CHAPTER XI.

LOWER CARBONIFEROUS; FORMATION VIII.

874. We now reach, in our upward progress, a great group of strata intervening between the Black Shale, just described, and the Coal Measures. This group is mostly limestone; in addition, it contains beds of shale, a few sandstones, and, in its lower part especially, heavy layers of chert. Its maximum thickness is about 1200 feet.

875. It has been found convenient to divide this formation into two groups, as follows:

8,b. *Mountain Limestone,* the greater and upper portion, the greatest presentation of which is on the slopes of the Cumberland Table-land.

8,a. *Siliceous Group,* of which cherty limestones, calcareo-siliceous rocks, and heavy layers of solid chert, are quite characteristic; forms, often, ridges in the Eastern Valley, and plateaus (the Highlands) in Middle Tennessee.

This division is the most useful that can be made, so far, at least, as the consideration of the topographical and agricultural features of the State are concerned. Each member will be the subject of a section.

SECTION I.

THE SILICEOUS GROUP. (8,a.)

LOWER, OR PROTEAN MEMBER—UPPER, OR LITHOSTROTION BED; ST. LOUIS LIMESTONE—USEFUL ROCKS, MINERALS, AGRICULTURAL FEATURES.

876. The name *"Siliceous Stratum,"* was used by Troost in his Reports, and was intended to embrace about the same rocks as are here described. The epithet, *Siliceous,* refers to the fact that the formation contains, very generally, or is in good part made up of, siliceous material in some form

or other. This material may be chert, fine sandstone, silico-calcareous rocks, or siliceous shale.

877. The Siliceous *Group* includes the two following members, the lithological characters of which, as observed in Middle Tennessee, are briefly given.

(b) *Lithostrotion, or Coral, Bed;* this, the upper part, is cherty limestone, fossiliferous, often crinoidal, sometimes siliceous and argillaceous, and everywhere characterized by a large coral, known to geologists as *Lithostrotion Canadense.* The bed is the equivalent of the *St. Louis Limestone* of the Missouri geologists, and has a maximum thickness of about 250 feet.

(a) *The Lower, or Protean Member;* a series of strata, silico-calcareous in the main; often limestone; often sky-blue, silico-calcareous, and sometimes argillaceous, rock, weathering into shale; the series containing, as a characteristic feature, especially in its middle and lower portions, heavy layers of chert, ranging in thickness from an inch to two feet, and alternating with the other rocks of the member. In addition, the series holds layers, and locally heavy beds, of crinoidal limestones.

The strata, very generally, excepting the purer limestones, are sparsely dotted with small concretions, usually siliceous. At a few points, well-formed geodes, lined inside with quartz crystals, occur of considerable size. Thickness, in general, from 250 to 300 feet, but falling, in the southern part of the State, below this.

878. (a) *Lower, or Protean Membe*r.—I have, above, briefly characterized the two members of the Group as they are presented west of the Cumberland Table-land.

The lithological features of the *Lithostrotion Bed* are comparatively constant. But not so with the *Lower Member.* In some sections the layers of chert in this are wanting, as at Paradice's Hill, on the Clarksville road, in the northwestern part of Davidson county, (§ 246,) where the mass is siliceous and argillaceous limestone, containing small calcareous and siliceous concretions, and running down into bluish shale.* See, also, § 732. Again, on Obey River, in Overton county, near the Kentucky line, the rock is of such a character as almost wholly

* In 1846, Dr. D. D. Owen and Dr. J. G. Norwood made the following section at this point (Researches among the Protozoic and Carboniferous Rocks of Central Kentucky, &c., p.4.)

(4) At top; soil, siliceous beds, and nodules ..... 77 feet.
(3) Fine siliceous rock, with segregations of impure limestone ..... 29 feet.
(2) Impure argillaceous limestone, with calcareous concretions, and beds of water-limestone, passing downwards into bluish gray argillaceous shale ..... 178 feet.
(1) Top of *Black Shale* at the foot of the hill, and at a vertical distance below the summit of ..... 284 feet.

to weather into shale. These instances are, however, exceptional. The chert-layers are generally present, and outcrop in the upper parts, and at the tops of the hills on all sides of the Central Basin. They cap, too, the highest hills and ridges within it. As presented around the Basin, the Lower Member of the Siliceous Group is often a leached mass of chert-layers, alternating with sandy shale.

879. In the southern part of the State, at certain points, the member is cherty, crinoidal limestone, resembling the Lithostrotion Bed above. In fact, going southward, the lower member becomes thin, and below Huntsville, on the anticlinals of Alabama, the two members, in my opinion, become one bed, characterized throughout by *Lithostrotion Canadense.**

880. It may be well to mention here, some of the local beds occurring in the *Lower Member* of the Siliceous Group in Middle Tennessee.

Layers of gray *crinoidal limestone* occur at many points; sometimes these become beds from ten to fifty, or more, feet in thickness. They are either pure or impure limestone. Such beds furnish the crinoids of White's Creek, in Davidson county, and at other points.

881. In Hickman county, on Piny River, and extending northwesterly to the valleys of Sugar, Tumbling, and other creeks, in Humphreys, is a bed of current-formed, metal-ringing, bluish gray limestone, made up of grains of comminuted shells. It occupies a position on, or near the Black Shale, and has a maximum thickness of not less than 150 feet, though its thickness is generally much less. The bed occurs near the top of the bluff at Montgomery's Mill, and represents the Siliceous Group in the section presented at that place. (See § 821.) The entire bed is sufficiently well characterized in what is said of it in the section referred to. The bed is seen at Vernon, on Piny. It contributes not a little to the agricultural value of the Piny River Valley.

882. In the *Checkered-house* bluff on the Cumberland River, in Stewart County, mentioned in § 365, the layers of rock are separable into two groups; the upper, including gray and crinoidal limestone, with more or less chert in nodules, and from 200 to 250 feet in thickness, is the Lithostrotion Bed; the lower is a bed of calcareous rock, full of *burry* chert, a thickness of 150 feet of which is exposed in the bluff. The upper portion of the latter rock, aside from the abundance of the burs, is something like the metal-ringing limestone mentioned in the last paragraph. The thickness of this rock is, perhaps, considerably more than 150 feet. It occurs at a number of points in Stewart County, and lies not very far above the Black Shale.

* A little below Gadsden, in Alabama, I have seen a number of specimens of this coral in an outcrop of the Siliceous chert, very near the Black Shale.

883. In the counties of Wayne, Lewis, Hickman, Humphreys, and in the western parts of Williamson and Maury, the base of the Siliceous Group often presents itself as a pale blue, fetid, calcareo-siliceous shale, alternating in layers, more or less, with chert. At some points the chert layers are numerous, making half, or more than half, the mass; then, again, they are wanting through considerable vertical distances, so as to leave beds of shale, without chert, from ten to fifty feet in thickness. At a few points beds of this shale occur from 60 to 100 feet in thickness, as at Col. Cooper's, on Swan Creek, in Lewis County, where it is nearly or quite 100 feet, und without chert. The shale is seen in Green River, at Waynesboro', measuring, a little below the town, 40 feet. It is also shown in the section at White's Mill, on Buffalo. (§ 859.) It occurs, however, at numerous localities. The shale at Paradice's Hill, (§ 878, note,) may be referred to it. I have said that it is fetid; it has often, however, an agreeable and remarkable aromatic odor.

This shale is mainly interesting from the fact that it contains a fauna which has not been much studied, and in which species of *Trilobites, Conularia, Atrypa, Discina, Lingula, Chonetes, Leda, Pleurotomaria,* and of other genera, occur.

884. In much of the region between the Central Basin and the Western Valley, especially in Lewis, Wayne, Perry, Hickman, Dickson and Humphreys counties, the Lower Member of the Siliceous Group often presents itself, as a stratified, *leached mass* of soft, pale-yellowish, or orange-gray, porous *sandstone,* which can be easily sawn or cut with an axe. Many exposures, sometimes great bluffs, of this material, occur at intervals along the water courses, the original rock having lost its calcareous part and its sky-blue color by weathering.

It is a common circumstance, in traveling through the region mentioned, to meet with a farm-house having a neat chimney built out of square blocks of this sandstone. As a building material it will answer well for many purposes. Entire houses might be constructed out of it. After exposure it becomes harder than when first quarried. The manner of working this sandstone, and the uses made of it, recall, although a very different rock, the *"rotten limestone"* of Mississippi and Alabama.

885. The "*chalk,"* of Wayne, and of other counties, may be mentioned in connection with the sandstone above. The rocks of the formation, and more especially the chert, instead of presenting their weathered masses in the form of a soft sandstone, often afford considerable beds of a harsh, pulverulent, white, stratified substance, locally called *chalk.* About three miles south of Waynesboro' is the mouth of a tributary of Green River, which is known as *Chalk Creek,* so named on account of the occurrence of the chalky substance in its bed and along its banks. The" chalk" is seen for three or four miles along this stream. On, beyond this valley, and about nine miles from Waynesboro, on Full Branch, a tributary of Indian Creek, an exposure of 30 feet of it was observed. It also occurs in the heads of the hollows leading down into the valley of Beech Creek, and in similar positions on the waters of many other creeks.

As presented in the banks of the streams, it is an alternation of soft and harder layers, mostly white, some of it yellowish. It is mainly siliceous, and layers occur showing the transition from chert to "chalk." Occasionally a thin layer of plastic clay occurs with the others. The material frequently resembles *kaolin,* and has been mistaken for it. It occurs in great quantities, and doubtless will be put to some useful purpose. If the opportunity be presented, it will be investigated with reference to its economic relations.

886. This Lower, or Protean, Member of the Siliceous Group, is, in general, equivalent to the divisions of the Lower Carboniferous Limestone lying below the St. Louis Limestone. It is, perhaps, more especially the equivalent of the Keokuk Limestone; it contains, however, some Burlington forms. Below are some of the species occurring in this member. It, was my intention to give, so far as possible, a full list of all the Lower Carboniferous species that have been met with in Tennessee, but want of time prevents it. The White's Creek Crinoids, of Troost, are from this formation, but few of them, however, are included here.*

(1) *Spirifer imbrex,* Hall. Occurs *immediately* above the Black Shale below Huggins's Mill, near Manchester, in Coffee County, associated with *Productus semireticulatus;* also in the same horizon at White's Creek Springs, and near Col. Robinson's, on the Middle Fork of Cold Water, in Lincoln County.

(2) *Spirifer subæqualis?* Hall. Sumner County, Louisville and Nashville Railroad Tunnel.

(3) *Spirifer tenuicostatus,* Hall? Same locality as the last.

(4) *Spirifer suborbicularis,* Hall. Tunnel of Louisville and Nashville Railroad; and also Col. Robinson's, in Lincoln County.

(5) *Spirifer subcuspidatus,* Hall. Hawkins County, East Tennessee.

(6) *Spirifer lineatus,* Martin. *(S. pseudolineatus,* Hall) Many localities.

(7) Orthis Michelini, L'Eveille. White's Creek; Col. Robinson's, Middle Fork of Cold Water, Lincoln County.

(8) *Platyceras equilatera?* Hall. Falls of Caney Fork, below Col. Bosson's house.

(9) *Granatocrinus granulatus,* Roemer. *(G. cidariformis,* Troost.) Middle Fork of Cold Water, Lincoln County.

(10) *Agaricocrinus Americanus,* Roemer. *(A. tuberosus,* Troost.) Cannon County, near Woodbury; White's Creek Springs.

• On most of the specimens of the species enumerated, I have had the benefit of the opinions of Prof. James Hall, A. H. Worthen, and Prof. A. Winchell, and to these savans I express my obligations.

(11) *Actinocrinus conicus,* Cassedy and Lyon. *(conocrinus tuberculosus,* Troost.) White's Creek Springs; Cannon County associated with the last.

(12) *Actinocrinus Nashvillæ,* Troost. White's Creek; Ridge in Sumner County.

(13) *Actinocrinus (Batocrinus) magnificus,* Cassedy and Lyon. White's Creek.

(14) *Actinocrinus (Dorycrinus) Gouldi,* Hall. Ridge Sumner County.

(15) *Cyathocrinus stellatus,* Hall. White's Creek Springs.

(16) *Forbesiocrinus Meeki,* Hall. Same locality as the last.

(17) *Forbesiocrinus Saffordi,* Hall. Near White's Creek Springs, in Davidson County.

(18) *Icthiocrinis tiaræformis,* Troost. White's Creek Springs.

887. Most of the above species, occurring out of Tennessee, are Keokuk forms. *Spirifer imbrex* and *Orthis Michelini* are found in the Burlington Limestone. *Spirifer subæqualis,* and *S. tenuicostatus* are Warsaw forms, and the latter also Keokuk. (See table at the end of this chapter.)

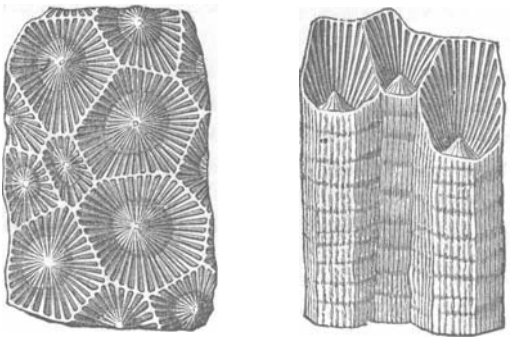
888. (b) *Upper Lithostrotion Bed; St. Louis Limestone.*—Some of the general features of this member of the Siliceous Group, as it is presented in Middle Tennessee, have been given in § 877. The *chert* of these rocks is quite characteristic as well as the large corals.

It occurs, for the most part, in nodular or lenticular, though often rough, masses, and not in extensive layers, like the chert or flint of the lower siliceous. Moreover, it is usually highly fossiliferous, abounding in lace-like *bryozoa.* Whenever the rocks of the Lithostrotion Bed are present, the surface is strewed, more or less, with loose, half-decomposed masses of chert, from which fossils may be obtained. The soil overlying it is generally red, made so by oxide of iron liberated in the decomposition of the cherty masses. And here, I am inclined to think, we have a clue to the source of the iron accumulated in the ore-banks of our western iron-region.

889. There is no considerable area in Middle Tennessee, presenting the lower rocks of the Siliceous Group, in which, upon the highest points, as upon the ridges, traces, at least, of the Lithostrotion Bed are not to be found. It is a very common circumstance, in traveling on the Highlands, to meet with the large coral (always silicified) and the chert characterizing the

formation. Even in the areas where all the limestone has been leached away, some of these are often left to tell of its former presence.

(FIG. 1.) (FIG. 2.)



Lithostrotion Canadense.

The above cuts are representations of the large coral to which reference is so frequently made in this section. Fig. 1 is a view from above, showing the cup-like ends of the prisms; fig. 2 is a lateral view.

(Taken from Dana's Manual.)

890. This bed may be regarded as covering an area nearly coextensive with that of the Highlands of Middle Tennessee (page 81,) although, at many points, but a few of its lowest layers are present. At some, all is gone, as I have stated, but remnants of its cherty parts. Where absent, or nearly so, the Lower Siliceous being at the surface, the country is generally poor, and such regions constitute the "barrens." (See § 216.) Where, however, the Lithostrotion Bed is present, in some volume, the soil is red and the lands are generally rich. In the areas spoken of in § 217, it is this formation which gives the lands their character.

891. An interesting topographical feature, more nearly connected with this formation than any other, is presented in the "sink-holes" which everywhere occur within the areas underlaid by it. See § 218.

892. The following places are located upon the Lithostrotion Bed: Springfield, Clarksville, Charlotte, Dover, Lawrenceburg, Winchester, McMinnville, Sparta, Smithville, Cookville and Livingston. Waverly, Centreville, Linden and Waynesboro' are upon strata of the Lower Member of the Siliceous Group; while Newberg and Manchester occupy an inter-

mediate position. Camden, in Benton, is located on the siliceous group, on the line of its western abrupt termination.

893. The most marked area underlaid by these rocks, is the belt spoken of in § 217, lying along the western base of the Cumberland Table-land. The rocks of the bed generally outcrop, in considerable volume at the base of the Table land on its west side, extending more or less upward on its slopes. Another marked area is found in the counties of Robertson, Montgomery and Stewart, north of the Cumberland River. The fertile red lands of this area give us our most important tobacco region. In it may be included the plains of Southern Kentucky, much of which are based on the same formation.

894. It may be well to introduce here a section of the rocks at Clarksville, in further illustration of the character of the Lithostrotion Bed. The section was taken near the mouth of Red River, at a time, however, when the Cumberland was tolerably high, and covered the lowest layers. (Compare § 882.)

(7) *Rocks at the top* of the hills covered with soil; loose, fossiliferous, cherty masses, with occasionally a specimen of *L. Canadense* strewed over the surface ..... 30 feet.

(6) *Bluish limestone,* siliceous, moderately cherty, contains small concretionary cavities..... 15 feet.

(5) *Limestone,* not cherty, contains a small *Granatocrinus* .....20 feet.

(4) *Limestone,* mostly like No.6; contains *L. Canadense* .....32 feet.

(3) *Limestone,* like that above, with plates and spines of species of *Archæocidaris* abundant, fragments and plates of *Melonites multipora,* in its lower part *Pentremites obliquatus?* etc ..... 48 feet.

(2) *Limestone,* light-bluish, massive, crinoidal, semi-oolitic, without chert; some of the layers abound in plates of *Melonites;* thirty feet measured down to the high water at the time, say ..... 40 feet.

(1) Below the last, as seen at other times, the limestone is thin-bedded and cherty, containing, occasionally, crinoidal layers; seen in the bed of the river about Clarksville, say..... 30 feet.

895. The beds above are all fossiliferous. Among the species occurring are *Spirifer lineatus, S. tenuicostatus, S. subcardiiformis, Hemipronites crenistria, Pentremites conoideus,* the small, undescribed *Zaphrentis,* mentioned in the list below, plates of species of *Melonites,* more or less, in all the beds, etc.

896. The following are a few of the species occurring in the Lithostrotion, or St. Louis, Limestone of Tennessee. It is my purpose to give a more complete list on some future occasion. The fossils are generally silicified.

(1) *Lithostrotion Canadense,* Castelnau. Found at nearly all points with the rocks of the formation.

(2) *Lithostrotion proliferum,* Hall. Clarksville and Cowan; not as common as the last.

(3) *Zaphrentis spinulifera,* Hall. Many localities.

(4) *Zaphrentis,* undes? a small species, from a half to three-fourths of an inch in length, having short spines on its surface, occurs abundantly at Clarksville, Charlotte, Estill Springs, and also, as Mr. Worthen informs me, at Spurgen Hill, Indiana.

(5) *Pentremites conoideus,* Hall. Clarksville, Iron Mountain Furnace, Charlotte, Cowan, &c.

(6) *Pentremites obliquatus?* Roemer. (See plate I, Fig. 2 a, b, c, d.) Its horizon is given in the Clarksville section above.

(7) *Dichocrinus simplex,* Shumard. Charlotte, and at other points. Dr. Troost's specimens of *"Doliolocrinus ovalis,"* the same as this, were not found at Sparta, Tenn., but came from a point a few miles north of Scottsville, in Kentucky. Sparta, however, might be a locality.

(8) *Melonites multipora,* Owen. Clarksville, Charlotte; and other points.

(9) *Melonites Stewartii,* Safford. Differs from *M. Multipora* in having fewer rows of plates in the interambulacral spaces; the latter also rise in more rounded ridges. Other points of difference are also presented. See plate I, Fig. 1, a, b, c, d. The precise locality of this fossil is not known to me; it is, however, from Middle Tennessee, and I have reason to think, from the Lithostrotion Bed. I take pleasure in dedicating this species to my distinguished friend, Prof. Wm. M. Stewart, of Clarksville.

(10) *Spirifer tenuicostatus,* Hall. Clarksville, Tunnel of the L. and N. Railroad, in Sumner county, Charlotte, Cowan, etc.

(11) *Spirifer subcardiiformis,* Hall. Clarksville.

(12) *Spirifer Keokuk,* Hall? Cowan, and other points; may be a new species.

(13) *Spirifer Leidyi,* Norwood and Pratten. Clarksville, Charlotte, Cowan, Sparta, &c.

(14) *Spirifer spinosus,* Norwood and Pratten. Same localities as last.
(15) *Spirifer lineatus,* Martin. At many points.
(16) *Hemipronites (Streptorhyncus) crenistria.* At many localities.
(17) *Retzia vera,* Hall. Sparta, Cowan, &c.
(18) *Rhynchonella mutata,* Hall. Sparta.
(19) *Productus pileiformis,* McChesney. Clarksville and Cowan.
(20) *Productus punctatus,* Martin. Clarksville, Charlotte, etc.
(21) *Conularia Missouriensis,* Swallow. Sparta, and vicinity of Clarksville. A fine specimen of this was presented to me by Prof. W. M. Stewart.

897. Many of the above species are characteristic forms of the St. Louis Limestone; others, in the Northwestern States, are found in horizons either above or below this.

898. *Consideration of Siliceous Group in General Resumed.*—As yet, I have, for the most part, considered this Group with reference to its two members in Middle Tennessee. It will now be taken as a whole. So far as its presentation in East Tennessee is concerned, no division is practicable.

899. The group is one of great extent in Middle Tennessee. A greater or less thickness of its strata constitutes, at all points, the cap-rock of the natural division of the State, described in the First Part of this Report as the *Highlands* or *Highland Rim* of Middle Tennessee. (See pages 81-96.) The area of the Siliceous Group is the same as that of the Highlands, and both have the same limits. To the siliceous material of the former is to be attributed the present existence of the latter, as a plateau, or collection of plateaus. This material makes the strata of the Group weather-resisting, and hence, when they are horizontal, or approximately so, plateau-making. The Group is, in fact, a hard crust, which, although elevated, has had power to resist, to a considerable extent, denuding agencies.

900. The *Central Basin* is a large oval area in which this *crust* has been broken through, undermined, and removed. (§§ 208, 209 and 867.) Beneath the crust the strata are comparatively soft, yield to the action of water, and, where uncovered, wash away. In this way not only has the Central Basin been formed, with its ramifications, like those of the

Caney Fork and Duck River, (§§ 234, 235,) but also the Western Valley and its branches. (§250-256.) See, also, the Map.

901. The mutual relations of the Lower and Lithostrotion beds, as to the proportional parts of the Highlands they underlie, have been referred to in §§ 889 and 890. Among the areas underlaid by Lithostrotion rocks, certain special ones are mentioned in § 893.

902. In the *Valley of East Tennessee*, the Siliceous Group, outside of its topographical relations, has very little interest attached to it. It does not present itself here as the cap-rock of a plateau, for the reason that its strata, like those of the other formations, are very generally tilted, or inclined at a considerable angle to the horizon. It is here, like certain other groups, *ridge-making,* and for reasons that have been given. (See remarks under the Iron Limestone, § 628.)

903. In this part of the State it is often associated with the two underlying formations of the Black Shale and the Dyestone Group, in the *Dyestone Ridges,* the three making the *trio* mentioned on a previous page. (See § 783, and also, § 862.)

The formation occurs at nearly all of the presentations of the Black Shale, with which it is in contact, either on one side or the other. It is seen in the ridge immediately west of Montvale Springs, at which point it is mostly sandstone. (§ 801 and *a,* in diagram, p. 190.) It occurs along the eastern base of Clinch Mountain, and generally forms a ridge, the Black Shale lying between it and the mountain. In Hawkins it outcrops on both sides of the synclinal spoken of in § 863, the outcrop on the Clinch Mountain side forming *Pine Mountain;* further south, and about opposite Rice's, both outcrops contribute to form *Stone Mountain.* (§ 758(2).)

904. In Hancock County are two principal outcropping lines of it. These are crossed by the section in § 753; one lies in the ridge starting up northeast of Sneedville; the other is on the northwest side of Newman's Ridge. (See, also, diagram on page 208.) The Siliceous Group is also seen in the Cumberland Gap section, in § 756, as well as in the diagram just referred to. It occurs in most of the Dyestone Ridges as a1ready stated. (See §§ 358, 782 to 801, also diagrams pages 139 and 142.)

As to the difference between the chert of the Siliceous Group and that of the Knox Dolomite, see § 537.

905. *Rocks of Special Use, Minerals, and Agricultural Features of the Siliceous Group*.—In paragraph 884 I have spoken of the *soft sandstone* resulting from the leaching of certain rocks in that Group. Considering the wide extent of country in which this is found, the ease with which it is worked, and the uses to which it may be applied, this sandstone becomes a matter of considerable interest. It may be added that, occasionally, a layer of it occurs fine enough to be used as a *polishing powder*, like tripoli; much of it might be used for scouring purposes, in the place of Bristol brick.

The siliceous, chalky material, of Wayne, has been mentioned in § 885.

906. Much of the Group is too rough and cherty to be used for building purposes, nevertheless it contains, especially in its upper portion, many layers of limestone of compact structure, without chert, and well-bedded for quarrying. Some such layers, exposed along the Cumberland River, are oolitic, of a light gray color, and are a desirable building stone.

907. Near the heads of several of the small valleys in Stewart County, are deposits of fire clay, of considerable interest. One of these, situated on the Cumberland Iron Works property, and near the "Morgan Bank," has furnished material for fire-brick for many years. The bed is in a flat bottom, near the head of a small valley. It is grayish-white, lies in a compact stratum beneath a superficial layer of gravel from three to five feet thick. It is well exposed in two or three pits, some of which have been sunk in the clay five or six feet without reaching the bottom. The bed is quite extensive doubtless, and may underlie several acres. The clay has been in use at the furnaces, and was used at the old rolling mill for many years. Mixed with fine gravel, it makes an excellent fire-brick. It has been in demand at other points. Much of it has been shipped down the river to Hillman's Works, in Kentucky.

908. A bed of clay situated like this, and similar to it, though not as extensive, was seen about four miles southwest of Cumberland City, in Stewart County. Highly esteemed fire-brick have been made from this, also, and used in the furnaces.

909. These beds are located in valleys of the Siliceous Group. The material in them comes from the decomposition of silico-argillaceous layers,

and has been brought to these places by water, and deposited. Doubtless, other beds, in addition to those known, may be found at spots where the conditions are similar.

910. It is upon this formation that most of the *Iron Ore banks* of the Western Iron Region of Tennessee rests. The *ore* itself is, doubtless, of a much more recent age than the underlying rocks, and perhaps is synchronous with the bed of *water-worn* gravel, which appears almost everywhere on the ridges within the ore region.

911. The *matrix* of the ore in the banks is made up, in good part, of the *ruins* of the Siliceous Group, angular, half-decomposed chert and clay; to these, is sometimes added, near the top of the banks, water-worn gravel. This mass, generally located on the top of a ridge, is often a hundred feet deep. The ore appears to have been introduced into it by water, or, at least, to have been precipitated within it from water.

912. I have been much inclined to think that the principal and original source of the ore has been the ferruginous chert of the Lithostrotion Bed. (§ 888.) It has iron enough to color the soil characteristically red. The banks are centres, at which, through the agency of chalybeate waters, drawing their iron from the decomposing chert, the ore has accumulated. The consideration of these ore-banks, however, properly goes with the description of the gravel-bed mentioned.

913. The only successful borings made in Tennessee for *petroleum*, as yet, are in this formation, and these are in a region of limited area on Spring Creek, in the southern part of Overton County.

Three borings within 150 yards of each other, obtained oil at a very moderate depth—from 22 to 52 feet. The supply was not lasting, however, and the borings were made deeper. The *Newman Well* has been the most productive, and has yielded many barrels of oil. What its condition is now, I know not. In this region the Black Shale is about 200 feet below the surface. The Siliceous Group above it is made up of alternating layers of limestone and chert. The body of oil appears to have been in the latter formation, but its source may have been deeper.

914. On the West Fork of Obey, a short distance north of the crossing of the Livingston and Jamestown road, is a group

of *oil springs* in this formation which are quite promising. The oil comes to the surface near the water's edge. No boring has been made at this point. Other springs occur on this stream.

Some petroleum has also been found on Jones Creek, in Dickson County.

915. *Quartz geodes* of some size and interest, are found in the rocks of this formation at several localities. Among these, may be mentioned a point on the ridge east of Chestnut Mound, and near the Putnam and Smith County line; another a few miles east of Woodbury, on the McMinnville road. At both localities interesting specimens may be found lined inside with crystals of quartz. At that near Woodbury, the geodes afford sometimes rhombohedral crystals with mere traces of modifying planes. (-1.)

916. At Alisonia, in Franklin County, fine specimens of native sulphur have been obtained in these rocks. In some specimens, the sulphur is in beautiful crystals. Native sulphur is frequently met with in the lower part of the formation, and sometimes fills small siliceous geodes.

917. The agricultural features of the Siliceous Group have been referred to several times, and need not be dwelt upon now. What is said in §§ 216 and 217, in reference to the agricultural features of the Highlands, applies, of course, here. See, also, §§ 890 and 893.

SECTION II.

THE MOUNTAIN LIMESTONE. (8,b.)

918. This is a heavy body of limestone, constituting, for the most part, the base of the Cumberland Table-land. Its strata outcrop on the slopes of this great plateau, from beneath the overlying sandstones and conglomerates, on all sides, (§ 175.) Its boldest and most important presentation is on the western slope. It generally appears on the eastern side, but its outcrop, owing to the disturbed condition of the rocks in this part of the State, (§ 344,) is not uniform, either as to height above the valleys, or as to the

manner or position in which the strata are presented at the surface. At a few points on this side the formation does not appear at all, being ingulfed by local faults, and the strata of the Coal Measures being in the valleys. Such is the case in the region of the Saltworks, in Anderson County, and at a point below Kimbrough's, in Roane County. The outcrops of this limestone, not connected with the Table-land, will be noticed below.

919. The *Mountain Limestone* is a heavy group of limestones and shales, the latter constituting, in the aggregate, about one-fourth of the mass. In addition to these, the strata include a *sandstone,* which, in the more northern counties, is from 40 to 50 feet thick. The group has its maximum thickness in the southern part of the State, where it is about 720 feet. Going northward, its volume becomes less, until, near the Kentucky line, it is reduced to 400 feet.

920. Several sections will be given below, in which are presented the strata of the Mountain Limestone. Two of these present not only this formation, but the entire *Lower Carboniferous Series,* from the Black Shale to the Coal Measures.

In these sections the lithological features of the Mountain Limestone are given in detail. The beds may be grouped and characterized, in general, as follows:

(f.) At top, next below Coal Measures, very generally a stratum of *crinoidal limestone,* sometimes with more or less shale above, and from 4 to 70 feet in thickness. (§ 960.)

(e.) *Variegated Shales and Marl,* with occasionally a layer of limestone, from 50 to 130 feet.

(d.) *Argillaceous Limestone,* usually interstratified with more or less shale, which is sometimes variegated; the limestone is a light bluish-gray, fine-grained rock, ("lithographic limestone," or a mud-stone,) breaking with conchoidal fracture, and crumbling under the weather. It occasionally includes layers of blue fossiliferous and other limestones, (as No.6, of the Spring Creek Section, and Nos. 17 and 18, of the Sewanee Section.) From 60 to 150 feet thick.

(c.) *Blue Fossiliferous Limestones* mainly, some beds oolitic, some argillaceous, with occasionally a layer of shale, from 90 to 170 feet.

(b.) *Sandstone,* fine-grained, often flaggy, caps, and gives character to the benches and plateaus mentioned in §§ 192 and 193. In White and Overton Counties, it is from 40 to 50 feet thick; in the Sewanee Section it is poorly represented by about 8 feet of sandstone, more or less calcareous. This sandstone has not been observed on the eastern side of the Tableland. In Alabama, south of the Tennessee River in the anticlinal valleys, it becomes a heavy formation.

(a.) *Limestones*, with a few beds of shale; fossiliferous; beds often oolitic; occasionally argillaceous; from 160 to 270 feet.

The sections below give, not only lithological details, but also, to a limited extent, paleontological features.

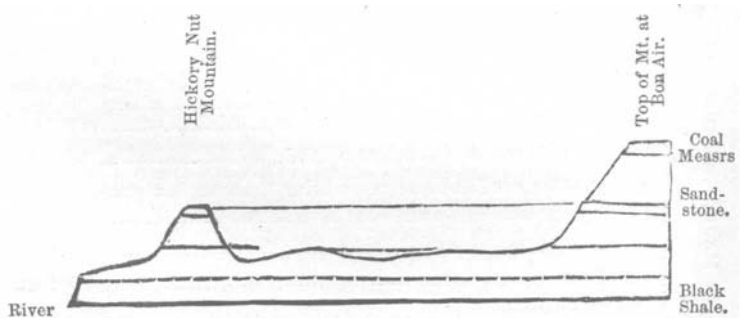
921. (1.) The first presents the entire thickness of the *Lower Carboniferous Limestone*, near the head of Spring Creek, in Overton and Putnam Counties. It embraces all the strata, from the Black Shale to the Coal Measures. It is a combination of two sections; the lower one begins below with the Nashville Formation, in the boring of the "*Jackson oil Well,*" which is located about three-fourths of a mile from the *Newman Well*, (§ 913,) at the foot of the "first bench" of the Tableland, (§ 192,) on Spring Creek, (or rather, near this creek, on its tributary, Hurricane,) and ascends to the sandstone at the top of the bench; the second, or upper one, commences with this sandstone, at Esq. Cooper's, between three and four miles south of the locality of the first, and ascends with the Walton Road to the top of the mountain. The strata of the Coal Series were not measured.

Coal Measures.	(3) *Sandstone*, on a high point south of the road. Thickness?	
	(2) *Shales*, a heavy bed, with clay iron-stones. This, with the sandstones, was estimated to be	130 feet.
	(1) *Sandstone*, upper part thin-bedded or shaly,	120 feet.
	In all	250 feet?
Mountain Limestone.	(10) *Blue Limestone*,	4 feet.
	(9) *Variegated Shale*, brown, gray and green,	12 feet.
	(8) *Shale and Marl*, mostly gray, with some brown and green at top; at intervals some thin layers harder than others,	40 feet.
	(7) *Argillaceous Limestone*, dull bluish gray, breaking with conchoidal fracture; has cavities containing *dolomite*,	27 feet.
	(6) *Blue Limestone*, fossiliferous,	22 feet.
	(5) *Argillaceous Limestone*, resembling 7, above, but more compact, and somewhat fossiliferous,	20 feet.
	(4) Blue Limestones,	85 feet.
	(3) Shales,	6 feet.
	(2) Sandstone, fine-grained, more or less flaggy,	48 feet.
	(1) Blue Limestone, fossiliferous,	168 feet.
	Entire thickness,	432 feet.

LITHOSTROTION BED. *Upper Siliceous.*	(2) *Cherty Limestone*, limestone not seen; chert abundant on the surface,	128 feet.
	(1) *Limestone*, impure, of water-lime aspect, lower part containing sparry blue layers; contains *Lithostrotion Canadense*,	75 feet.
	In all,	203 feet.
PROTEAN BED. *Lower Siliceous.*	*Sandstone*, fine-grained, seen at a number of points in Overton and Putnam,	8 feet.
	Limestone, blue, fetid, rather coarse, fossiliferous and crinoidal, seen,	45 feet.
	Rocks penetrated by the boring of the Jackson Well: many layers chert,	216 feet.
	In all,	269 feet.
BLACK SHALE, resting on the Nashville Formation,		28 feet.

922. The two following sections combined, give the series of Lower Carboniferous strata, as found in White County, complete, from the Black Shale to the Coal Measures. The first and uppermost is a section of the slope of the mountain, or Table-land, taken at a point from four to five miles east of Sparta, and running up to Bon Air. It includes the *sandstone* of the *Mountain Limestone* division.

The latter, or second section, was, taken in the vicinity of the Falls of Caney Fork, and extends from an outcrop of the Black Shale, in the river below the Falls, upward, to the sandstone capping Hickory-nut Mountain, and the same, geologically: as that mentioned above. The diagram below illustrates how the two sections are related:



The heavy line at the bottom is the *Black Shale;* the *Coal Measures* cap the Mountain, or Table-land, at Bon Air; the *sandstone* uniting the sec-

tions, occupies, on the right, an intermediate position, and is seen to cap Hickory-nut Mountain on the left. The space between the Black Shale and the Coal Measures is all Siliceous Group and Mountain Limestone.

923. This will be designated as the *Bon Air Section.*

Coal Measures.	(2) *Conglomerate*, capping the mountain at Bon Air.....	90 feet.
	(1) *Shales*, with three or four thin seams of *Coal*, ...	102 feet.
	In all,.....	192 feet.
Mountain Limestone. Form. 8, b.	(8) *Limestone*, bluish, crinoidal, contains *Archimides Swallovana*, some layers oolitic,.....	40 feet.
	(7) *Variegated Shales and Marls*, green, brown and gray; thin, harder layers at intervals; about the middle of the mass is a layer of shale full of *Athyris ambigua*, and also containing *spirifer bisulcatus*.....	100 feet.
	(6) *Shale or Marl*, with two or three beds of impure fossiliferous limestone and some cherty layers at top,	15 feet.
	(5) *Limestone*, hard, blue, fossiliferous, weathering brown; contains cavities holding *barite*,.....	7 feet.
	(4) *Shale and Limestone* in alternating layers; upper part mostly shale, lower part mostly limestone; shales variegated, mostly greenish, some brown; limestone, bluish gray, fine-grained, argillaceous, breaking with conchoidal fracture, non-fossiliferous; at the base a cherty layer,.....	63 feet.
	(3) *Limestone*, blue, fossiliferous, with occasionally a thin layer of shale; much of it oolitic; contains *Pentremites Godonii* and *P. pyriformis*, *Agassizocrinus*, &c.; has an argillaceous local layer in its middle part, about five feet thick, with a band of breccia marble above; at base, shale five or six feet,.....	123 feet.
	(2) Sandstone, fine-grained, and at some points flaggy, forms a bench around the mountain. (See note under § 192,).....	40 feet.
	(1) *Limestone*, in alternating, oolitic, sparry, crinoidal, and fine-grained, argillaceous layers; two or three thin layers cherty; contains the same *Pentremites* as above, also *Agassizocrinus dactyliformis*, *Aspidodus crenulatus*, *Zaphrentis spinulifera*, etc.; lower fifty feet of rock not seen,.....	213 feet.
	In all,.....	601 feet.
	Lithostrotion Bed, or *St. Louis Limestone*, (*Upper Siliceous,*) at the base of the mountain; rocks mostly concealed, but surface covered with decomposing, fossiliferous,	

cherty masses, and among them specimens of *Lithostrotion Canadense;* thickness from the lowest point accessible, ... 100 feet.

924. Below is the section in the region of the Falls of Caney Fork. We may call it the *Hickory-nut Mountain Section.*

Mt. Limestone.
- (2) Sandstone, at top of Hickory-nut Mountain; same as 2 (*Mountain Limestone*) of last section, ... 40 feet.
- (1) *Limestone.* (See Bon Air Section above.) ..... 215 feet.
- In all ..... 255 feet.

Lithostrotion Bed, or *St. Louis Limestone,* (*Upper Siliceous;*) cherty limestone, containing *Lithostrotion Canadense*; chert, for the most part, in nodular masses, and much of it highly fossiliferous, ... 244 feet.

Protean Bed. (*Lower Siliceous.*)
- (5) *Limestone* at the general level of the country above the valley of Caney Fork, more or less cherty, ... 100 feet.
- (4) *Limestone,* bluish, crinoidal, without chert, ... 30 feet.
- (3) *Rock* weathering into shale, ... 20 feet.
- (2) *Limestone and Chert;* crinoidal limestone interstratified with heavy, rough layers of chert, ... 68 feet.
- (1) *Limestone and Chert;* near the base mostly layers of chert, separated by thin seams of crinoidal limestone, above siliceous limestone, with more or less chert, and abounding in large crinoidal stems, ... 57 feet.

Black Shale, seen at top 15 feet, below not seen; in all down to the river, ... 36 feet.

925. The following is a section of the Lower Carboniferous Limestone in Franklin County, as presented along the Chattanooga and Sewanee Railroad, from Cowan to the *brow* of the mountain. We will call it the *Sewanee Section.* (See page 74, (7.))

Coal Measures.
- (4) *Sandstone,* forms a bluff along the mountain at this point, ... 52 feet.
- (3) *Shale* with a thin seam of coal, ... 14 feet.
- (2) *Sandstone,* rather thin-bedded, at the base a ferruginous, shaly layer, containing fossil *nuts, calamites,* etc., ... 25 to 30 feet.
- (1) *Local bed* of sandy, ferruginous shale, and a hard, sandy, heavy ferruginous rock, below this bluish and brownish shale, ... 12 feet.
- In all, ... 108 feet.

MOUNTAIN LIMESTONE.

(21) *Limestone and Shale;* rocks not well exposed; three feet of crinoidal limestone seen at the top; below this, variegated, brown and red shales, doubtless, with some limestone,..... 85 feet.

(20) *Limestone*, blue and light-blue, the latter oolitic..... 32 feet.

(19) *Shale and Limestone* in alternating beds; shale greenish, bluish-gray, and brownish, and most abundant; limestone fine-grained, argillaceous, gives conchoidal fracture, breaks into angular pieces on exposure. This division is much like 4, (*Mountain Limestone,*) of the Bon Air Section. The old Bowers' road crosses the railroad track on this,..... 70 feet.

(18) *Limestone*, rough, hard, rather thin-bedded, dark-gray, with sometimes a brownish tinge; has cavities lined with chalcedonic quartz, and some filled with gypsum; includes a few layers of shale,..... 25 feet.

(17) *Limestone*, blue, fossiliferous, some of it oolitic; *Pentremites pyriformis, Spirifer bisulcatus*, etc.,..... 21 feet.

(16) *Limestone and Shale*, like 19, above; the most of it thick-bedded limestone; decomposes easily, like that referred to above, both forming glady places along the sides of the mountain,..... 35 feet.

(15) *Limestone*, heavy-bedded; lower part abounds in cavities, some filled with gypsum,..... 55 feet.

(14) *Limestone*, dove-colored, argillaceous, weathers in rough layers, contains cavities lined with crystals; eight feet of the middle part rather even-bedded, with a line of small chert nodules in one layer... 28 feet.

(13) *Limestone*, mostly oolitic, heavy-bedded and light-bluish, fossiliferous; near the base *Archimedes Pentremites*, etc.,..... 50 feet.

(12) *Shales and Limestone* alternating; above argillaceous limestone, weathering to shale, containing cavities lined with crystals of *quartz* and of *calcite* (8 feet;) below this blue, compact, fossiliferous limestone; (6 feet;) then a limestone weathering to a dirty drab, (4 feet;) argillaceous dove-colored limestone, (3 feet ;) blue fossiliferous limestone, (3 feet,)..... 26 feet.

(11) *Shale*, greenish and bluish,..... 12 feet.

(10) SANDSTONE, fine-grained, micaceous and calcareous, 8 feet.

(9) *Shale;* contains a few layers of limestone, one in its middle part three feet thick and oolitic; fossiliferous,..... 31 feet.

MOUNTAIN LIMESTONE.—*Continued.*

(8) *Limestone*, (13 E,) thick-bedded, lower part dark-blue and sparry; upper, light bluish-gray and oolitic; at top, a foot or two of thin limestones and shales abounding in *Archimedes;* the whole mass very fossiliferous; (see list of species,) ..... 13 feet.

(7) *Greenish Shale*, with a bed of limestone three feet thick four feet from the bottom; mass fossiliferous, contains *Astraea* (*Palastræa*) *carbonaria?* ..... 27 feet.

(6) *Limestone*, mostly dove-colored, some layers compact without fossils, others sparry, with them; at top is a layer of bluish-gray oolitic limestone, five feet thick, which forms the ceiling of the Nashville and Chattanooga Railroad Tunnel at its western end; the Tunnel enters the mountain from the west in this bed ..... 32 feet.

(5) *Limestone*, knotty and argillaceous, weathers into knotty lumps and shale; lower layers contain *Archimedes*, ... 9 feet.

(4) *Limestone*, mostly thick-bedded, much of it oolitic and light-colored, some crinoidal, other beds compact argillaceous; contains the common *Pentremites*.. 70 feet.

(3) *Limestone*, blue, thin-bedded, with cherty seams; contains *Archimedes* and *Pentremites*, ... 8 feet.

(2) *Limestone*, beautiful bed of gray limestone, with but a trace of blue, ... 20 feet.

(1) *Limestone*, alternating beds of gray oolitic, and dove-colored, or blue, argillaceous limestones, ... 57 feet.

Entire thickness, ... 704 feet.

LITHOSTROTION BED, or *St. Louis Limestone.*

Cherty Limestone, very fossiliferous, down to the creek at Cowan, about ..... 110 feet.

926. I add here, for comparison, a section of the strata exposed in Monte Sana, near Huntsville, Alabama. It was taken by A. H. Worthen, now Director of the Geological Survey of Illinois, and first published in Prof. Hall's Report on the Geology of Iowa. (Vol. I, Part I, page 114.)

It appears here with some changes, having been revised recently by Mr. Worthen. I am requested to state that the thickness of the different strata were only estimated.

COAL MEASURES.

Ferruginous sandstone, ... 30 feet.

Slate and impure coal ..... 4 feet.

Chester Group.	Light bluish-gray limestone, containing teeth of *Aspidodus crenulatus*, N. & W., *Pentremites Godonii*, and *Archimedes*,	50 feet.
	Shaly limestone, somewhat cherty, containing *Spirifer bisulcatus*, and *Terebratula ambigua*, mostly hidden under a covered slope,	100 to 120 feet.
	Compact bluish-gray limestone, semi-oolitic in part, containing *Pentremites Godonii*, *P. pyriformis*, and *Archimedes*,	250 feet.
	Ferruginous sandstone with fossil plants,	10 to 15 feet.
	Compact gray limestone, with *Pentremites* and *Archimedes* in abundance, *Zeacrinus*, two or three species, *Agassizocrinus conicus*, *Productus elegans*, *P. semireticulatus*, etc.,	200 feet.
	Decomposing cherty layers,	4 feet.
St. Louis Group.	Gray, cherty limestones, with some highly oolitic beds, containing *Lithostrotion Canadense*, *L. proliferum*, *Spirifer striatus?* and joints of crinoidea, with *Productus ovatus?* and *P. semireticulatus*, etc.,	150 to 200 feet.
Keokuk?	Dark bluish-gray, siliceous rock, weathering to shale in some localities, with a few fossil shells scarcely determinable,	100 feet.

927. *Paleontology of the Mountain Limestone.*—A number of the species occurring in these rocks have been given in the sections, and their horizons exhibited. The cuts below represent two of the forms; these are both common and characteristic.

Fig. 1. Fig. 2,a. Fig. 2,b.

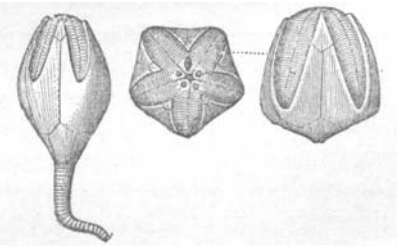


Fig. 1, *Pentremites pyriformis;* Fig. 2,*a* and 2,*b*, *Pentremites Godonii* (*florealis*.)

In the following list, a few of the species of the Mountain Limestone, including those of the sections, are presented:

(§ 886.)

(1) *Astræa* (*Palastræa*) *carbonaria?* McCoy. My specimens are doubtfully referred to McCoy's species. The fossil, in fine specimens, is found in No.7, of the Sewanee Section. (§ 925.) It also occurs at Crab Orchard, in Cumberland County, and back of Stevenson, Alabama.

(2) *Zaphrentis spinulifera,* Hal1. In both (a) and (c,) §920. Associated with the last at the localities mentioned.

(3) *Archimedes Swallovana,* Hall. Occurs at intervals, pretty well through the entire group.

(4) *Pentremites Godonii,* DeFrance. Occurs in both the upper and lower parts of the formation, like the last.

(5) *Pentremites pyriformis,* Say. Cosmopolitan, like 3 and 4.

Between one and two miles north of Cowan, in Franklin County, and on the end of a spur running out from the Table-land, is a rich locality of *pentremites,* and other fossils. The bed in which they occur is shaly, and has about the horizon of the shales in the vicinity of the Nashville and Chattanooga Railroad Tunnel.

(6) *Pentremites obesus,* Lyon. Lower part of No.6, Sewanee Section. (§ 925.)

(7) *Dichocrinus sex-lobatus?* Shumard. Pentremital locality mentioned under No. 5.

(8) *Agassizocrinus dactyliformis,* Troost. No.1, Bon Air Section, (§ 923;) Pentremital locality near Cowan, and other horizons and localities.

(9) *Spirifer bisulcatus,* Sowerby. (S. increbescens, Hall.) Bon Air Section, No.7; Sewanee Section, No. 17, and at many other points.

(10) *Spirifer spinosus,* Norwood and Pratten. Top of bed No. 4, Sewanee Section, and just below Tunnel.

(11) *Spirifer Leidyi,* Norwood and Pratten. No.5, Sewanee Section; Montvale Springs, in Blount County.

(12) *Spirifer lineatus,* Martin, *(S. pseudo-lineatus,* Hall.) Nos. 5 and 8, Sewanee Section, and many other localities, including Montvale Springs.

(13) *Spirifer Keokuk,* Hall? No.8, Sewanee Section, and No.1, Bon Air Section. (See § 349 (12).)

(14) *Spiriferina Kelloggi,* Swallow. Nos. 5, 7 and 8, Sewanee Section.

(15) *Hemipronites* (*Stretorhyncus*) *crenistria.* No.8, Sewanee Section, and other localities.

(16) *Athyris ambigua,* Sowerby. *(A. subquadrata,* Hall.) Nos. 3 and 7, Bon Air Section; Nos. 7 and 8, Sewanee Section.

(17) *Terebratula trinuclea,* Hall. No.5, Sewanee Section.

(18) *Rhynchonella explanata?* McChesney. No.5, Sewanee Section.

(19) *Athyris Royissii,* L'Eveille. *(A. sublamellosa,* Hall. Pentremital locality near Cowan, and at many other points.

(20) *Productus semireticulatus,* Martin. Cosmopolitan.

(21) *Productus Cora.* Cosmopolitan, like the last. Both of these occur below, in the Siliceous Group.

(22) *Productus pileiformis,* McChesney. Bed No. 8, Sewanee Section.

(23) *Productus longispinus.* No. 8, Sewanee Section.

(24) *Productus elegans,* Norwood and Pratten. Same locality and horizon as the last.

(25) *Productus punctatus,* Martin. No. 8, Sewanee Section, and other points.

(26) *Aspidodus crenulatus,* Newb. and Worthen. Bed 20, Sewanee Section, and, *perhaps,* upper part of No.1, Bon Air Section.

(27) *Claydodus magnificus,* Tuomey. No. 8 of the Sewanee Section, and at a lower horizon of the same section.

928. Many of the above species are characteristic of the *Kaskaskia* (or Chester) Limestone, of the Northwestern States, and very nearly all of them occur in that formation. The *Mountain Limestone* of this State, is, therefore, its equivalent. The *Warsaw Limestone* is not distinguished here as a separate Bed. (See the *table* at the end of this chapter.)

929. In paragraph 918, the occurrence of the Mountain Limestone on the slopes of the Cumberland Table-land has been spoken of. The Table-land, as there referred to, includes its outliers. On some of these the presentation of the strata of the formation is high and bold, as, for instance, around the end of *Lookout Mountain,* near Chattanooga, (§ 189,) and of *Ben Lomond,* near McMinnville, (page 75.) Other out-1iers, on the slopes of which these rocks outcrop, are *Pilot Mountain,* in Warren, *Milk-sick Mountain,* in White, and *Pilot Knob,* and others, in Overton, as well as the *Short Mountains,* in Cannon, (§§ 190 and 191.) The "*little mountains,*" spoken of in § 192, are capped with the sandstone of this formation, and have a structure like that of Hickory-nut Mountain, a section of which has been given. (See §§ 922 and 924.) Of this class is the long flat-topped and much notched ridge in Overton, which reaches

out so far from the mountain region to the northwest, between the waters of Roaring and Obey's rivers.

930. In East Tennessee there are but few outliers proper, of the Table-land. A *trace* of the synclinal, in which Lookout Mountain rests, appears to extend up as far as the Rhea County line, presenting a strip of Mountain Limestone on the eastside of the Tennessee Valley, (§ 121.)

Lone Mountain, in the southern part of Rhea, is an outlier, having Carboniferous Limestone around it.

Attention may be called here, to the outcrop of this Limestone at the western base of *Pine Mountain,* on the southeast side of the Elk Fork Valley, §§ 180, 354. In the diagram on page 142, the *unnumbered space* below 9 on the right, is 8,b, or the *Mountain Limestone.)* Attention, also, is directed to the manner of its outcrop in Sequatchee and Lookout Valleys, (diagram, p. 139 and Map.) With reference to the exposure of this formation at Crab Orchard and Grassy Cove in Cumberland County, see page 138.

931. It remains to notice the belts of *Mountain Limestone* which occur, disconnected with the Table-land. There are several of these in East Tennessee, as follows:

(1) The *Montvale Belt,* in Blount County. This has been noticed in § 801. The strip runs for several miles in front of Chilhowee Mountain.

(2) The *Hawkins Belt,* held in the synclinal described in § 863. The strip of country lying immediately southeast of *Pine Mountain* is underlaid by this formation. This is a belt of considerable extent.

(3) *A narrow belt* in the ridge east of Sneedville, (§ 753.)

(4) In *Newman's Ridge,* at its crest and on its western slope, (§ 753.)

(5) A long belt, sometimes a mile wide, at the eastern base of White Oak Mountain, in the southern part of East Tennessee, (§§ 773 and 774.)

932. *Minerals, Rocks of Special Use, and Agricultural Features of the Mountain Limestone.*—A number of the layers of this formation contain geodes and cavities affording, often, beautiful crystals. The following minerals have been observed. (See sections.)

1. *Dolomite,* in cavities.
2. *Barite,* (*Heavy Spar,*) also in cavities.
3. *Quartz,* in many forms; in geodes lined with chalcedony.
4. *Gypsum,* in cavities or geodes; sometimes in balls of considerable size, as white and flesh-colored *Alabaster.*

(5) *Epsomite, (Epsom Salt,)* in considerable abundance in many of the caves in the limestones of the Table-land, as those on the Gulf of Caney Fork, in White County, and on the East Fork of Obey, in Overton and Fen-

tress. At many of them the salt could be prepared for market by the barrel.

(6) *Nitre*, in many caves along the slopes of the Table-land. These caves yielded, during the first part of this century, a very large amount of nitre, and at that time the most available part of the nitre-earth they contained, was worked over. The mineral most abundant in the earth is, doubtless, *nitrocalcite.*

(7) *Galenite*, (*Lead Ore*,) occasionally met with in limited quantity, in small veins.

(8) *Petroleum* occurs in this formation in the deep and narrow valley of the Big South Fork of the Cumberland River, in the old Beaty Salt Well, near the Tennessee line, in Kentucky.

933. Many of the limestones of this formation could be used with advantage for building purposes. Some of the oolitic limestones, and those, too, that are accessible by means of the Nashville and Chattanooga Railroad, are a beautiful, grayish white, and durable building material.

The *argillaceous limestone* mentioned in § 920 (d) has been used in masonry, but it is a comparatively worthless material, as the history of the abutments of the Running Water Bridge, on the N. & C. road, which are built of it, demonstrates.

934. The sandstone of the formation (§ 920 (b)) often presents itself, especially in Overton and White, as good flags. It would also supply, at many points, easily quarried and desirable building stone.

935. The Mountain Limestone, unlike the Trenton, Nashville, and several other formations, outcrops in no very extended flat or rolling areas, and therefore its agricultural value is comparatively limited. But on the slopes of the mountains it often underlies a strong, rich soil, which supports, frequently, heavy forests of the finest timber, large poplars, walnuts, white oaks, etc. Many small but rich farms are located upon it. Such places are well adapted to the raising of fruit.

With reference to the large springs issuing from the limestones of this formation, see note, page 68.

936. On the next two pages is presented a table of geological equivalents, prepared by Dr. A. Winchell, of Ann Arbor, Michigan. It is mainly confined to the subdivisions of the Lower Carboniferous Formation.

TABLE OF GEOLOGICAL EQUIVALENTS. (By A. WINCHELL.)

NEW YORK.	ONTARIO.	MICHIGAN.	OHIO.	INDIANA.	ILLINOIS.
(Wanting?)	(Wanting.)	Parma Conglomerate.	Conglomerate.	Conglomerate.	Conglomerate.
(Wanting.)	(Wanting.)		False Coal Measures.	?	False Coal Measures.
(Wanting.)	(Wanting.)	Carboniferous Limest'e. Michigan Salt Group.	(Wanting.)	(Wanting.)	Chester Limestone.
				St. Louis Limestone.	St. Louis Limestone.
				Warsaw Limestone.	Warsaw Limestone.
				Keokuk Limestone. Gray Limestone. Brown Shale. Knobstones.	Keokuk Limestone.
					Burlington Limestone.
Catskill Group, including "Carboniferous Cong." and Chemung Cong.	(Wanting.)	Marshall Group.	Waverly Series, in part.	Rockford Limestone and Williamsport Gritstone.	Kinderhook Group.
Chemung Group. Portage Group, embracing the Cashaqua Shale.	Portage Shales.	Huron Group. embracing Micaceous Schists and Flags, Argillaceous Shale, Green Shale,	Chocolate Shale Series. (Base of Waverley Series.)	(Wanting.)	(Wanting.)
Genesee Shale.	Hamilton Shale.	Black Shale.	Black Shale.	Black Shale.	Black Shale.
Hamilton Group.	Hamilton Group.	Hamilton Group.	Hamilton Group.	Hamilton Group.	Hamilton Group.

Iowa.	Missouri.	Kentucky.	Tennessee.	Europe.
?	?	Conglomerate.	Conglomerate.	Millstone Grit.
Kaskaskia ?	?	False Coal Measures.	False Coal Measures.	?
Kaskaskia Limestone.		Kaskaskia Limestone.	Mountain Limestone.	Mountain Limestone.
St. Louis Limestone.	St. Louis Limestone.	St. Louis Limestone.	Upper Siliceous, (b.)	
Warsaw Limestone.	Warsaw Limestone.	?		
Keokuk Limestone.	Keokuk Limestone.	Keokuk Limestone. Knobstones.	Lower Siliceous, (a.)	
Burlington Limestone.	Burlington Limestone.			
Yellow Sandstone Series.	Chouteau Limestone. Vermicular Sandstone and Shale. Lithographic Limestone.	(Wanting.)	(Wanting.)	Old red Sandstone, (Scotland.) Yellow Sandstone, (Ireland.) Westphalian Schists.
Perhaps lower part of Yellow Sandstone Series.	Bluish Shales.	Argillaceous Beds.	(Wanting.)	Cypridinenschiefer.
		Black Shale.	Black Shale.	
Hamilton Group.	Hamilton Group.	Hamilton Group.	(Wanting.)	Orthoceras Schiefer. Speriferen Sandstein, (Nassau.)