both zoophytic and molluscous, besides containing frequent remains of fish. Certain portions of the bed which are softer and more cretaceous in appearance, embrace irregular, oval balls, sometimes of the size of a hasle nut or almond, which are green and often mottled like serpentine. Their surface is often sprinkled over with coarse grains of sand. In hydrochloric acid, they are principally dissolved with rapid effervescence; from which, ammonia throws down a copious precipitate of phosphate of lime and magnesia, and the clear liquor subsequently affords abundance of lime and magnesia. The matter not taken up by the acid appears to be sand and green earth. It is not easy to explain the origin of these green nodules. The marly limestone has the following composition:

Silica,	16.00
Carbonate of lime and magnesia,	80.00
Phosphate of lime and magnesia,	2.80
Alumina,	1.00
Water,	2.00
	101.80

REMARKS.

Prior to these analyses, it was difficult to account, in any very satisfactory manner, for the known efficacy of such marls in agriculture; since the soils on which several of them had been employed were known by analysis, to be no more deficient in carbonate of lime and magnesia than the prolific soils of the Mississippi Valley. The reason assigned for marling in South Carolina, by Mr. Ruffin, viz: that carbonate of lime is thereby afforded to land, does not appear to me to be the chief motive the planter has for following up this practice.* It would rather appear that the soluble saline matter and bitumen are also among the active ingredients of this species of mineral manure, while the phosphate of lime and magnesia, is that constituent which, in my opinion, is decidedly paramount to all others.

This view of the efficacy of phosphatic marls accords with what is known of the large proportion of phosphate of lime and magnesia found in the fruits of plants, and especially in those of the cereals; it having been observed that where this amendment is employed, that the maturation of the grain is more perfect, the quantity and quality both, being highly promoted.

To place the requisition of these phosphates by plants, especially in the ripening of seed, in a still stronger light, I may, in conclusion, quote the recent experiments of Dr. Vogel, (*See Annalen der Chimie und Pharmacie*, 1844,) on the distribution of mineral substances by the individual organs of plants. This interesting paper commences with the statement of what was known before, viz: that the incombustible residues obtained from different organs of the same plant do not agree with one another in composition; the ingredients being often quite different in kind, and always in their proportions. For instance, the ashes of the tubers of the po-

* This writer, in his Report on the Agricultural survey of this State, (p. 51, et seq. 1843,) observes, that this ingredient has a strong chemical attraction for soluble, putrescent matters, vegetable and animal, and a power of combining with them, forming compounds which cannot be decomposed by air, water or heat, and which cannot therefore go to waste, but which are perfectly decomposable by the powers of growing vegetation, and therefore may be profitably and entirely used as food for plants. Herein, he observes, is the great secret of the benefit of Calcareous manures. Other useful services enumerated by the same judicious writer, are their neutralizing the acidity of certain soils, altering the texture and absorbency of others, causing crops to mature earlier; also as being an essential aliment of plants, of preventing malaria, and finally of serving to impart to plants such a healthy and vigorous state of growth as to enable them *to escape the ordinary* sources of injury.

tato are quite different from those derived from the tops; while other diversities again exist between the composition of the balls and that of the stems.

Dr. Vogel selected for his experiments the ashes of the Pyrus spectabilis and of the Sambucus nigra.

In the trunks of the first of these plants he found,

Alkaline carbonates,	4.6
Carbonate of lime,	82.2
Carbonate of magnesia,	4.9
Phosphate of lime and magnesia,	8.8
	100.5

In the leaves were found,

Alkaline carbonates, with traces of chloride of sodium, sulphate of potassa, and alkaline phosphates,	6.8
Carbonate of lime,	72.9
Carbonate of magnesia,	9.76
Phosphate of lime and magnesia,	10.50
	99.90

In the fruit,

Alkaline carbonates,	1.9
Alkaline phosphates,	14.1
Carbonate of lime,	37.00
Carbonate of magnesia,	5.52
Phosphate of lime and magnesia,	18.60
Silica,	3.70
	97.92

On comparing these results, it appears that the soluble salts are nearly eight times greater in the fruit than in the stem. The phosphates augment also in the fruit, while the carbonates fall off from 86 to 45.

In the Sambucus nigra, the quantity of phosphoric acid in the trunk, amounted to 10.5 p. c., whilst in the leaves, 13.6, and in the fruit to 20.3, p. c.

REPORT ON THE SOILS,

FROM THE ST. JOHN'S COLLETON AGRICULTURAL SOCIETY, EDISTO ISLAND.

The following is a catalogue of the soils submitted for my examination.

A. *Virgin Wet Mud.*
B. *Deposit Wet Mud, or that taken from a spot from which mud was taken two years ago.*
C. *Close sandy soil from high land.*
D. *Dark gray soil from land rather flat for cotton.*
E. *Very light sandy soil—very high land.*
F. *Dark gray soil from land rather low.*
G. *Close yellow sandy soil—high land.*
H. *Close yellow soil from the most productive parts of my tract—high land.*
I. *Mud that has been exposed to the action of the sun for nearly two months.*
K. *Mud taken from the cotton field in which it was buried last year.*

The general aspect of these soils is uniformly sandy; the size and shape of the grains being analogous to those of the high sand banks, every where common on the Atlantic coast. When cleared, by washing, or by heat, of the small portion of impalpably fine mineral and organic matter with which the grains of sand are enveloped, they are then observed to be so fine as to be agitated by a very slight current of air.

In color the soils vary from a light yellowish white, to an ash-gray. The order in which they pass through these shades, beginning with the lightest, is as follows. F, G, C, H, E, D.

The capacity of different soils for water being a point of acknowledged importance in determining their adaptation to particular crops, I commenced my inquiries with a view to ascertain the relation of these soils to moisture.

Specimens, selected for the purpose, were first exposed to a dry atmosphere for many days, and then dried in equal weights, at temperatures below the point at which the organic matter could be decomposed or dissipated.

100 parts of	F	lost	1.66	100 parts of	G	lost	2.83
" "	H	"	2.36	" "	D	"	2.83
" "	C	"	2.37	" "	I	"	11.36
" "	E	"	2.66	" "	K	"	14 00

In connection with the present inquiry, I endeavored to learn the proportion of organic matter existing in the soils. In settling this point, it may be remarked that an uncommon preponderance of animal, over vegetable, organic matter was noticed, the odor of amonia being particularly abundant, during the decomposition by heat; and in no soil was it so striking as in H. The smell of sulphur was also emitted, in common with that of amonia, by specimens I and K. The results under this head, were as follows.

100 parts of	F	lost	1.75	100 parts of	D	lost	3.38
" "	E	"	1.90	" "	C	"	2.66
" "	H	"	2.41	" "	I	"	8.33
" "	G	"	2.16	" "	K	"	9.66

The difficulty of settling the proportions of water and organic matter in soils is so great, that absolute precision is not claimed for the foregoing results; nevertheless the care with which these ingredients of the soils were deduced, leads me to hope that the approximation arrived at is as close as can well be obtained.

By adding together the *water of absorption* and the organic matter, as above detailed, we have the loss in weight experienced by each soil on being heated from a state of atmospheric dryness to full ignition. Thus, the loss in 100 parts of F equals 3.41.

The loss in 100 parts of	E	equals	4.56	The loss in 100 parts of	D	equals	6.16
" " "	H	"	4.77	" " "	I	"	19.69
" " "	G	"	4.99	" " "	K	"	23.66
" " "	C	"	5.03				

With a view to obtain some correction for inaccuracies in the determination of the water of absorption and the organic matter as above given, a specimen of pure silicious sand of the same fineness as the soils under examination, was heated from atmospheric dryness to ignition. Its loss in weight was 2.08 per cent. If we take this as a constant quantity, and allow it to represent the water of absorption in each soil, and deduct it from the entire loss by heat of each soil, we shall be furnished in the remainders with another view of the organic contents of the soils, which may possibly be more accurate than the one already given; although it cannot be absolutely correct, for the reason that the more the organic matter of a soil, the greater will be its powers of retaining humidity. Now deducting from the loss by igniting 100 parts of F, 2.08, and we have 1.33.

Deducting from loss by igniting 100 parts of	E,	we have	2.48
" " "	H,	"	2.69
" " "	G,	"	2.91
" " "	C,	"	2.95
" " "	D.	"	4.08

The organic matter, as deduced by the two methods above explained, will, therefore, stand thus—

In 100 parts of	F	by first method	1.75,	by second	1.33
"	E	"	1.90,	"	2.48
"	H	"	2.41,	"	2.69
"	G	"	2.16,	"	2.91
"	C	"	2.66,	"	2.95
"	D	"	3.33,	"	4.08

In order to obtain additional information respecting the powers af attraction possessed by the soils for water, comparative experiments were made to determine their saturating points, *i. e.* how much these weights would be augmented, after being thoroughly drenched with water on filters, the weight being taken, in each instance, as soon as all dropping from the filter had ceased. The following numbers express the saturating capacities of the soils for water.

K........605	G........325	E........305
I........480	C........321	F........293
D........342	H........315	Pure sand.235

Some experiments were also made with a view to ascertain their comparative rates of drying from a condition of saturation. The following table embraces the results obtained under this head:

48 parts of	K	when saturated	took up 60.5	of water,	and lost	in	16 hours	21.5,
"	I	"	48.0	"		"	"	19.3,
"	C	"	32.1	"		"	"	18.1,
"	H	"	31.5	"		"	"	20.1,
"	F	"	29.3	"		"	"	18.3,
"	Pure sand	"	23.5	"		"	"	15 7.

By deducting the water lost in drying, from the amount absorbed in saturating the soils, we ascertain the quantity left adhering to each.—

The 48 parts of	K	will have	39.0	of water.
"	I	"	28.7	"
"	C	"	14.0	"
"	H	"	12.0	"
"	F	"	11.0	"
"	Pure sand		6.8	"

An acquaintance with these facts will aid in forming an estimate of the advantages which one soil will possess over another in permitting its plants to recover from the effects of excessive rains. I next entered upon the analysis of the mineral constitution of the soils.

1. *Composition of C.*

Silica,..	92.57
Alumina,..	1.70
Per Oxide of Iron, with a feeble trace of Carbonate of Lime, and of Phosphate of Lime,..	0.70
	94.97
Water of absorption and organic matter,......................	5.03
	100.00

2. *Composition of D.*

Silica,	91.64
Alumina,	1.70
Per Oxide of Iron, with a feeble trace of Carbonate of Lime and of Phosphate of Lime	50
	93.84
Water of absorption and organic matter,	6.16
	100.00

3. *Composition of E.*

Silica,	94.00
Alumina,	94
Per Oxide of Iron, with a feeble trace of Carbonate of Lime and of Phosphate of Lime,	50
	95.44
Water of absorption and organic matter,	4.56
	100.00

4. *Composition of F.*

Silica,	95.00
Alumina,	79
Per Oxide of Iron, with a feeble trace of Carbonate of Lime and of Phosphate of Lime,	80
	96.59
Water of absorption, and organic matter,	3.41
	100.00

5. *Composition of G.*

Silica,	93.00
Alumina,	81
Per Oxide of Iron, with a feeble trace of Carbonate of Lime and of Phosphate of Lime,	1.20
	95 01
Water of absorption and organic matter	4.99
	100.00

6. *Composition of H.*

Silica,	93.23
Alumina,	1.05
Per Oxide of Iron, with a trace of Phosphate of Lime,	0.60
Carbonate of Lime,	0.35
	95.23
Water of absorption and organic matter,	4.77
	100.00

7. Composition of K.

Silica, with fine gravel consisting of fragments of Feldspar, Hornblende, and other hard siliceous minerals,	61.75
Alumina,	9
Per Oxide of Iron	5.80
Carbonate of Lime,	20
Phosphate of Lime,*	20
	77.04
Water of absoption and organic matter,	23.66
	100.00

It may be mentioned, as a very unexpected fact, that K. on being treated with heat and acids, and thus cleared of its soluble matter, left, in place of a fine siliceous sand, a gravel whose particles were generally many times as large as those of the sand of the soils, while they differed still more from the sand, in not being composed of quartz, but of feldspar, hornblende, epidote, &c.—minerals which are heavier and less frangible than quartz. The superior toughness and specific gravity of these substances would, therefore, serve to impede their comminution and transportation by the action of the sea, and they might be expected to form accumulations upon the sides and bottoms of rivers and inlets, where their gradual disintegration and decomposition, and constant intermixture with organic matter, would convert them into the clay-like aggregates such as we find in specimen K.†

The operation of this marsh-mud as a manure upon the soils under examination, depends not merely on the saline, organic, and calcareous matter it contains, but is referrible, in part, to the large proportion of the aluminous or argillaceous ingredient, whose mechanical effects on sandy lands, in promoting the retention of moisture, are eminently beneficial.

The very small proportion of carbonate of lime in the marsh-mud proves that as a mineral amendment for soils deficient in calcareous matter, it cannot be substituted for marl, or shells; one or the other of which ought to be employed in conjunction with the mud.

The saline matter of the marsh-mud, A. and B. is abundant. When treated with their weight of pure water, the fluid is strongly impregnated with all the soluble substances found in sea-water, and in addition, with traces of sulphuretted hydrogen. The stimulating effects of the salts, as well as their mechanical agency in favoring the absorption of moisture from their deliquescing properties, must be apparent.

The soil H, is remarkably distinguished from all the rest by the amount of carbonate of lime it contains.—This is plainly in the condition of broken shells, their fragments being discernible with the naked eye. In adaptation to the cotton plant, this soil is described as surpassing every other. I am disposed to ascribe this superiority to the carbonate of lime, since, in other respects, the soil scarcely differs from many others.

May not the peculiar fertility of new sea-island cotton land be owing to the proportion of comminuted shells natural to such soils, and the deterioration of these lands under long cultivation, ascribable to the exhaustion of carbonate of lime?

The addition of a marsh-mud, which abounds in a gravel of feldspar and hornblende, like K, must undoubtedly be greatly superior to one whose mineral basis is only siliceous sand. This consideration appears to me

* After the Alumina had been separated from the oxide of iron and phosphate of lime by an alkaline ley, the oxide of iron and phosphate of lime were washed, dried and weighed. They were then ignited with carbonate of soda, in order to decompose the phosphate of lime. Acetic acid was added until all the lime was dissolved. The per oxide of iron, which was not attacked by the acid, was now separated and weighed. The difference between its first and last weight, gives the amount of phosphate.

† On heating a fragment of K to whiteness in a crucible, it was converted into a well fused and very hard brick-like compound.

to demand attention from the planter. It has fallen under my observation that the marsh-mud employed on one cotton plantation on James Island, has this sandy basis. That the inferior production of this soil to that marked H, is wholly owing to this cause, I would by no means assert; still I incline to the opinion that it is largely concerned in producing the difference of fertility between the two soils.

CHARLES UPHAM SHEPPARD.

Analysis of the Cotton Lands on the head waters of Cooper River; By Dr. J. L. Smith.

The specimens marked 1, are from the surface, and 2 from the subsoil.

A.—*Somerset, near Somerset Creek, in* 1000 *parts.*

	1	2
Sand,	760	800
Clay,	140	155
Moisture,	30	25
Vegetable matter,	70	20

The portion of 1000 parts soluble in warm muriatic acid, furnished:

	1	2
Alumina,	3.40	3.00
Oxide of iron,	2.70	2.05
Lime,	1.20	1 30
Phosphoric acid,	2.00	2.30
Chlorine,	trace	trace
Potash and Soda,	trace	trace
Sulphuric acid,	—	—
Magnesia,	0.30	0.20

B. ——— *in* 1000 *parts.*

	1	2
Sand,	800	850
Clay,	170	132
Moisture,	10	10
Vegetable matter,	20	8

The portion of 1000 grains of the soil soluble in warm muriatic acid, furnished:

	1	2
Alumina,	1.200	1.150
Oxide of iron,	1.100	1.200
Lime,	1.000	0.600
Phosphoric acid,	0 160	0.175
Chlorine	0 060	0 040
Potash and soda, (chiefly soda)	0.080	0.060

C.—*Chapel Hill*, (*Frierson's*) *in* 1000 *parts.*

	1	2
Sand,	680	700
Clay	270	252
Moisture,	20	18
Vegetable matter,	30	30

Portion of 1000 parts soluble in warm muriatic acid, furnished:

	1	2
Alumina,	1.300	1.320
Oxide of iron	1.500	1.400
Lime,	0.410	0.510
Phosphoric acid,	—	—
Chlorine,	0.369	0.250
Potash and soda, (chiefly soda,)	0.520	0.420

D.—*Ophir*, *in* 1000 *parts.*

	1	2
Sand,	800	850
Clay,	166	122
Moisture,	12	13
Vegetable matter,	22	15

The portion of 1000 grains of the soil, soluble in warm muriatic acid, furnished:

	1	2
Alumina,	1.200	2.800
Oxide of iron	1.544	1.600
Phosphoric acid,	0.294	0.367
Chlorine,	0 120	0.573
Potash and soda, (chiefly potash)	0.030	0.450
Lime,	0.520	3.320

E.—*Pineopolis*, (*pine barren*) *in* 1000 *parts.*

	1
Sand,	900
Clay,	62
Misture,	8
Vegetable matter,	30

The portion of 1000 grains of the soil, soluble in warm muriatic acid, furnished.

Alumina,	0.637
Oxide of iron,	0 368
Lime,	0.125
Chlorine,	trace
Potash and soda,	trace

F.—*Cedar Spring*, *near Hepworth*, *in* 1000 *parts.*

	1	2
Sand,	860	905
Clay,	55	50
Moisture,	25	25
Vegetable matter,	60	20

The portion of 1000 grains of the soil, soluble in diluted muriatic acid, furnished.

	1	2
Alumina,	2.600	2.800
Oxide of iron,	0.350	0.360
Lime,	1.200	1.400
Phosphoric acid,	0.050	0.060
Chlorine,	0.290	0.280
Potash and soda, (chiefly soda.)	0.200	0.150
Sulphuric acid,	0.560	0.570
Magnesia,	0.100	0.050

G.—*Cedar Spring, western extremity, in* 1000 *parts.*

	1
Sand	700
Clay,	253
Moisture,	22
Vegetable matter,	25

Portion of 1000 grains soluble in warm muriatic acid, furnished:

Alumina,	0.630
Oxide of iron,	0.900
Lime,	1.100
Phosphoric acid,	0.025
Chlorine,	0.020
Potash and soda,	0.400

H.—*Somerton, (Biggin Swamp.) in* 1000 *parts.*

	1	2
Sand,	810	870
Clay,	102	95
Moisture,	28	20
Vegetable matter,	60	15

The portion of 1000 grains soluble in warm muriatic acid, furnished:

	1	2
Alumina,	6.200	5.500
Oxide of iron,	2.300	2.100
Lime,	0.710	0850
Phosphoric acid,	1.150	1.210
Clcrine,	0.230	0120
Potash and soda,	0.520	0.600
Sulphuric acid,	0.510	0.300
Magnesia,	0.250	0.100

I.—*Hog-swamp, (Negrohead,) in* 1000 *parts.*

	1
Sand,	760
Clay,	200
Moisture,	10
Vegetable matter,	30

The portion of 1000 grains soluble in warm muriatic acid, furnished:

Alumina,	2.250
Oxide of iron,	3.000
Lime,	10.400

M.

Phosphoric acid,	0.220
Chlorine,	0.154
Potash and soda, (chiefly soda,)	0.080

This soil effervesced when the acid was poured upon it.

J:—*Hog-swamp*, (*W. J. Dennis' clay land*,) in 1000 *parts*.

	1	2
Sand,	730	775
Clay	150	140
Moisture,	40	45
Vegetable matter,	80	40

The portion of 1000 grains soluble in warm muriatic acid, furnished:

	1	1
Alumina,	5.200	4.800
Oxide of iron	8.530	8.200
Lime,	1.600	0 850
Phosphoric acid,	0.080	0.085
Chlorine,	0 044	0.025
Potash and soda, (chiefly soda,)	0.020	0.010

K.—*Mrs. Prioleau* (*Ward's*,) in 1000 *parts*.

	1	2
Sand,	760	783
Clay,	130	125
Moisture,	40	42
Vegetable matter,	70	50

The portion of 1000 grains soluble in warm muriatic acid, furnished:

	1	2
Alumina,	5 400	4.500
Oxide of iron,	4.500	4.020
Lime,	4 620	3.210
Phosphoric acid	0.160	0.280

L.—*A. J. Harvey's*, (*Dubois*,) in 1000 *parts*.

	1	2
Sand,	825	862
Clay,	140	120
Moisture,	10	8
Vegetable matter,	25	10

The portion of 1000 grains soluble in warm muriatic acid, furnished:

	1	2
Alumina	2 300	1.800
Oxide of iron	1 500	1 650
Lime	0 450	0.620
Phosphoric acid,	0.120	0.200
Potash and soda,	trace	trace
Magnesia,	0 130	0.150

M.—*H. Harvey's Fair forrest Swamp*, in 1000 *parts*.

	1	2
Sand,	820	875
Clay,	100	90
Moisture	30	20
Vegetable matter,	50	15

The portion of 1000 grains soluble in warm muriatic acid, furnished:

	1	2
Alumina,	1.100	1500
Oxide of iron	0.950	0650
Lime	0.420	0 610
Phosphoric acid	0.060	0.080
Potash	trace.	trace.

N.—*Eutaw*, (*Jas. Gaillard*,) *marled land*, in 1000 *parts*.

Sand,	800
Clay	110
Moisture	32
Vegetable matter,	58

The portion of 1000 grains soluble in warm muriatic acid, furnished:

Alumina,	2 400
Oxide of iron,	1.680
Phosphoric acid,	0.200
Lime,	3.200
Potash,	traces.

Effervesced slightly.

O.—*Eutaw*, (*Jas. Gaillard*,) *unmarled*, in 1000 *parts*.

	1
Sand,	850
Clay	100
Moisture,	25
Vegetable matter,	25

The portion of 1000 grains soluble in warm muriatic acid, furnished:

	1
Alumina,	1.800
Oxide of iron,	1.420
Lime,	0.550
Phosphoric acid,	0.050
Chlorine	trace.
Soda and potash,	trace.
Sulphuric acid,	trace.

P.—*Walworth*, (*T. W. Porcher*,) in 1000 *parts*.

	1
Sand,	720
Clay,	180
Moisture,	40
Vegetable matter,	60

The portion of 1000 grains soluble in warm muriatic acid, furnished:

	I
Alumina	3.200
Oxide of iron,	0.900
Lime,	0.350
Phosphoric acid,	0.075
Potash,	

R.—*Mexico*, (*S. Porcher*,) *in* 1000 *parts*.

	1
Sand,	705
Clay,	250
Moisture,	20
Vegetable matter,	25

The portion of 1000 grains soluble in warm muriatic acid, furnished:

	1
Alumina,	3.300
Oxide of iron,	2.500
Lime,	1.260
Phosphoric acid,	0.030
Chlorine,	trace.
Potash and soda,	trace.
Sulphuric acid,	trace.

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