CHAPTER VIII.

THE TRENTON AND NASHVILLE GROUPS; FORMATIONS III AND IV.

577. Succeeding the dolomites of the *Knox Group,* we have, both in East and Middle Tennessee, beds of blue, highly fossiliferous, limestones, equivalent, in general, to beds, which, in New York, are referred to the Chazy, Black River, and Trenton Formations. In East Tennessee it is generally an easy matter to know when, in traversing the country, we pass from the rocks of the upper Knox to those of the Trenton. There is some admixture of gray and blue strata in the horizon of junction, but the compact gray (or variegated gray) strata, and the gray chert on one side, and the blue limestone (often knotty and fragile) on the other, are quite in contrast. On the one side, too, rises the ridge—on the other is the valley. This is a lithological and topographical contrast; as to fossils, there is more or less blending.

578. The blue limestones referred to above, constitute a group which retains its general features tolerably well throughout both Middle and East Tennessee. But not so with the overlying and remaining beds of the Lower Silurian Formations. These, in East Tennessee, present a different aspect from what they do in Middle Tennessee. Moreover, they present differences in the Eastern Valley itself, being on the northwest side mainly limestones, and on the southeast, shales. Again, in certain regions, or belts, of the valley, they include several interpolated and interesting beds of special character, making, altogether, a series quite heterogeneous.

In the Basin of Middle Tennessee the entire series of Trenton and Nashville rocks is much the same from bottom to top, being mainly different varieties of *blue limestone.*

579. I will notice first the Trenton and Nashville Series, as presented in East Tennessee Valley, and after that, pass to the consideration of the same rocks in Middle Tennessee. The Central Basin (p. 97) has some claims to be considered, first,

for the reason that it has become in Tennessee, typical ground, so far as these rocks are concerned, a fact due to the undisturbed condition and fine development of the strata, and to the greater study given to its fossil species. In the *Basin*, the strata are, without difficulty, grouped into the two divisions which I have named *Trenton* and *Nashville.* In the *Eastern Valley*, they are not, in this Report, thus systematically grouped, but are considered together as the *Trenton and Nashville Series.* Notwithstanding the claims of the Basin, it will be more in accordance with the order adopted, to commence with the formations of the Eastern Valley.

SECTION I.

THE TRENTON AND NASHVILLE SERIES IN THE VALLEY OF EAST TENNESSEE.

GENERAL CHARACTERS;—SECTIONS NEAR KNOXVILLE—INTERPOLATED BEDS. **A,** THE BLUE OR MACLUREA LIMESTONE—LITIIOLOGICAL CHARACTER, THICKNESS—TOPOGRAPHY, EXTENT AND RANGE—PALÆONTOLOGY, AGE: (1) THE RED AND GRAY MARBLE—EXTENT AND RANGE, THE RED BELT;— (2) THE IRON LIMESTONE—LITHOLOGICAL AND OTHER CHARACTERS—EXTENT AND RANGE—THE RED KNOBS;—(3) OTHER SPECIAL BEDS—DIVISION NEXT ABOVE IRON-LIMESTONE, AND THE CRINOID BED—THE UPPER MARBLE—THE BROWN SHALE. **B,** THE UPPER MEMBER OF THE SERIES;—(a) THE SHALE (EASTERN)—THE GRAY BELT, ITS TOPOGRAPHY—AREAS OF SHALE, SYNCLINALS—LITHOLOGICAL CHARACTER; GRAPTOLITES;—(b) LIMESTONE AND SHALE (WESTERN)—TOPOGRAPHY, AREAS—LITHOLOGICAL AND OTHER CHARACTERS; TRANSITION BEDS; APPENDIX;—USEFUL ROCK AND MINERALS;—AGRICULTURAL FEATURES.

580. *General Characters.*—The Trenton and Nashville rocks in East Tennessee, may, *in general*, be described as follows:

They are first a stratum of blue limestone, more or less argillaceous, from 200 to 600 feet thick, (§ 590;) then above this a great body of sky-blue calcareous and often sandy shales, weathering yellowish gray, or buff, and containing occasionally thin flaggy limestones, and at some points, thin sandstones.

We thus divide the series into two members, the *Blue Lime-*

stone and the *Shale.* The latter has a maximum thickness of about 2000 feet.

581. The upper member, as thus characterized, pertains properly to the middle and southeastern portions of the Valley, supposing the latter to be divided longitudinally. In going to the northwest, towards the Cumberland Table-land, in any part of the Valley, the shale becomes more and more calcareous, approaching the condition the same strata present in Middle Tennessee.

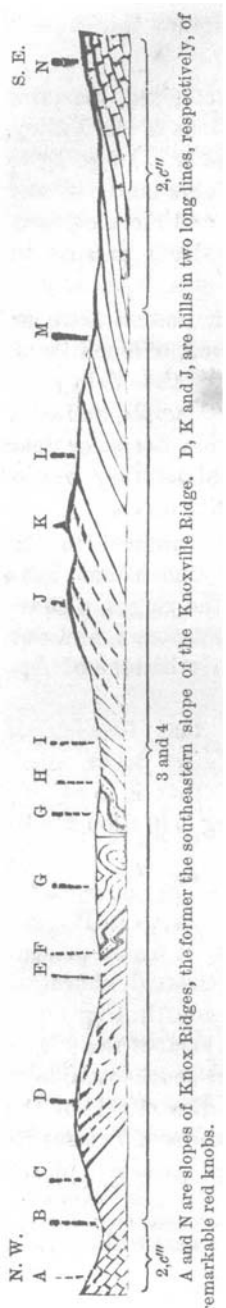
582. I have given above, let it be noted, *general* features. There are special features, as before remarked, of much interest and importance. In the middle portion of the Valley the *Shale* contains interpolated or local beds of *marble,* and of a *hard, sandy, iron-limestone.* One bed of marble lies at or near the base of the shale; the iron-limestones and another bed of marble, are interstratified with layers at higher levels.

583. These interpolated beds are mostly confined to the middle portion of the Valley. Their longer dimensions have approximately, the direction of the trend of the ridges, a characteristic, by the way, of other beds to be mentioned, and one that is interesting as to its bearing on the early history of Appalachian movement.

And here it may be added, generally, that lithological changes in *most of the formations of the Valley* occur much more rapidly in going "across the country," that is to say, to the northwest or southeast, than in traversing it in a longitudinal, or northeast and southwest direction.

584. *Sections in the vicinity of Knoxville—The Interpolated Beds.*— If a section across the strata, on a line between Rogersville and Greeneville, were taken, a portion of it would present the Trenton and Nashville Series in its twofold character of *blue limestone* and *shale,* (§ 580,) the latter constituting much the larger, and by far the more conspicuous part of the whole. Intersecting, however, the same series on the southeast side of Knoxville, or say, more generally, on the southeast side of the ridge Knoxville is located upon, (§ 543, (*e,*)) the section loses its simple character, and becomes varied by the presence of the interpolated or local beds just spoken of.

585. I present on the next page a section across the belt of



A and N are slopes of Knox Ridges, the former the southeastern slope of the Knoxville Ridge. D, K and J, are hills in two long lines, respectively, of remarkable red knobs.

Trenton and Nashville rocks, which lies next east, or southeast, of Knoxville. The section was taken a few miles northeast of Knoxville; the line of it runs to the northwest and southeast near the mouth of the French Broad River.

586. The following is the series of beds and formations, presented in the section in descending order:

(7.) *Calcareous Shale,* (G, G,) with occasionally thin, flaggy limestones and a few layers of hard, sandy limestone; contains *Leptaena sericea, Strophomena alternata* and *S.filitexta.* This and the shales below are sky-blue, weathering yellowish gray, or buff. Owing to, folds thickness uncertain, say in feet, ...400?

(6.) *Red Marble,* (F, H,) fossiliferous, variegated, mostly red marble, with gray and greenish layers j folded and thickness doubtful, say ..... 300?

(5.) *Calcareous Shale,* (E, I,) with more or less flaggy, fossiliferous limestone; thickness doubtful, as above, say ..... 500?

(4.) *Iron.limestone,* (D, J, K,) a hard, sandy, very ferruginous limestone, weathering to a porous, dark brown, sandy *skeleton*; fossiliferous, among the species *Asaphus platycephalus* common. Thickness from 200 to 300 feet 250

(3.) *Calcareous Shale* containing interstratified beds of iron-limestone, as well as of blue, flaggy limestones. (The division above (4) might be included in this, as the upper member.) 400

(2.) *Red and Gray Marble,* (C, L,) coralline, grayish white, and variegated 380

(1.) *Blue Limestone,* (B, M,) argillaceous, fossiliferous; contains *Maclurea magna,* and is followed below by rocks of the Knox Group 500

587. The Knoxville Ridge has a belt of Trenton and Nashville rocks on its northwest side, also. The general section on

page 204, crosses this. It lies between the ridge M, and that on which the city is located. Commencing with a bed of reddish brown shales in this valley, and proceeding in a northwesterly direction to the base of the ridge, M, the series of strata in this belt is approximately, in descending order, as follows:

(6.) *Brownish-red Shale;* a more or less calcareous rock, weathering into shale; contains some grayish layers more calcareous. This bed is crossed on a Clinton road before reaching the Knoxville Cemetery gate; it occurs in several folds. Thickness uncertain, say (in feet) ..... 300?

(5.) *Calcareous Shale,* with occasionally thin, flaggy, fossiliferous limestones. The shales are sky-blue, weathering buff and yellowish gray. They measure across their outcrop 1700 feet; allowing for dip, plications, etc., their thickness may be *estimated* at ..... 1000?

(4.) *Iron-Limestone,* like No.4 in last section, about 100

(3.) *Calcareous Shale,* sky-blue, weathering buff 320

(2,*c*.) *Variegated Marble...* 375

(2,*b*.) *Blue Limestone* like No. 1, below 136

(2,*a*.) *Variegated Marble*..... 35

(1.) *Blue Limestone,* same as No.1 of last section, and resting on strata of the Knox Group 510

588. In passing from the belt of Trenton and Nashville rocks on the southeast side of Knoxville, to that on the northwest, the two being separated by a dolomite ridge, considerable change occurs in the strata. This may be seen by comparing the two sections just given. The *Iron Limestone,* for example, on the northwest has lost its prominence. On the southeast it has volume enough to form high hills; (the red hills seen across the river from Knoxville;) on the northwest it gives no marked topographical feature.* In the belts still further northwest it soon thins out and is not seen. This is in harmony with statement made in (§ 583.)

589. Another difference in the sections, is the presence of the bed of *Brownish-red Shale* in one, (the northwestern,) and its absence in the other, unless, indeed, the Red Marble of the eastern section, is synchronous, the marble, being the product

* It may be mentioned here, that this band of Iron Limestone on the northwest of Knoxville, becomes heavier when traced "down the country" to the southwest. It soon begins to form characteristic red knobs, and ultimately makes a conspicuous line of them.

of a local, encrinal, and coralline colony. Fragments of corals, and the buttons and plates of crinoids, in quantity, mixed with red marly mud, would harden into such rock.

With these remarks, we pass to the special consideration of the Strata.

A.—THE BLUE, OR MACLUREA LIMESTONE.

590. This is the lower Blue Limestone Member of the Trenton and Nashville Series, spoken of in §§ 580 and 584; it is, too, the lowest bed in the two sections on page 230. I propose to call it the *Maclurea Limestone*, for the reason, that the large and conspicuous fossil shell, *Maclurea Magna*, is found in it, and, at some points, very abundantly, as at Kingsport, in Sullivan County.

591. *Lithological Character; Thickness.*—The geological position of this formation, is next above the Knox Dolomite. (§ 535.) It is, generally, a blue, more or less, argillaceous limestone. In the central part of the valley, it is often knotty, and breaks up, more or less, in lumps, in weathering. In some regions, as in the northern part of Jefferson, and in the vicinity of Bull's Gap, it breaks in small blocks, and has been designated, the *"Block Limestone."* In this same region, too, it is rich in fragments of trilobites, *Asaphus, Ampyx, and Illaenus.*

592. In the northeastern counties, Greene, Washington, Carter, and Sullivan, the formation presents, generally, a more compact limestone, and is greatly reduced in thickness. At Greeneville, for instance, it is not more than 120 feet thick. It lies just southeast of this town, in a clear section, between the Shale and the Knox Dolomite.* It is, at this point, a blue limestone, some of the layers of which, are blackish blue, and much intersected by small veins of calcite. Masses of the latter might be selected, from which beautiful marble slabs could be sawn.

593. In Washington, and in Sullivan east of Blountsville, as well as northeastward in Virginia, the Maclurea Limestone

* Immediately southeast of Greeneville, the line of a long *Shale* ridge passes. This ridge is narrow, tolerably sharp, and is made by the lower part of the Trenton and Nashville Shale. Along the base of this ridge, and, at some points, on both sides of the Shale, the Maclurea Limestone is seen.

presents very much the character that it does at Greeneville. At some points, it is reduced to a thickness of fifty feet.

594. Going southwestward from Greene County, the formation, wherever it outcrops, is much the same as at Greeneville. It is so at Newport, which town is located upon it and the overlying shale. (§ 457.) A few miles east of Sevierville, on both of the forks of the Little Pigeon, its blue layers are seen separating the gray dolomites and the shale. (§§ 447 and 453.) The rocks here, show, to some extent, the knotty structure.

595. A short distance east of Benton, in Polk County, the formation is intersected. It lies at the western base of a shale and sandstone ridge. Below the shale, is, first, a bed of blue argillaceous, flaggy limestone, containing Maclurea; then succeeds a blue, compact, fossiliferous limestone, which is followed by Knox Strata. The formation is heavier in this region than further north.

596. On the northwest side of the valley, that is to say, on the side next to the Cumberland Table-land, the Maclurea Limestone is not distinguished from the overlying part of the Trenton and Nashville Series, by any well marked lithological characters. As before stated, the entire series begins, here, to exhibit Middle Tennessee features, (§ 581,) and is much the same throughout.

597. The maximum thickness of the Maclurea Limestone is about 600 feet, and, as stated, its minimum, (in the northeastern corner of the State,) is 50. At no point in an unbroken section, presenting the two contiguous formations, have I seen this group absent.

598. *Topography; Extent and Range*.—These limestones are, usually, valley-making, and, in connection with the other and overlying rocks of the Trenton and Nashville Series, have, especially in the northwestern half of the valley, yielded to denuding agencies, and formed many fine valley-ranges. (See§§ 649 and 650.) In some of these ranges, the Maclurea Limestones, when highly tilted,* present themselves in low rounded ridges, along which the strata outcrop in parallel lines, forming glady places, often with a growth of red cedar .

* In which position, like shales, they are more commonly found, than are the solid, heavy bedded strata.

599. In the Trenton and Nashville Valleys, pertaining to the great and long ribbons, into which the formations have been faulted, and which are intersected in going from Knoxville to the Cumberland Table-land, (§§ 508 and 510,) the place of the Maclurea Limestone is on the northwest side of each valley, and next to the ridge-making Knox Dolomite. In the valleys lying along the base of the Table-land, as for instance, Powell's Valley in Claiborne and Campbell, and Tennessee Valley in Rhea and Hamilton, the place of the formation is on the southeast side, the formations occurring successively in ascending order in going to the northwest.

600. The great *anticlinal* ranges, like that of Claiborne, Union and Campbell, and that of Sequatchee Valley,* (§ 514,) when presenting a central belt of Knox Strata, have this belt bordered on both sides by Maclurea Limestones. And, so too, a *synclinal* range of Trenton and Nashville Strata, will show a border of Maclurea Limestones on both sides. This is, for the most part, true of the great range, (the Gray Belt, § 640,) which extends from Kingsport on the Holston, quite through the State. Its border throughout, on the northwest side, is made up of these limestones; on the southeast side, they are, at some points, engulfed in local faults, though at most points, appearing in place.

601. In some regions where the strata dip but little, considerable areas are underlaid by the Maclurea Limestone. Such an area is crossed by the section on page 230, at M, or between L and N. The argillaceous crumbling limestones form a glady belt, abounding in red cedars. Such places recall forcibly the great cedar glades of the Central Basin, (§ 240,) which, by the way, are located on certain flaggy layers of the same formation.

The area above extends a number of miles southwestward, and is brought up on the end of an anticlinal point, as may be seen by referring to the map. The road from Knoxville to Sevierville crosses this outcrop of Maclurea Limestone, which, along this line, is, perhaps two miles wide. It contracts, how-

* In reference to the anticlinal of Sequatchee Valley, it must be stated, that in the middle and southern part of the valley, the anticlinal fold is faulted on the northwest side, and, in some parts, the Maclurea Limestone, and, indeed, the whole Trenton and Nashville Series, is engulfed.

ever, rapidly, and further to the southwest, disappears beneath the higher beds—the marble, shales, and iron-limestone.

602. In the region of Strawberry Plains,* above and below, along certain lines, there is much of this rock. The running out of the synclinal mentioned in § 551, brings it up. It occurs, for the most part, in bands between the dolomites of the Knox Group and the overlying marbles, etc. There are, also, similar anticlinal and synclinal points in Jefferson, Greene, and other counties, which cause this formation to outcrop in belts and areas more or less extended.

603. *Palæontology; Age.*—The fossils of the Maclurea Limestone have not, as yet, been thoroughly studied. It is at some points quite rich in species, many of which are new forms. The following are some that have been observed:

1. *Maclurea magna, Lesueur.* This is an abundant and characteristic fossil in this formation. It is found at numerous localities in the Valley, in fact, we may say, wherever the bed outcrops. Among the localities, the following may be mentioned: the western base of the ridge next east of Benton, in Polk County; the blue limestone on the east side of the railroad, at Lenoir's in Roane County; the outcrops of the formation around Knoxville; the blue limestone at Kingsport, in Sullivan, etc.

The locality at Kingsport is a noted one; the rocks are so full of the shells, and casts of this species, that they attract much attention.

2. *Rhynconella plena,* Hall. This species is abundant in the blue limestone at Lenoir's.
3. *Leptaena sericea,* Sowerby. In Sevier County, a few miles east of Sevierville, at the junction of this formation with the upper division—the shale—of the Trenton and Nashville series. (§ 594.)
4. *Orthis bellarugosa,* Conrad. Near Benton, in Polk County, associated with *Maclurea magna.*
5. *Strophomena incrassata,* Hall. East of Benton, same locality as the last.
6. *Orthoccras pertinax,* Billings. Collected at Lenoir's, in association with *Rhynconella plena* and *Maclurea magna.*
7. *Illaenus latidorsata?* Hall. In the “block limestone," White Horn Creek, Jefferson County. (§ 591.)
8. *Asaphus canalis,* Conrad. "Block limestone," same locality as last, and other localities.
9. *Ampyx Jillsoni,* Safford. " Block limestone," east side of Bull's Gap.

* The Depot at Strawberry Plains is built of the Maclurea Limestone.

604. The above species are found in the middle and south-eastern portions of the valley (dividing the latter longitudinally) in which the *Maclurea Limestone* is a distinct lithological group. Approaching the Cumberland Table-land, the lower portion of the *Series* (taking the Trenton and Nashville Groups together) presents many of the forms to be enumerated hereafter, as belonging to the Trenton Formation in Middle Tennessee.

In the list above, 1, 2 and 6 are *Chazy,* or *Black River* forms, or both; 5 and 8 are *Chazy,* but also *Trenton* and *Hudson River;* 4 is *Trenton,* and 3 is *Trenton* and *Hudson River*. The formation is doubtless about equivalent to the Chazy and Black River rocks, of New York and Canada, rocks that we include, with Dana, in the Trenton Group, or Period.

(1.) THE RED AND GRAY MARBLE.

605. This (the first interpolated bed, § 582) is represented in the section (C, L,) on page 230, as resting upon the limestone just described. It is also given in the table on page 231. In the latter the bed is duplicated. This may be due to a fault and displacement, or the marble, 2,*a,* may be in its natural position—interpolated between strata of the Maclurea Limestone. For several miles to the northeast, on this range, the same arrangement is observed.

606. *Lithological Character*.—This bed is one of great interest on account of the valuable marble for ornamental and building purposes, it can supply. In the section, page 230, it is 380 feet thick. The bed is, in general, a variegated crinoidal and coralline limestone. Its colors are grayish white, and brownish red; sometimes pinkish red, or even greenish. The latter colors, however, are not common. The most esteemed variety has, when polished, a bright ground of brownish red colors, mottled more or less freely, with white or gray spots, or fleecy clouds. These clouds and spots, in that of first quality, are well defined, and, to the naked eye, show little of their fossiliferous character. The whitish spots are due, for the most part, to the presence of corals, with small cells like *Chaetetes* or *Stenopora.*

607. At some points, much of the bed becomes grayish

white, without admixture of red. It is then called "white marble," (in reality, grayish white,) and is esteemed for tombstones, monuments, floors, ornamental gate posts, as a building material, and for other purposes.

A few miles northeast of Knoxville, and near the line of the section on page 230, is a valuable quarry, of the gray variety.* The section of the entire bed, at this point, commencing at the bottom and ascending, is as follows:

1st. Variegated, with gray and red, so as to be more or less flesh-colored..... .... 55 feet
2d. Grayish-white, no red ..... 95 "
3d. More or less reddish, especially upper part ....230 "

The quarry is in the middle, or 2d portion, which is here, the most valuable.

Marble of much the same quality is found at the mouth of the French Broad River. This belongs to the bed, L, in the section just referred to. The Williams quarry is in the belt represented at C, in the same section.

608. *Sloan's quarry* is located on a ridge, nearly two miles north of Knoxville, and near the East Tennessee and Virginia Railroad. It is on the duplicated range spoken of in § 605. This range runs parallel with the Knox Dolomite belt, forming the ridge, M, in the section on page 204, from which it is separated by Maclurea Limestone. At this quarry, the section is much the same as that in § 586.

The variegated variety has, for the most part, been obtained here, and the locality is interesting, as being that from which most of the marble in the State Capitol, at Nashville, was taken.

609. Hawkins County has, so far, supplied the most desirable marble from this formation. That used in ornamenting the Capitol, at Washington, is from Hawkins. The best display of Tennessee marble to be seen anywhere, is at the National Capitol. As an ornamental rock, that of Hawkins County is, of its class, unsurpassed. The authorities at Washington caused an extensive quarry to be opened at the point

*This quarry, when I visited it last, in August, 1858, was owned by Col. John Williams, and it may be held by him now. It was sold, in the bed, to the quarry-men, at the rate of eight cents per cubic foot.

where the marble range of the county strikes the Holston River. The supply is unlimited. The rock is of the most desirable variegated variety.

610. *Extent and Range; the Red Belt.*—By referring to the Map, it will be seen that an important area of Trenton and Nashville rocks, originates a little south, or west, of New Market, and runs through the Valley, to Georgia.* Its widest part is southeast of Knoxville. It will be seen, also, that the Knoxville Ridge, or rather, the formation which makes it, rises a few miles to the northeast of the city, and splits off an arm of this area, the arm running out before reaching Athens; and again, that another arm, though much shorter, is split off by a dolomite range commencing several miles east of Knoxville, and running northeastward.† Taking this area, with its arms, we may, as it is desirable to have a name, call it the *Red Belt,* of the Trenton and Nashville Series.

611. In this *Red Belt,* as above described, the marble-bed we are considering, is pretty generally found in place. Its position, with reference to the other formations, is as represented in the section on page 230, the Maclurea Limestone separating it from the Knox Dolomite. It exists in greatest force in Knox County, its maximum thickness being not far from 400 feet. It is found in the vicinity of Strawberry Plains, and has been traced southward through the western parts of Blount and Monroe, the eastern part of Roane, to McMinn.

612. In the belt of the Trenton and Nashville Series, lying next west of the one just considered—that immediately west of Webb's Ridge and Clinch Mountain—the marble is, again, observed, but it is not as heavy, and, at intervals, is absent. In the northern part of the valley, west of Copper Ridge, a narrow band occurs, but west of this, it is not seen.

613. In Hawkins County, the marble is part of a comparatively short belt of Trenton and Nashville rocks, lying west of

*There is, however, one break in this range. On the road from Cleveland to Ducktown, at the point of the: range intersected, the Trenton and Nashville Series is entirely wanting, the upper part of the Knox Group appearing on the surface. A little to the north of this, however, the rocks are seen, the "red hills," one of the great features of this range, being conspicuous.

†The last mentioned dolomite range is the one at N, in the section on page 230.

Rogersville, but separated from the town, by a conspicuous ridge. This belt is cut off at each end by one of the great faults. It is, however, sixteen or seventeen miles long, the marble lying on the southwest side, and running nearly through, its whole length. As in the vicinity of Knoxville, the marble bed is separated from the Knox Dolomites, by the Maclurea blue limestones. It is from fifty, to two or three hundred feet in thickness. The government quarry, (§ 609,) is near the southwestern end of the range.

Southeast of the Red Belt and the Hawkins Range, the marble is not observed, or, at most, exists only in traces.

614. Originally, when continuous, this rock occupied a long belt-like area, reaching from the northern part of McMinn County, to the Virginia line north of Rogersville. It had the general trend of the present country. Although a hundred and twenty miles long, it was, perhaps, not anywhere, twenty wide. Early in Appalachian movements, this bed appears to have rested in a shallow trough, and, in this, the coral and crinoidal animals may have flourished and died, one generation after another, each leaving their calcareous remains, and contributing to the mass which is now a solid rock, noted for its use and beauty. (See § 583.) In the succeeding part of the Report, this bed will be further considered.

(2.) THE IRON-LIMESTONE.

615. From Knoxville, across the Holston, there may be seen, a line of high hills. These are covered, more or less, with a deep red soil, and belong to a remarkable line of red knobs which runs far down the valley. This line is one of the ranges spoken of in the First Part of the Report. (§§ 106 and 112.) These red hills owe their topographical features, and their red soils, primarily, to a highly ferruginous, sandy, fossiliferous limestone, to which I have given the name at the head of this section. This rock occurs in strata of various thicknesses, and is interstratified with calcareous shale and flaggy limestones.

616. *Lithological and Other Characters.*—Under the name *Iron-limestone*, I include not only, the characteristic ferruginous rock, but, also, the shales and the limestones associated with it. The group includes divisions 3 and 4, of the table on page 230. The maximum thickness is about 700 feet.

617. The characteristic rock, is a hard, dark gray, or dark bluish gray, iron-colored limestone. As stated, it is highly fer-

ruginous, giving the soil, in decomposing, its strong, red color, and even yielding, at some points, oxide, rich enough to be called ore. Its powder is light gray, mottled with red. The iron, doubtless, exists, for the most part, in the rock, in the form of carbonate. In addition to the ferruginous matter present, it is generally well loaded with sandy impurity, a circumstance also contributing to its peculiar character. Its hardness is due to the sand present. At a few points, I have observed small pea-like pebbles in some of its layers, making it a conglomerate; but this is rare.

When the rock is thoroughly weathered, it becomes a light, spongy, dark brown, sandy mass, and such masses are strewed over the areas in which it outcrops.*

618. Were it not for this sandy impurity, certain layers of the iron-rock might be used as an iron-ore. It is an interesting question, as to whether science or experience, will ever bring forward practicable methods for the separation of iron from such a rock as this. To do it, would, indeed, be a great achievement, and would add vastly to the mineral wealth of the world. There are other rocks in Tennessee which are equally ferruginous, as, for instance, the White Oak Mountain Sandstones, to be described. Like this, many of them are deeply red with iron. The aggregate amount of metal such rocks contain, is very great.

619. When the iron-rock is exposed to the action of water, as in a bluff on a river, a laminar structure is often made apparent, the laminæ, from half an inch to an inch, or more, in thickness, and separated by softer plates, being brought out in relief. Such exposures often exhibit cross-stratification, a fact indicating the formations of the beds in running water. These features may be seen in the bluffs at the mouth of the Little Tennessee, opposite Lenoir's, and on the Holston, at other points.

620. The Iron-limestone *as a group*, includes divisions 3 and 4, on page 230, the entire thickness being 650 feet. In more detail, the section is as follows, numbered in ascending order:

8. Iron-limestone proper ..... 250 feet
7. Blue, flaggy limestone, with some shales ..... 155 "
6. Iron-lime·stone..... 6 "
5. Blue, flaggy limestone ..... 22 "

* The rock is, at some points, very fossiliferous, fragments of trilobites and crinoidal buttons being especially conspicuous. These give some of its layers a marble-like aspect. Other layers, at times, present an oolitic structure, but these features are subordinate to the general character above given.

4. Iron-limestone ..... 45 feet
3. Shale, lower part interstratified with Iron-limestone ..... 117 "
2. Iron-limestone ..... 52 "
1. Shale, (resting on the marble-bed) ..... 3 "

650

621. Another section, about a mile southwest of the last, is as follows:

5. Iron-limestone, top not seen ..... 175 feet
4. Shales with flaggy Iron-limestone..... 88 "
3. Shale? ..... 224 "
2. Iron-limestone ..... 33 "
1. Shale, (resting on the marble-bed) ..... 30 "

622. Much of the Iron-limestone of these sections, is thin-bedded and flaggy, and such, for the most part, is the general character of the rock. The surfaces of its layers often show ripple-marks, another circumstance indicating its formation in a current of water.

The *blue* flags, also ripple-marked, sometimes graduate into the iron-rock, while, on the other hand, they as often run into shales. The shales have very frequently a bright buff color, but sometimes are grayish-yellow. They are the weathered outcrops of blue calcareous and argillaceous strata.

The flags are used extensively, for curbing and paving purposes, in Knoxville. There is a point from which they are obtained, near Williams' marble quarry. A mile and a half, or two miles above Knoxville, the Holston River intersects the range. The flags are quarried on a hill-side, near the river, and conveniently boated down.

623. There is a good presentation of the rocks of this group in the cuts of the Knoxville and Charleston Railroad, beyond the Holston, and immediately opposite Knoxville. The first cut presents mostly shale, with, however, two beds of iron-rock; the next, together with the hill-sides, gives a great display of the iron-rock, the mass being not less than 200 feet thick; and there is still a third cut in which the rock is seen. The mass of the second cut is generally thin-bedded; some of for the layers are of good thickness for building purposes. Stone for the construction of the railroad culverts, were quarried from them. Some of the layers are quite crinoidal, and inclined to be red and gray, approaching marble in appearance.

624. All of the rocks of the group are more or less fossiliferous, especially the blue flags and the iron-rock. The fossils have not been systematically studied, but enough is known to justify the reference of this bed, as well as the marble-bed below, to the *Trenton.*

There is a shaly limestone in this group, found in the red hills east of Chatata Valley, in Bradley County, which is remarkably filled with *Orthocerata* and allied genera. The bed is eight or ten feet thick. A *Lituites* is found here much like *L. undatus,* Conrad. Most of the species are, perhaps, new.

625. *Extent and Range; The Iron-limestone* is mainly confined to the *Red Belt* of the *Trenton and Nashville Series.* (§ 610.) I have thus named this belt on account of its red hills and the iron-limestone which makes and colors them. The maximum volume of the group is in Knox County. It diminishes in thickness going southwestward, and runs out in Chatata Valley in Bradley. It becomes also, less important northeastward, and disappears in the region of Strawberry Plains. Outside of the *Red Belt,* to the north, or northeast, it does not appear in any of the areas occupied by the Trenton and Nashville rocks.

To the southeast, however, in Blount County, there is a strip of it making a line of red knobs in front of Chilhowee Mountain. It is here in a range of Trenton and Nashville rocks, which extends, in a southwesterly direction, nearly to the Hiwassee River. Within this the iron-rock first appears near the northeastern end of Chilhowee Mountain, and extends with the range of rocks to the vicinity of the river. In front of the north end of Star's Mountain, the Iron-rock, nearly horizontal, occupies a belt three or four miles wide.

626. On the northwest side of Knoxville the rock occurs, but much reduced in volume, as we have seen (§§ 587 and 588.)* In the Trenton and Nashville ranges still further northwest, as stated, it has thinned out, or, at most, but mere traces of it are to be found.

From what has been said, the extent of the *Iron-limestone,* when continuous, and unbroken by Appalachian movements, can, in part, at least, be made out. It did not extend as far

* The Trenton and Nashville belt referred to in § 587, is one of the arms of the *Red Belt* described in § 610.

northward as the marble-bed below it. Its western limit was much the same as that of the marble, while its extent southwestward and southeastward, was greater. Its longer dimension was in the direction of the general trend of the Valley, in that respect agreeing with the marble, (§614.)

627. The upper iron-rock bed of the group, appears to have been the most persistent. The lower ones run out and [?]e place to shales. Thus, in the section in § 587, we have 320 feet of shales next above the marble. So, in McMinn and Bradley Counties, there is a heavy bed of shales and thin limestones, between the Maclurea Limestone and the iron-rock stratum.

628. *"The Red Knobs."*—These have been referred to several times. (§§ 106, 112 and 615.) The outcrops of the iron-limestones, especially when the rocks are tilted and in considerable volume, generally present ridges, or lines of knobs.

The hard rocks, not yielding to the action of the weather, or to disintegrating agencies, like other neighboring beds, have been left in elevated crests and peaks. In some cases, a single bed or plate of hard rock, has given origin to a ridge, first, by itself resisting the wear and tear of the weather, and secondly, by *protecting,* from such action, softer material below it.

A ridge formed by a comparatively thin stratum of rock, is, generally, found cut up into a line of knobs, for the reason that the *protecting* plate, being thin, is easily fissured, and each fissure originates a gap.

629. The most conspicuous, and longest line of red knobs, is that passing near Knoxville, on the southeast side. This has been sufficiently described. (§§ 112, 615.)

Another, is found in the Trenton and Nashville belt, immediately west of the Knoxville Ridge. Traces of it are seen opposite the city; it becomes more marked southwestward; is represented by low, red hills, near, and to the southeast of Loudon, but soon runs out when traced further southwestward.

A line is, generally, to be found on the southwest side of the *Red Belt.* (§ 610.) This coalesces with the main line in the southern part of McMinn and in Bradley. Another line of knobs runs near the mouth of the French Broad River.

In addition to these, one in front of Chilhowee Mountain has been spoken of. (§ 625.)

630. The Red Belt is, in general, a synclinal trough. Where wide, as in Knox County, the strata, in the central portion, run in moderate waves, and are, in places, approximately horizontal. This, in certain sections, brings the iron-rock, (as well as the other special beds,) several times to the surface. Thus, in crossing the belt along the Knoxville and Maryville road, quite a number of areas are crossed, in which the iron-rock outcrops. It usually alternates with a calcareous shale, weathering buff. Some of the iron-rock, along this route, is oolitic.

(3.) OTHER SPECIAL BEDS ABOVE THE IRON-LIMESTONE.

631. *The Division above the Iron-rock, and its lower part, the Crinoid Bed.*—In the section §§ 585 and 586, the last division is succeeded, in ascending order, by a heavy series of calcareous strata, mostly, weathering to a buff shale, but containing, more or less, flaggy, blue limestone. The thickness of the series is uncertain. It is given in the section, as 500? The corresponding horizon, in the section on page 231, has it 1000? It may be placed at about 800.

632. The lower part of the division, is in the line of the section, (§ 585,) a group of shaly limestones about 100 feet thick, which is well filled with shells and crinoids. This group rests upon the *Iron-limestone.* I have named it the *Crinoid Bed.* Among the species occurring in this bed, the following were seen; *Orthis Bellarugosa?* Conrad. *Strophomena incrassata,* Hall. *Asaphus canalis,* Conrad. Several new species of *Orthis* occur, as well as new forms of *Paleocrinus, Rhodocrinus, Hybocrinus,* and *Carabocrinus.*

The abundance of crinoidal remains, not only in this bed, but, also, in many of the strata, between this and the *Maclurea Limestone,* is a noteworthy circumstance.

633. *The Upper Marble*.—Succeeding the division last noticed, is another bed of variegated marble. This is a reddish-brown rock, with white or gray, rarely greenish, clouds and bands. Like the lower marble, (§ 605,) it is coralline and crinoidal. It resembles the lower bed, but is not as valuable. Its maximum thickness has been estimated at about 300 feet. It can be traced, southwestward, through Knox, the western parts of

Blount and Monroe, and through McMinn into Bradley.* It generally, presents itself in two parallel bands, occupying a place within the two principal lines of red knobs, pertaining to the Red Belt. (§§ 610, 630.) In the section from Athens to the southeast, across the belt mentioned, one range of this marble is intersected about a mile from the town. This section, also, shows the two ranges of the red knobs.

634. Outside of the Red Belt, this bed, at least as marble, is not in noteworthy volume. A trace of it may be seen, occasionally, in the first Trenton and Nashville ranges, northwest of Knoxville.

In the section from the government marble quarry in Hawkins, across the valley, in a northwesterly direction to Short Mountain, a marble is intersected, which may be referred to this bed.

635. *The Brown Shale*.—In the table on page 231, we have in the place of the Red Marble of the preceding table, a bed of brownish-red shales, and this we take to be synchronous with the marble. To this I have already referred. (§ 589.) The marble itself, when traced to the southwest, is, at intervals, much like this shale; at some points the bed is shale and marble, mixed. The beds of the two sections will be regarded as one.

636. West and northwest of Knoxville, the *Brown Shale* rarely presents a marble-like aspect, and is but little fossiliferous. It occurs in all, or nearly all, of the valleys of the Trenton and Nashville Formations lying between Knoxville and the Cumberland Table-land. It usually presents itself in long belts, which run longitudinally with the valleys. Its strata dip at all angles; and when the inclination is considerable, which is more frequently the case than otherwise, it forms long, low, "hog-back" ridges.

These ridges are sometimes nearly destitute of soil, the strata outcropping in parallel bands. A growth of red cedar is frequently met with upon them.

* There is a bed of gray, crinoidal marble a few feet below the iron-rock of the red hills in the northern part of Bradley, which may be a local stratum, referable to the Iron-limestone Group. It is separated from an iron-rock, by the orthoceratite bed, mentioned in § 624.

637. In § 634, I have spoken of a marble between the Government quarry and Short Mountain, in Hawkins County. Seven or eight miles to the northeast, this marble appears to be represented by a belt of the Brown Shale at the southeastern base of the Devil's Nose.

The valley-ranges intersected west of Knoxville, and containing Trenton and Nashville rocks, show the Brown Shale far to the southwest. In Roane and Meigs counties, some of the more compact layers, clouded with dove-colored bands, are regarded as marble. It has been used in making the foundation of the Courthouse in Kingston.

Northeast and east of the Red Belt, this formation has not been observed.

638. The Brown Shale is, when freshly quarried, a compact, brownish-red, calcareous rock. As ordinarily seen, it is weathered into shale The compact rock from the range west of Knoxville, has been used for making hydraulic lime, which has answered a good purpose.

This completes the consideration of the beds given in the sections on pages 230 and 231, with the exception of the calcareous shale above the Red Marble in the first, which is referred to the general division to be described.

B. THE UPPER MEMBER OF THE TRENTON AND NASHVILLE SERIES.

639. I include in this, all of the strata of the series above the *Maclurea Limestone.* (§ 509.) This embraces, of course, the interpolated beds already described. This classification is the same as that given on page 228. The upper member is there designated as the *Shale.* It must be borne in mind, however, that while the division is shale in the southeastern part of the Valley, it becomes mostly limestone in the northwestern. (§ 581.)

It will be well to consider this formation under two separate heads, these referring respectively to its different presentations in the southeastern and northwestern portions of the Valley.

(a) *The Shale,* (Eastern.)

640. *The Gray Belt; its Topography.*—Before speaking of the lithological and other features of the *Shale,* I will notice a very important area in which it is found, and to which it gives character.

If the reader will take the map, and direct his attention to the Valley of East Tennessee, among the belts of Trenton and Nashville rocks, he will observe a large, club-shaped one commencing north of Kingsport, on the Virginia line, and extending nearly to the Hiwassee River. This is the largest area of these rocks in East Tennessee, the *Red Belt* (§ 610) being the next in extent. And as we have found it convenient to have a name for the latter, so it will be of service to christen this. We will denominate it the *Gray Belt,* from the prevalence of earthy gray rocks and knobs.

The boundaries, form, and range, of the *Gray Belt,* are best appreciated by a reference to the map.

641. The most characteristic topographical feature of this area, is the presence of isolated knobs. Many portions of it are spoken of, locally, as "*The Knobs."* The knobs are conical hills of all heights, from 100 to 500 feet. Sometimes they are more or less elongated, forming short ridges. In certain regions, they are closely set, making a wild country traversed by narrow, labyrinthine, but rich and fertile valleys.* Knobby portions occur in Hawkins and Greene, on both sides of Bays Mountains, also in Cocke, Sevier, Blount, Monroe and McMinn. In Sevier County, around the northern end of Chilhowee Mountain, the knobby feature is very bold.

642. The prevailing knobs are, as stated, earthy gray, and in this respect, in contrast with the characteristic knobs of the Red Belt. The lower end of the Gray Belt, however, has some of the red knobs, owing to the presence of the strip of *iron-rock* mentioned in § 625.

643. It is to be observed that the northern wide part of the belt embraces the mountain ridges to which the collective name of *Bay's Mountain Group* has been given. (p. 43.) These ridges are capped with a formation—the *Clinch Mountain Sandstone*—which is not included in the Trenton and Nashville Series. The topographical feature presented in this group, must be considered apart from those which are characteristic of the *Gray Belt* in general.

* Some of these regions when viewed from high points, look like *mammoth potato patches,* the hills, however, not in very regular rows.

644. *Areas of the Shale; Synclinals.*—The *Gray Belt* just described, is the most important and marked area of this shale. East of it, in Sullivan, Carter, Washington and Greene counties, are other areas, but they are comparatively very limited. Those in Sullivan, and in the western part of Carter, are the most important. Their number and extent can be seen upon the Map. They are all characteristically knobby belts. (§ 110.)

In Washington and Greene, the lower beds of the *Shale* are presented in very narrow "*black slate ridges."* (§ 11 0.) One of these ridges (that passing immediately back of Greeneville) has been spoken of. (§ 592 and note.) It may be taken as a type of the rest. The *Shale* rests in a compressed trough of *Maclurea Limestone.*

The shale and sandstone of the ridge east of Benton, in Polk County, referred to in § 595, may be mentioned here. The rocks are shales below with a sandstone above. This ridge borders a fault. (See section page 185.) The formation is that numbered 3 and 4.

In addition to the areas mentioned, the *Red Belt* may be regarded as containing this *Shale.* It is the great matrix holding the interpolated beds. Here, however, the formation is more calcareous, and presents, more or less, flaggy limestone.

645. In most of the belts and areas mentioned, including the *Gray Belt,* the *Shale* is held in synclinal troughs and rests upon the *Maclurea Limestone.* Some of the troughs are locally faulted on their eastern side, as, for example, the Gray Belt in the section on page 190. See, also, § 600. It is remarkable that these wide synclinal waves are found on the side of the Valley next to the great mountains.

644. *Lithological Character; Graptolites.*—The formation is, in general, a great body of sky-blue calcareous shales, more or less sandy, weathering to a yellowish-gray color, as stated in § 580. In addition to the characters given the base of the formation, in the eastern border counties, (including Sullivan,) as far down as Blount, is a fine dark or black shale, becoming, in places, 100 or 150 feet thick. This often appears as a margin along the limits of the *Shale* followed below by the *Maclurea Limestone.* The black shale is prominent in the "slate ridges" spo-

ken of. (§ 644.) It abounds, very generally, in *graptolites*.* The *graptolites* are, however, not confined to this lower stratum; they run up into the main body of the *Shale*, and are found at numerous localities. I have sometimes denominated the formation the *Graptolite Shale*. These fossils have not, as yet, been studied. Some of them will, doubtless, prove to be new species.

645. In the middle and upper parts of the *Shale*, especially east of Bay's Mountains and southward in the *Gray Belt*, plates of a hard calcareous sandstone are met with, to which the knobs owe, in part, their origin, very much as the red knobs owe theirs to the iron-rock. (§ 628.)

This sandstone has the color of the shales with which it is associated.

646. The following is a section of the *Shale* from Bull's Gap† westward to White Horn Creek, a distance of nearly one mile. The rocks dip southeastward at an average rate of 30 or 40 degrees; the dip, however, ranging from 5° to 90°. Immediately at the Gap, the strata form a synclinal axis, dipping to the northwest after passing it.

(3)	*Reddish-brown Calcareous Shale.* This constitutes the base of the ridge at the Gap. The top not seen. Above it, on the surface, are detached masses of grayish-white sandstone—*Clinch Mountain Sandstone.* The shale and sandstone are referred to the same formation, (5,*a*.) Thickness of the shale seen.....	80 feet.
(2)	*Calcareous Shale*, or argillaceous pale brownish, bluish, or rarely greenish, limestone, weathering to shale.....	112 feet.
	Sky-blue Calcareous Shale, and thin blue flaggy Limestones.....	77 feet.
	Sky-blue Calcareous Shale, with occasionally flaggy limestones. Has a few layers of calcareous sandstone.....	933 feet.
	Sky-blue Calcareous Shale, weathering grayish buff.....	860 feet.

* These are fossils, which, in the shales, are long and narrow, and have the form of blades of grass, excepting that they have saw-like edges.

† Bull's Gap is at the northeast corner of Jefferson County, and is the point at which the East Tennessee and Virginia Railroad passes the middle ridge of the Bay's Mountain Group. (§ 99.)

(1) *Maclurea Limestone,* in thin layers, with shaly seams, and breaking into blocks—"Block Limestone," (§ 591,) contains *Trilobites,* and other fossils.
Thickness seen.....200 feet.

647. Division (2) is the *Shale.* Its thickness here is 1982 feet. This is near the maximum, which has been placed at 2000. (§ 580.) The flaggy limestones show that we are advancing westward, or rather, northwestward, the formation becoming more calcareous.

This section may be compared with that on page 230. The principal difference is in the absence in this, of the marbles and iron limestones. The blue limestones in both, are fossiliferous.

(b) *Limestone and Shale.* (Western.)

648. The lithological changes that occur in the upper portion of the *Trenton and Nashville Series,* in going from the southeastern portion of the Valley to the northwestern, have been already given. (§§ 578, 581, 596, and 639.) .

The difference in topographical features presented by these rocks in the two portions, is also quite marked, and will be noticed.

649. *Topography; Areas.* West of the *Red Belt,* (§ 610,) and the Holston River, this division and the *Maclurea Limestone,* are best considered together. In fact, it is not always easy to separate them, as they form a natural group. (§ 596.) I have spoken of them collectively as the *Series,* and will continue to do so.

In the part of the Valley we are now considering, these rocks outcrop in long ribbon-like areas, making one class of the remarkable valley-ranges mentioned in the First Part of this Report. (§§ 119, 120, 121.) The special topographical features of the eastern knobby belts, are, in general, lost in these ranges. There are, however, a few exceptional areas, which are more or less knobby. The Hawkins Belt, in part, and the wide area at the south end of Clinch Mountain, both mentioned below, are examples.

650. The western valley-ranges of this *Series* are enumerated on the next page. Most of them have been referred to. The reader will be aided in tracing them out, by having the Map before him.

(1.) The *Hawkins Belt,* west of Rogersville. This supplies one of the beds of marble. (§ 613.) The area is short, being cut off by the long fault, lying on the east side of the *Clinch Mountain* region.

(2.) *Beaver Creek Range.* This lies next northwest of *Clinch Mountain,* and, further south, includes the valley of *Beaver Creek.* It has Copper Ridge on its northwest side. This range widens out in a local area around the south end of *Clinch Mountain,* and also around *House Mountain.* (§ 98.) Going southwestward, it then bifurcates; the eastern arm runs west of *Webb's Ridge,* and, further down, forms a part of *Grassy Valley,* in Knox County; the western is the *Beaver Creek Valley.* Both arms run out between the Tennessee and Hiwassee Rivers.

(3.) *Raccoon Valley Range.* This belt is known in Knox and Anderson Counties, as *Raccoon Valley.* It extends northeastward to Virginia. The mouth of Indian Creek, in Grainger, is in it, as well as a portion of Clinch River, in Hancock. It forms a wide valley at the point intersected by the Tennessee River, but, like the arms of the last range, runs out before reaching the Hiwassee.

(4.) *Hickory Valley Range.* This is known, in the northern part of Union County, as *Hickory Valley.* It lies immediately west of *Powell's Mountain,* in Claiborne and Hancock, as well as west of *Lone Mountain,* in Grainger and Union. It widens out locally, around the south end of Powell's Mountain. From its point of intersection with Clinch River, it runs southwestward toward Maynardville. Still further southwestward, it runs out at least as a valley-range of the *Trenton and Nashville Series.*

(5.) *Big Valley Range.* The portion of this, in Anderson and Union Counties, is known as the *Big Valley.* The range has been instanced, on a previous page, as an example of the long valleys in this section of East Tennessee. (See § 120.) It is there spoken of as continuous. There is, however, one break in it, made by a local uplift of the rocks of the Knox Group. This break is in Claiborne County. This range includes *Savannah Valley,* in the southern part of East Tennessee and west of White Oak Mountain. At the northern end of the Mountain just mentioned, the rocks of the *Series* spread out in a wide local area. Over a good part of it, the rocks are nearly horizontal.

(6.) *Washington Range.* A short range, running next west of the iron-ore ridges in the region of *Half-moon Island.* Washington, in Rhea County, is located upon it.

(7.) *Chattanooga Range.* A part of the Valley south of Chattanooga and east of Lookout Mountain, is underlaid by the rocks of this Series.

(8.) The *Mountain Range.* This important belt is so called, for the reason that it skirts the eastern base of the Cumberland Table-land, with but few breaks (due to local faults,) from Virginia to Georgia. The range is noticed in § 121, to which the reader is referred. In Hamilton County, its strata form a well-defined, anti-clinal axis, to which the valley of Lookout Creek belongs. (See section on page 139, at F.)

(9.) The *Elk Range.* The valley of the *Elk Fork* is, for the most part, made up of other formations. It contains, however, a narrow strip of Trenton rocks, brought to the light, as shown in the section on page 142.

(10.) The *Sequatchee Ranges.* On both sides of *Sequatchee Valley,* are minor valley-ranges, in which these rocks outcrop. (See section on page 139; also § 600, and note.)

651. When a mountain bounds one of these Trenton and Nashville ranges, on either side, the upper strata of the *Series* are usually found at a greater or less elevation, on the slope facing the range. This is especially true of those mountains, which, like the *Clinch,* are made up of an inclined plate of *Niagara Sandstone,* (5,*a*.) This formation,* when present, is next above the *Trenton and Nashville Series.* In the mountains which it makes, the tilted sandstone forms one slope, and presents its outcropping edge at the summit. This exposes the edges of the softer strata of the underlying formation on the other slope. These are, however, protected from washing and denudation, by the hard plate of rock overlying them. (Compare § 628.) *Clinch, Powell's* and *Lone Mountains* (the latter that of Grainger and Union Counties) present the upper strata of the *Trenton and Nashville Series,* on their western slopes. Some of the Bay's Mountain ridges are like these; others, have the sandstone on the west, the underlying rocks outcropping on the eastern, or rather southeastern, side. Some isolated peaks, or short mountains, like *Chimney Top* and *Fodder Stack,* (§ 99,) and like *Devil's Nose* and *House Mountain,* (§ 98,) have a bed of sandstone on top, while outcropping on the slopes all around, are the strata of the underlying formation. In the southern part of the Valley, White Oak Mountain has the rocks of the *Series* under consideration, on its western side, and outcropping around its northern end.

652. It must be observed that the upper layers of the *Knox Dolomite* are often found either on one side or the other of the above valley-ranges. They contribute, also, in some regions, to the area of the range. The side of the valley-range, in which the junction of the two formations occurs, is generally the northwestern. In the *Mountain Valley Range,* (§ 650, (8,)) the reverse is the case. I have already spoken of the position of

*This formation includes a bed of red shale below the sandstone, which, in common with the Trenton and Nashville rocks below, is protected by the sandstone proper.

the *Maclurea Limestone,* (§§ 599 and 600,) and to this the reader is referred. The upper member of the Series will, of course, follow in ascending order. (See sections on pages 189 and 208, and remarks upon them.)

653. *Lithological, and other Characters.*—The entire Series is limestone and shale. The lower part, mainly blue limestone; the upper part, though more calcareous than the same member in the *Red* and *Gray belts,* (§ 610 and 640,) is less so than the equivalent rocks in the *Central Basin,* (§ 227.) The uppermost beds of the Series are, very generally, shale and shaly limestone. In descending Clinch Mountain, on the northwest side, for instance, we find below the white hard sandstone, first, a bed of brownish-red shale, (included in a group with the sandstone,) then several hundred feet of sky-blue shale, running down into thin-bedded blue limestone. These upper beds contain, at many points, Nashville fossils. Below the beds mentioned, occur other beds of shale, one of which has been considered important enough to be noticed, (§§ 635, 636.)

The thickness of the Trenton and Nashville Series diminishes a few hundred feet, going westward.

654. *Transition Beds; Appendix.*—At the top of the Nashville Formation, in the western part of the Valley, are, at certain localities, rocks, which appear to be beds of passage from the formation mentioned, to the *Dyestone Group,* described below. In the next chapter, a section, taken on the Nashville and Chattanooga Railroad, just above Lookout Station, and near the Georgia line, will be presented, in which these beds will be given. They contain such fossils as *Orthis testudinaria, O. bellarugosa? Strophomena planoconvexa, S. tenuistriata, Leptæna Sericea, Atrypa marginalis,* &c.

655. *Useful Rocks and Minerals.*—The *Trenton* and *Nashville Series* affords, in East Tennessee, several beds of *rock-material* susceptible of practical application. Among them, the *marbles* stand prominent. The geological relations, and general features of these, have been given. See pages 232, 236, 244, and 246. It likewise supplies *flags,* (§ 622,) and other building material, in addition to the marble. Certain layers of *iron-limestone,* (§ 623,) and many beds of blue limestone, in the different belts of the Series, yield building stone, of excellent

quality. It contains, too, no lack of rock for making excellent lime; the gray marbles, among many beds which might be mentioned, are well adapted to this purpose. The *Brown Shale* affords material for *hydraulei lime,* (§ 638.) These useful products will be further noticed in the Third Part of the Report.

656. *Calcite* in small veins is quite common in the *Maclurea Limestone.* Such veins occur, also, in the *Shale* in the southeastern part of the Valley. Some of the veins in the Shale contain, imbedded in the calcite, isolated, and often beautiful crystals of *Quartz,* as on Boyd's Creek, east of Brabson's Store, in the western part of Sevier County, in the region of Bull's Gap, and at points between that and Dandridge, in the vicinity of Warrensburg, in Greene County, and at other localities. They are also observed in Greene County, on the surface overlying the *Maclurea Limestone,* and in small veins, at a point half-a-mile north of the road from Greeneville towards Chimney Top Mountain. At some localities, these crystals are quite abundant on the ground, their facets sparkling in the sunshine like diamonds. They were all, doubtless, originally imbedded in the veins of calcite. Small, isolated crystals of *Gypsum* are found in the soil over the shale, at a number of points east of the Bay's Mountain Group. Veins of *Heavy Spar,* (*Barite,*) also occur. At the quartz locality, near the Greeneville and Chimney Top road, a vein of this, of the fetid crystalline variety, is found. Masses on the surface indicate a vein a foot or more thick.

657. *Iron-ore* is found as *Limonite* on the surface, and in deposits in the soil overlying these rocks, at many points, but not constituting extensive banks. The ore results from the decomposition of *Pyrites* found locally in bunches in the shales.

Near the Benton and Madisonville road, about eleven miles from the latter place, and in McMinn County, is a heavy bed of *Fossil Iron-ore,* known as Hill's Bank. The ore resembles very much the *Dyestone* of the *Niagara Period.* It lies, however, between the *Maclurea Limestone* and the *Trenton and Nashville Shale,* and may belong to the *Series* embracing these. It contains flattened, oolitic grains and crinoidal buttons, but no recognizable fossils were seen. The bed may be traced for nearly half-a-mile, and at some points, is fifty or sixty feet

wide. See, also, remarks on the Iron-limestone as an ore. (§ 618.)

658. *Agricultural Features.*—The strata of the *Trenton and Nashville Series* form the basis of much of the best arable land in East Tennessee. They are the rocks of many rich and beautiful valleys. The long ranges enumerated in § 650, the *Beaver Creek Range,* the *Raccoon Valley Range,* the *Hickory Valley Range,* the *Big Valley* and *Mountain Ranges,* the *Sequatchee Ranges,* and others, are just so many long lines of farming regions, susceptible of high cultivation. They are now more or less improved, presenting some among the most desirable agricultural sections in the State; but there is room for greater improvement and a higher state of cultivation. The resources of these valleys, of such natural beauty with their rills and watercourses, (§ 147,) their invigorating and healthy air, have not reached their full development. This, however, they will do, and perhaps, at no distant day.

The soils of the valleys are usually strong, being derived from calcareous rocks, more or less argillaceous, and are well adapted to the production of small grain, corn, grass and fruit. In nearly all cases, the valleys belonging to the ranges mentioned, have, on one side or the other, a gently sloping ridge facing the valley. The slope can often be cultivated nearly to the summit. Thus, the farmer can have upland and low land, and arrange his fields with reference to special and varied purposes. These slopes are underlaid by the magnesian limestone formation, *(Knox Dolomite,)* and generally have a productive, strong soil.

659. In the southeastern portion of the Valley, as in the *Gray Belt,* (§ 640,) the agricultural features of this *Series* are quite different. There the *Shale,* together with its peculiar topography, determines the agricultural capabilities. In the *Knobby Regions,* the arable lands do not lie in large bodies, but the narrow winding valleys and the hill-sides are rich, and often present a heavy growth of large white oaks, poplars and hickories. At many points these lands are in cultivation, and in passing through *"The Knobs"* of some sections, the traveler meets, at almost every turn, with a cabin and a miniature farm. Such areas have been denominated, with some force, "The Poor Man's Rich Country."

660. To the knobby regions of the *Red Belt*, (§ 610,) the same remarks are applicable. These, however, are by no means, so extensive as those of the other.

The *Shale*, however, presents us with some valleys of considerable extent like that, for instance, of Lick Creek, in Greene County. The soils of these are not as strong, generally, as those of the limestone areas, but many of them are productive and well adapted to the production of wheat, grass, etc.

In the *Red Belt* the valleys are better defined, and contain many very desirable farming sections.

SECTION III.

THE TRENTON AND NASHVILLE SERIES IN MIDDLE TENNESSEE.

661. Leaving Sequatchee Valley, and passing westward, there are no more outcrops of the rocks of the *Trenton and Nashville Series* until we enter the *Central Basin* of Middle Tennessee. This Basin, second to no natural division of the State in importance and interest, has been described so far as its topographical and structural relations are concerned. The reader is referred to pages 97-104, 134-136, and 148, as well as to the section in Chapter X. See, also, Map.

662. We are now in a field of very different character from that of the great *Valley of East Tennessee*. Within the *Basin*, the direction and form of the subordinate valleys have *comparatively* little to do with the rocks. There is no marked northeast and southwest trend; there are no long and straight valley-ranges; no undeviating ridge-lines a score, or *seven-score*, miles in length; no lines of bold, red knobs; and, finally, no bounding mountain-ranges, grouping, and comparatively sinking, the minor parallel valleys and ridges, and all else, into one great, fluted, long, and beautiful *Valley*.

In East Tennessee the geology of the country is intimately connected with the topography, and one cannot be properly studied without keeping in mind the other.

663. In the *Central Basin*, the rocks are horizontal, or nearly so, and, below the formation of *siliceous* strata which make the *crest* surrounding and overlooking the oval area, are approxi-

mately homogeneous in lithological character. If we exclude the formation making the crest, and confine ourselves to the homogeneous rocks, or in other words, to the *Series* under consideration, the connection between the strata and the topography is only occasionally manifested. If, however, that be included, the connection becomes general, and is seen in this, that the hard *siliceous* rocks have resisted denudation giving us the crest and the outlines of the Basin, and also in the fact that they have remained to form the cap and protecting rock of the higher included ridges.

664. In the Basin the rocks of the *Trenton and Nashville Series* are mainly blue limestone throughout. The beds of these differ, more or less, in certain particulars to be mentioned. Occasionally a limited bed of shale is met with, and some beds of red and gray limestones occur, but these are exceptional. The entire *Series* is about 1000 feet thick, and is equally divided between the *Trenton* and *Nashville* formations. (§ 577.) The bottom is not seen, the *Knox Dolomite* not coming to the surface at any point.* The top, on the eastern side of the Basin, is in contact with the *Black Shale,* all intervening formations being absent. On the western side, it is generally separated from the *Shale* by *Niagara,* and sometimes *Lower Helderberg rocks,* but not always.

665. The section on a following page, in Chapter X, shows how these rocks are brought to the surface, and the relations they sustain to the other formations. The strata are presented as they occur along the line of the Nashville and Chattanooga Railroad, from Tullahoma to Nashville, and along the Edgefield and Kentucky Railroad, from Nashville to the summit of the steep grade above Baker's Station. The entire line is a continuous one, and runs completely across the Basin. The geological, as well as the topographical features, of the Basin, as a whole, are also illustrated by the section.

666. The *Series* under consideration is a *natural group,* and though each of its members has many species of its own, yet

* The only region in Tennessee, west of the Cumberland Table-land, in which I have seen the *Knox Dolomite* is the *Wells Creek Basin.* (p. 147.) How thick the *Trenton and Nashville Series* may be here, I have not had the opportunity of ascertaining. There is, however, no reason for thinking that it is thicker than 1000 feet, indeed, I doubt if it reaches this. So far as can be ascertained, these rocks grow less in volume in that direction.

there are quite a number of forms uniting the two. It is divided, both on lithological and paleontological grounds, into its two *sub-groups.*

A.—THE TRENTON, OR LEBANON; FORMATION III.

GEOGRAPHICAL RELATIONS—THE BEDS OF THE FORMATION. (1) THE CENTRAL LIMESTONE—(2) PIERCE LIMESTONE—(3) THE RIDLEY LIMESTONE—(4) THE GLADE LIMESTONE—(5) CARTER'S CREEK LIMESTONE. AGRICULTURAL FEATURES, USEFUL ROCKS AND MINERALS OF THE TRENTON.

667. *Geographical Relations.*—The outcrop of the rocks included in this formation, occur over a considerable area, nearly half that of the Central Basin. Their strata may be regarded in general, as forming *the bottom* of the Basin, the strata and the bottom, however, being slightly tilted to the west. (§ 221.) The rocks outcrop at a higher elevation on the east side than on the west, and sink below the level of the rivers, at, or near, Nashville, Franklin, and Columbia, respectively. Nearly all of Wilson, Rutherford, Bedford and Marshall counties are within the outcrop of the Trenton Formation. The area of outcrop includes, also, parts of all the counties, excepting Franklin, contiguous to the section embracing those mentioned. On the map, a line is traced out separating the *Trenton* areas from those of the *Nashville Formation.*

This formation is one of great interest, especially from an agricultural point of view. The soils it yields are among the best. To the paleontologist it is an inviting field, its strata presenting a rich fossil flora.

668. *The Beds of the Formation.*—The *Trenton Formation* is made up of several beds, each characterized by special features. Arranged in their natural order, they are as follows :

(5) *Carter's Creek Limestone.* (*Topmost.*) A heavy-bedded, light blue, or dove-colored, limestone, the upper part often gray; contains *Stromatapora rugosa, Columnaria alveolata, Tetradium columnare, Petraia profunda, Strophomena filitexta, Rhynchonella recurvirostra, Orthoceras Bigsbyi, O. Huronense, Pleurotomaria lapicida. etc.* The thickness of the stratum is from 50 to 100 feet.

(4) *The Glade Limestone.* A stratum or light-blue, thin-bedded, or flaggy, limestones. Pre-eminently the bed of the great *"Cedar Glades"* of the Central Basin. Contains *Stropho-*

mena incrassata, S. filitexta, Orthis deflecta, O. perveta, O. tricenaria, Rltynchonella orientalis, Cyrtodonta obtusa, Trochonema umbilicata, Orthoceras rapax, Illaenus Americanus, Leperditia fabulites, etc. Maximum thickness 120 feet.

(3) *The Ridley Limestone.* Next below is this stratum—a group of heavy-bedded, light blue, or dove colored, limestones. Some of its fossils are as follows: *Orthoceras anceps, Stromatapora rugosa, Columnaria alveolata, Orthis bellarugosa, Camerella varians, Rhynchonella Ridleyana, etc.* The maximum thickness observed is 95 feet. .

(2) *Pierce Limestone.* A group of thin-bedded, flaggy limestones, with generally a heavy-bedded layer near the base. These rocks are highly fossiliferous and abound in *Bryozoa.* Among the fossils are *Orthis Stonensis, Rhynchonella Ridleyana, Dalmanites Troosti, etc.* The group has a maximum thickness of 27 feet.

(1) *Central Limestone.* An important group of thick-bedded, cherty limestones, of a light blue, or dove color. Contains *Salterella Billingsi,* and *Leperditia fabulites* in abundance; also *Cyrtoceras Stonense, Trochonema umbilicata?, Helicotoma Tennesseensis, H. declivis, Rhynchonella altilis, etc.*

This bed is the bottom-rock of the *Central Basin,* and presents in its heaviest exposures a thickness of about 100 feet.

669. It will be seen that the above limestones are all light-blue, or dove-colored, and that the groups are alternately thick and thin-bedded. It may also be mentioned here, that the thick-bedded groups are frequently *cherty,* though the two upper ones are much less so than the lower one. In accordance with our usual order, the lowest bed will be considered first.

670. (1) *The Central Limestone.*—As stated, this is an important body of limestones, and it is mostly so on account of its agricultural relations. Excepting the strata of the comparatively small *Well's Creek Basin,* (§§ 364, 553,) these rocks are the lowest in Tennessee west of the *Cumberland Table-land.* How they are brought to the surface, is shown in the section referred to in §665. Their outcrop occupies an approximately circular area around Murfreesboro, in Rutherford County. I have given the name above to the group, for the reason that it is thus presented in the very center of the State.

671. Murfreesboro is located upon these rocks. In going towards Nashville, from Murfreesboro, they appear at the sur-

face, with the exception of a few high points, as far, nearly, as Smyrna. Going south on the Chattanooga road, they are seen as far as Christiana and Christmas Creek. In this distance, however, several of the more elevated portions of the country crossed hold higher beds, and of these, mainly the *Ridley Limestone.* Towards Woodbury, they outcrop for a distance of three or three and-a-half miles. And finally, on the Lebanon road, the layers of the *Central Limestone* are exposed as far as Stone's River. These rocks thus occupy (excepting the hills and the low ridges, of which there are no great number) a circular area, having a diameter of from twelve to fifteen miles. Murfreesboro is about half-way between the center of this area and its eastern side.

672. I will add here, that, in Rutherford County, the overlying beds form, in succession, by their outcrops, concentric rings or circular belts around the area just mentioned.* This is especially true of the *Ridley* and *Glade* beds. The latter gives a very marked ring, made so by the *cedars* which so generally grow upon it. The *Cedar Ring* is crossed by the Chattanooga Railroad, about half way between Murfreesboro and Nashville, and is nearly or quite four miles wide. It encircles the outcrops of both the *Central* and the *Ridley* beds, in one large basin-like area of splendid country, nearly twenty miles across.

673, The lithological character of the *Central Limestone,* has been, in good part, already given. Its upper part, contains much black flint or chert, in thin layers and in nodules, the black color being due to the presence of a compound of iron. The decomposition of the flints, which is constantly going on, liberates the iron in the form of oxide, and this imparts a characteristic brownish-red, or chocolate color to the soil.

The limestones of the bed, are very generally fetid. At some points on Bradley's Creek, an upper layer is found, which is finely and beautifully laminated.

674. On the next page, is a section taken on Stone's River, at Pierce's mill, the point at which the Murfreesboro and Lebanon Turnpike crosses. It is one of a series of sections to be given, running up through the beds of the Trenton Formation.

* This must be taken in a general sense. The ridges break up, more or less, the symmetry of these circular belts, yet, in no great degree.

(3) *Ridley Limestone,* forms the top part of the bluff, opposite the mill; thick-bedded, light blue limestone, containing *Orthoceras anceps, Columnaria alveolata, Stromatopora rugosa,* and an other fossil sponge not described, and characteristic of the bed. Thickness 23 feet seen.

(2) *Pierce Limestone,* made up of the following rocks, in all 27 feet:

(*c.*) Thin-bedded layers, mostly, with smooth surfaces, and separated by thin, argillaceous, or shaly seams, very fossiliferous, contains *Bryoza,* &c. Thickness 19 feet.

(*b.*) Coarse, thick-bedded limestone—4 feet.

(*a.*) flaggy limestones, like the upper portion, (*c.*)—4 feet thick.

(1) *Central Limestone,* at the base of the bluff, very cherty, heavy-bedded, contains *Saltarella Billingsi, Orthoceras Bigsbyi, Leperditia fabulites, Helicotoma Tennesseensis, H. declivis,* and other species. At Pierce's Mill, but little of this bed is seen. Descending the river, however, its strata are observed to rise, until in a bluff half a mile below the mill, they are 70 feet thick.

675. The best known fossils, that occur in the Central Limestone, are given in the catalogue of species, at the end of this chapter. (See column C.) One of the most abundant species, is, *Salterella Billingsi.* Its beautiful thorn-like forms occur by thousands at some localities. *Leperditia fabulites* is, also, very abundant. The species mentioned, together with *Helicotoma Tennesseensis, and H. declivis,* occur at nearly all localities, and, in this association, are characteristic.

676. (2) *Pierce Limestone*.—This group has been so named on account of its fine exposure in the section at Pierce's Mill. It has been sufficiently characterized in § 668, and in the section just given. The group has no especial importance, excepting as a horizon of reference and of division. It is observed at many points in Rutherford, lying between the Central and the Ridley beds. In thickness, it is variable, often less than that given. At some points it is all flaggy limestone, the thick layer being absent.

677. (3) The *Ridley Limestone*.—The description of this has also been, in good part, anticipated. At Judge Ridley's Mill, near Old Jefferson, there is a good exposure of the rocks of this bed, and hence the name *Ridley.* The bed occupies the low grounds of this vicinity. At the mill, the thin limestones of the Pierce Bed are below it. *Orthoceras anceps,* and the characteristic sponge spoken of in § 674, (3,) are quite abundant in these rocks.

678. The following is a section taken at Las Casas, in the northeastern part of Rutherford, and not far from the Wilson County line. It was taken on the side of a rocky ridge. The entire *Ridley Bed* is presented in it.

(4) *The Glade Limestone.* This *caps* the ridge. The rocks are thin-bedded limestones, containing characteristic fossils.

(3) *Ridley Limestone.* Thick-bedded, dove-colored, limestone, presenting the general characters of the bed. There were observed here *Columnaria alveolata, Stromatopora rugosa, Tetradium fibratum,* among other fossils. Thickness 95 feet.

(2) *Pierce Limestone,* at the base of the ridge, and followed below towards the creek, by the *Central Limestone.*

679. The *Ridley Limestone* outcrops, in general, around the circular area of the *Central Limestone* in Rutherford. (§ 672.) Its belt is from half-a-mile to six miles in breadth.

The bed, however, occurs locally, on the higher grounds within the area mentioned. It is, also, sometimes made the surface-rock by local depressions in the strata.

680. Outside of Rutherford County this bed is but seldom seen. At a few points in some of the other counties in which the *Glade Limestone* is extensively presented, the top part of this bed is exposed by the removal of the overlying rocks. But such exposures are of limited extent, and are generally in low places, as, for instance, in the lower part of certain bluffs on the Cumberland River, between Wilson and Sumner. The bed, too, may be looked for in the lower parts of the bluffs on Duck River, between Columbia and Shelbyville.

681. (4) The *Glade Limestone*.—The outcrops of the rocks of this bed embrace large areas in the *Central Basin.* It is a group of much interest. Its rocks are, as has been stated, (§ 668,) thin, flaggy, fossiliferous, dove-colored limestones. The areas in which the group appears on the surface, abound in bare, or nearly bare, rocky places, called *glades.* Upon these, is, very generally, a growth of *red cedar,* the trees finding root in the crevices of the rocks. (§§ 240 241.) The cedars are not, however, confined to the bare places; they thrive and attain a large size where the soil of the group is deeper. The *glades* and the *cedars* almost always indicate the presence of these rocks beneath.

682. The principal areas presenting these rocks, are in Wilson, Rutherford, Bedford, and Marshall, and they extend west-

ward, more or less, into Maury, Williamson, and Davidson. These areas, also, are the cedar regions of Middle Tennessee. Reference has been made to the *cedar ring* encircling the outcrops of the Central and Ridley beds in Rutherford, in § 672.

The towns of *Lebanon, Shelbyville,* and *Columbia,* in part, are located upon this group. At all of these places, its rocks, presenting the same assemblage of fossils, are well exposed.

683. In 1851, the author contributed to the *American Journal of Science* and *Arts,* (Vol. XII, Second Series, p. 352,) a paper accompanied with a plate, on the *"Silurean Basin of Middle Tennessee,"* &c. On the plate, the portions of the Basin especially abounding in cedars, are indicated. There are seen to be three principal areas, namely: one in Wilson, in which Lebanon is located; the circular belt in Rutherford, and finally, the Duck River Valley, between Columbia and Shelbyville.

684. The section below, taken near Readyville, in the eastern part of Rutherford, presents the bed of the *Glade Limestone* entire.

(5) *Carter's Creek Limestone*.—The rocks of this bed form the top of the hill, are thick bedded, and have a thickness of 50 feet.

(4) *Glade Limestone*.—Thin bedded, flaggy limestone, presenting the usual features of the group; contains a heavy bedded layer, about three feet thick, near the middle, and another near the base. Entire thickness, 118 feet.

(3) *Ridley Limestone*.—This constitutes the base of the section, and forms a bluff running down to the level of the water. It has an exposure of 35 feet.

685. The flags of the glade bed, have, sometimes, thin clayey, or shaly seams between them, but not always, being separable without such seams. The surfaces of the flags are often, covered with *Bryozoa, Orthes,* fragments of *Trilobites,* and individuals of *Leperditia fabulites.* The individuals of the last mentioned species, are especially abundant.

686. (5) *The Carter's Creek Limestone*.—This is the uppermost division of the *Trenton Formation.* Its rocks are prominently exposed on *Carter's Creek* in Maury County, and hence, the name given to it. It is, here, a whitish gray rock, heavy bedded, and is quarried for building purposes, and for making lime. It contains some chert, and the characteristic fossils of the division.

This rock shows itself at many points along the railroad, between Columbia and Carter's Station. It often presents in

the bluffs, a castellated appearance, rising up in curious peaks or turrets, and attracting the attention of the traveler.

687. The rocks of the *Carter's Creek* division, *in general*, are, as stated in § 668, light blue, or dove-colored, heavy bedded limestones. In Maury County, the upper part is gray, as we have seen. At many points, at the very top of the group, are a few feet of thin bedded limestones, separated by thin, clayey partings, and, sometimes, by a layer of clay, afoot or more thick. These thin limestones, contain a group of fossils, recalling that of the *Glade Bed.*

688. As in the Ridley division, so in this, the limestones contain, occasionally, layers of chert or flint, but, as stated before, in less quantity than those presented in the *Central Limestone.**

The following group of fossils, is characteristic of the *Carter's Creek* division; *Orthaceras Bigsbyi, Stromatopora rugosa, Petraia profunda, Tetradium columnare, Columnaria alveolata,* and *C. Carterensis.* Individuals of these species, when found associated, determine, at once, the division.

The cedars of the *Glade Bed,* sometimes, extend over the rocks of this.

689. The following is a section, taken at the bluff, just below Cole's Ferry, on the Cumberland River. The point is between Lebanon and Gallatin. The section, so far as the division, under consideration, is concerned, is a complete one, and brings us up to the lower member of the *Nashville Formation* .

NASH. (1) *Orthis Bed*, represented by a few of its lowest sandy layers. This bed is the lowest member of the formation next described.

TRENTON. (5) *Carter's Cheek Limestone.* In the main, light blue, heavy bedded limestone, containing the usual fossils, and, otherwise, having the common characters of the division. The upper ten feet, is, mostly, thin bedded, and contains *Tetradium fibratum*, the cell-tubes in long stringy groups. The presence of *T. fibratum* in this, is, by the way, not usual in this horizon. Entire thickness 95 feet.

(4) *Glade Limestone.* All thin-bedded, excepting one heavy bedded layer eight feet thick, and 27 feet from the top. Entire thickness down to low water, 74 feet.

* It may be remarked here, that in all of the thick bedded divisions, the fossils are, generally, siliceous, while, as generally, in the thin bedded ones, they are calcareous.

690. At *Columbia,* a good section is to be seen. It includes both *Trenton* and *Nashville* rocks. The *Carter's Creek Limestone* is not as heavy as it is further north, and, moreover, differs in having a lighter color. The following, is the section.

NASHVILLE.

(2) *Middle Member.* A series of blue, highly fossiliferous limestones, running up to the top of "*Mount Parnassus.*" This division includes, here, about 200 feet of limestone, contains *Orthis lynx, O. occidentalis, Columnaria stellata, Ambonychia radiata, &c.* The upper layers are made up of small corals, *Stenopora, Constellaria,* and others. Specimens may be gathered on the top of the hill about the old fort, by the peck.

These rocks resemble those around the Capitol at Nashville. Just above the *Orthis bed,* at the base of this member, are layers, packed with individuals of *Strophomena alternata.*

(1) *Orthis Bed,* or *Lowest Member.* This is a group of blue, siliceous, and sandy limestones, some layers of which, are literally made up of individuals of *Orthis testudinaria.* The rock weathers into sandy masses and shales. The shells are generally silicified and the liberated ones are abundant on the surface. Towards the top, the bed is laminated, with, occasionally, cross stratification, characters showing the formation of this portion in a current. Thickness 60 feet.

TRENTON.

(5) *Carter's Creek Limestone.* Heavy bedded, light dove colored limestones below, and gray above. The rock is quarried for building purposes. Has the characteristic group of fossils, and contains some chert. This rock is exposed at the top of the bluff, at the old cemetery. Thickness about Columbia, from 50 to 60 feet.

(4) *Glade Limestone.* Well exposed in the bluff below the cemetery, and about the bridge. Thin bedded limestones with the usual fossils of this division. The greatest thickness seen above low water, is 80 feet.

691. The *Carter's Creek Limestone* occupies, in general, areas around those of the Glade Bed. It is also present in the hills and ridges occurring within the Glade areas. South of *Elk Ridge,* there are but few places where it comes to the surface, the limestones of the valleys, in that section of the *Central Basin,* (§§ 233, 237,) belonging, mainly, to the *Nashville Formation.* This division of the *Trenton,* however, does appear in the valley of Richland creek in Giles County. From Lyn-

ville, on down, to within five or six miles of Pulaski, its gray rocks are well seen at many points near the creeks. Campbellville is also located upon its rocks. A patch of it exists west of Pulaski; another, in the valley of the Elk, opposite upper Elkton.

692. A few miles below Columbia, the division sinks below the river; it is, then, only seen, occasionally, in patches, being brought to the surface on the backs of local waves. One of these patches occurs near Hampshire, another on Snow Creek, near Santa Fe, &c.

693. In Smith County, along the creeks between New Middleton and Carthage, as on Mulherrin, are exposures of the *Carter's Creek Limestone.* So, also, on Smith's Fork, in De Kalb and Smith, etc.

Liberty in De Kalb, Statesville in Wilson, Woodbury in Cannon, and *Columbia,* (in part.) in Maury, are located upon the rocks of this division. At Nashville, they come to the surface above the water-works, and are seen in the lower parts of the hills about Mt. Olivet. In the region of Mill Creek, on the Murfreesboro turnpike, are good exposures.

694. *Agricultural Features, Useful Rocks* and *Minerals of the Trenton.*—The *Central Basin,* has been denominated the garden of Tennessee. (§ 227.) Its lands, in general, are of first rate quality, strong and fertile, adapted to the raising of almost any thing that the climate will admit of. Cotton, corn, tobacco, small grain, and grasses, find congenial conditions in the soils of the basin, and flourish well. The area is the counterpart of the "Blue Grass Region" of Kentucky; it is the Blue Grass Region of Middle Tennessee. The rocks—the bases of the soils—are much the same in both.

695. The lands of the Basin fall naturally, into two divisions, the two being underlaid respectively, by the *Trenton* and *Nashville* Formations. To one group of lands, we may give the name *Trenton,* to the other, *Nashville.*

The soils derived from the Trenton rocks, are, as a general thing, more clayey than those from Nashville beds, the latter, containing more sandy, or siliceous matter. This difference, results from the difference in the composition of the limestones belonging to the respective formations, the one contains more argillaceous, and the other, more siliceous matter.

696. The fine country encircled by the *cedar ring* in Rutherford, has been referred to. (§ 672.) These red lands, are no-

ted for their productiveness, and constitute one of our most important cotton regions. The *Central Limestone* of the *Trenton,* very generally, has an excellent soil upon it. The sand formed by the disintegration of the black chert, helps to make the soil mellow, and the red oxide of iron, acts a part, as a chemical agent, to make it more fertile.

The *Ridley Limestone,* as to its agricultural presentations, may be classed with the *Central.* It does not contain as much chert, but, otherwise, in lithological character, the two are similar.

697. The *Glade Limestone* gives a strong, rather stiff subsoil, which has a fertile loam on top. Its lands are wheat, and grass lands. The great physical feature of this division is presented in its *cedar glades.* These originally covered, or, at least, the cedars grew, upon the greater part of its outcrop.

The better portions of the area are now in cultivation.

Many of the rocky glades are still covered with cedar,

The *Carter's Creek* division is, also, the basis of a good soil, nearly equal to that of the *Central Limestone.* It has not the characteristic red color of the latter, but contains, more or less, fine, sandy chert. Its outcrop is often presented in rocky ledges, or hill-sides, with little soil.

698. Stone, for building purposes, is obtained from all the heavy bedded divisions of the Trenton. The upper part of the Carter's Creek division, however, supplies a superior article. This whitish gray limestone, already spoken of in § 686, is quarried extensively in Maury County. It is conveniently located along the line of the railroad, and could be shipped to Nashville, or other points. Its nearly white color, its texture, and occurrence in layers of suitable thickness, make it desirable. Some layers contain chert; these must be refused. The lime this rock makes is very white.

699. The *Glade Bed* is the source of a supply of limestone flags. Many of these have a smooth surface, and if such alone, be used, make an excellent pavement. They are, however, too often put down with rough ones. Many pavements, are made of flags from this division, in Lebanon. Large flags, a yard across, and from two to four inches in thickness, can be obtained without much trouble. Flags can be found at all the extensive presentations of the rocks of the *Glade Bed.*

700. Such minerals as *Calcite, Barite, Fluorite, Galenite, (galena,) Sphalerite, (zinc blende,) Quartz, Pyrite, (pyrites,)* and tarry *Petroleums,* or *Pittasphalts,* have been observed in the Trenton, in Middle Tennessee. The tarry petroleums occur, occasionally, in all the heavy bedded divisions filling small cavities, which are usually lined with crystals of *calcite.* I have seen them in the vicinity of Lebanon, in the *Carter's Creek Limestone.* The *Central,* and *Ridley Limestones* contain such cavities, and the rocks themselves, are notably fetid.

Galenite, (lead ore,) occurs in small veins, at numerous points, with *Calcite, barite,* &c. There are veins of this sort in every county, but too small to be of value.

701. In Smith County, on Mulherrin Creek, is a considerable vein, running vertically through the *Carter's Creek Limestone.* This has been traced for several miles, and is, at points, a foot or more wide. It contains, mainly, *barite,* (heavy spar,) with *calcite,* and *fluorite.* In this gangue are bunches of lead ore, with, occasionally, some *zinc blende.* A shaft or two, has been sunk on this vein, near the Trousdale's Ferry and Lebanon road, and much *barite* thrown out, but with no special developments otherwise.

On Smith's Fork in De Kalb, is a vein, containing considerable *fluorite,* and some *galenite,* with lead.

B. —THE NASHVILLE; FORMATION IV.

DIVISIONS OF LOWER SILUREAN, NAMES AND EQUIVALENCY—(1) ORTHIS BED—(2 & 3) MIDDLE AND UPPER MEMBERS OF NASHVILLE:—ROCKS OF SPECIAL USE, AND MINERALS OF THE NASHVILLE FORMATION—CATALOGUE OF FOSSILS.

702. In the *Columbia* section, in § 690, the *junction* of the *Trenton* and *Nashville* formations is given.

The passage from one to the other, is well marked and abrupt. This is well seen at Columbia, and at all other points in the *Central Basin,* (§ 227,) where this rock-horizon is accessible. The Trenton ends with light colored, heavy bedded limestones, (immediately at the top, often thin bedded, with clayey seams, §687,) and the Nashville begins with a siliceous, blue, calcareous rock, weathering, often, into thin earthy, buff, sandy masses, and sometimes, into shales.

703. *Divisions of Lower Silurean, Names and Equivalency.*—The division of the *Lower Silurean* rocks of Middle Tennessee, into the two formations

adopted in this work, I made in 1851, in the paper referred to in § 683. In that paper, they were named, respectively, the *Stones River*, and *Nashville* groups. At that time, and in 1856, when the *Reconnoissance* was published, I hesitated as to the equivalency of the lowest member of the *Nashville Group*, (the *Orthis Bed*, to be described,) sometimes regarding it as *Upper Trenton*, and sometimes, as *Hudson River*. In the *Reconnoissance*, I wrote it *Upper Trenton.* This hesitation grew out of the extension of the *Trenton* species, upward, into the bed.

704. Notwithstanding this, the division was, or rather is, a natural one, and the two groups are equivalent, respectively, to the *Trenton* and *Hudson River* formations, as understood by American geologists. The name, *Stones River* has been dropped, but *Nashville* has been retained, and it embraced the same rocks in 1851, that it does now. It is true that *Trenton* species do run up into the lowest member, but so they do into the upper members, and are found in association with many *Hudson River* forms.*

705. But we have, in the *Orthis Bed*, the very characteristic species *Ambonychia radiata*, and *Cyrtolites ornatus*, both commencing here, and running up through the upper members. In addition, the bed holds *Rhynchonella modesta*, and *R. capax*, which, like the last, first appear in this bed and continue through the formation. (See note.)

On such grounds, we make the bed in question, *Hudson River*, and fix the equivalency of the entire *Nashville Formation.*

The lithological features of the beds concerned, so far as they can have any bearing, also place the plane of division, immediately below the Orthis Bed.

706. *Divisions of the Nashville Formation.* These are as follows:

(3) *Upper Member*, embracing about 200 feet of layers.
(2) *Middle Member*, embracing about as much as that above.
(1) *Orthis Bed.* The lowest division, having a thickness of from 50 to 70 feet. (§ 710.)

The *Orthis Bed* is a well marked division. The others will be considered together, as they constitute, naturally, a single group, and have only been separated, for more convenient reference.

707. (1) *The Orthis Bed.*—This division is one of considerable interest. Its place in the series, is shown in the *Columbia* section. (§ 690.) It is, in general, a siliceous, often shaly, calcareous rock. When freshly quarried it is blue. In its weathered condition, it often presents the appearance of a mixed

* The fact is, such forms are *Orthis lynx, O. Occidentalis, Rynchonella modesta*, and *R. capax*, are, at least, in Middle Tennessee, characteristic species of the Hudson (Nashville) Period. And the last three are so in Canada. See *Geology of Canada*, pp, 944 and 945.

bed of fine, thin, earthy, yellowish sandstones and shales. The weathered, detached blocks of the thin, flaggy layers, generally show a blue nucleus, when broken.

708. It is, frequently, especially in its western and southwestern presentations, a group of smoothly laminated flags, interstratified with shaly seams. Such is its typical character on the Tennessee River, in Hardin and Wayne counties, where its flags are burnt and ground into *hydraulic cement.* When wet, in the bottom of a creek, it looks much like the *Black Shale,* (Form. VII.,) and has been mistaken for it.* At Franklin, on the banks of the Harpeth, below the bridge, the bed may be seen, presenting its interstratified flag and shale character. On the Nashville and Lebanon Turnpike, immediately east of Mill Creek, at the foot of the hill on Wm. Nichol's place, it is well exposed, showing the same laminated condition. At this point, its flags have been exposed to the weather in a stone fence, for several years, and exhibit a tendency in the rock to break up in small pieces. At many points about Columbia, and in Maury County, it exhibits the same features as at Franklin.

709. In the more northern and eastern parts of the *Central Basin,* the bed frequently presents, with impure limestones, more or less shale, and, sometimes calcareous sandstone, or even a layer of cherty material. Almost at all points, throughout Middle Tennessee, where this division comes to the surface, it is seen to contain vast numbers of individuals of *Orthis testudinaria.* These are frequently silicified, and, in some regions, form compact flinty layers of adhering shells, as about Mount Pleasant, and at other points in Maury County. †

710. The thickness of the Orthis Bed, in the Basin, is from 50 to 60 feet. Southwestward, it appears to be thicker. Along the Tennessee River, in Hardin, Wayne and other counties, are many exposures, but I have never seen the bottom of the bed in any that have come under my observation. At Clifton, the bed shows a thickness of 70 feet above low water.

711. This bed has already been presented in one section, that taken at Columbia. (§ 690.) Below is the Clifton Sec-

* As for instace, a bed of it in Hardin County, in the rear of Savannah, on Horse Creek,

† A figure (8) of a small specimen of one of these shells, is given in the group, on a following page.

tion. It includes the strata seen at the landing, as well as the hydraulic rock at the cement works.

NIAGARA.

Brownish red, and gray limestone. The topmost rock at the landing, contains large crinoidal stems, and abounds in individuals of several species of *Orthoceras.* This forms the upper, and main part of the bluff, down as far as Carrollville. In some of the high bluffs below Clifton, it is 95 feet thick. At Clifton, its base is elevated, and the rock, traced up the river, soon runs out.

NASHVILLE.

Calcareous Shale, bluish, or greenish, contains *Leptæna sericea*, *Strophomena alternata*, and *Rynchonella capax.* Thickness 15 feet.

Blue Limestone, in rough layers, somewhat sandy; contains *Strophomena alternata*, S. *tenuistriata*, *Rynchonella capax*, *R. dentata*, *Cyclonema bilix*, *Columnaria stellata*, *Tetradium fibratum*, &c. Thickness 23 feet.

Orthis Bed. The *Hydraulic limestone*; a thin, and smooth bedded, fine, blue, impure limestone, breaking, more or less, with conchoidal fracture. The flags are separated by shaly matter; and have a thickness, generally, of from 2, to 4 or 5 inches.

Contains *Orthis testudinaria*, *Rynchonella modesta*, *Linguæ*, *Trilobites*, &c.

This forms the bluff at the cement works, the rocks sinking towards Clifton. Thickness down to low water, 70 feet.

The section above, has interesting features about it, aside from the Orthis Bed, to which reference will be made hereafter.

712. In the Central Basin, the bed under consideration outcrops in areas outside of those of the upper Trenton beds. In addition, it caps many of the low ridges and the limited local plateaus within those areas. It is, in a certain degree, a plateau-making stratum, a character due to its siliceous, and hence, weathering-resisting nature.

713. In Maury, Williamson, Davidson and Sumner, it is the basis of much splendid land. In Maury, especially between Columbia and Mount Pleasant, it underlies a country, much of which is unsurpassed. In general, when the beds of the creeks are in it, or but little below it, and the country devoid of high ridges, the lands overlying it are among the most desirable of the State. The soil it yields is argillaceous and calcareous, mellowed by the siliceous, or fine, sandy impurity of the rock.

714. Franklin, Columbia, in part, and Mount Pleasant, are located upon the Orthis bed. At Nashville, it rises to the surface east of the engine house of the water-works, and still further east, is the shaly rock of Mount Olivet. On the Murfreesboro turnpike, it is seen in the hills after passing Brown's Creek, and hundreds of its little *orthes* may be gathered along the road. At the wire bridge, the bed lies at the bottom of the river, and is only visible at low water.

715. The *Trenton* beds, with the exception of the *Wells' Creek* area, (§ 364,) are confined to the Central Basin. This is not the case with the Nashville beds. The latter appear, also, as we have seen, near the Tennessee River, in Hardin, and Wayne counties, or, in other words, in the *Western Valley*. (§ 708.) The outcrop of the Nashville rocks in this division of the State, is, however, very limited. It occurs in a number of separate areas, or patches, mostly confined to the bed of the Tennessee River, and the beds of some of its tributary creeks. By the local waving of the strata, the rocks are, alternately, above and below the water level of the streams. These exposures occur in the part of the Valley between the mouth of Cedar Creek, in the southern part of Perry, and Savannah.

716. Of the Nashville strata, in this region; the Orthis Bed, or the hydraulic rock, is, by far, the most conspicuous. Along the Tennessee, between the points mentioned, it is seen at the base of several of the bluffs. In these, it is overlaid, (with the other Nashville beds,) by variegated, red, and gray limestones, which often present a high, bold front. Its dark band resting on the water, is quite in contrast with the variegated and brighter ones above.

717. Exposures of the hydraulic rock occur, as stated, on Horse Creek, east of Savannah; also, on Indian, Hardins, and Beech creeks. On the upper part of the latter creek, not more than four miles from Waynesboro, is a patch of it, and others are met with on the same stream, in going down towards its mouth. It occurs, also, on the west side of the Tennessee River. About half a mile south of Saltillo Landing, in Hardin County, on a small stream, is a considerable bluff of it. At Saltillo, however, on the river, it does not appear, the lowest rock in the bluff being the variegated limestone.

718. This bed is interesting as a source of hydraulic cement. Its flags were burnt for this purpose, in Hardin county, twenty years ago. About the beginning of the war, Mr. G. A. Pillow and others, had completed arrangements for the manufac-

ture of cement on a large scale, and had actually commenced operations. The works were quite extensive and substantial, and located on the bluff a short distance above the landing at Clifton. Since the war, the works have been repaired, and put in operation again.

719. The cement manufactured, is of lighter color than the Louisville cement, and of good quality. In 1861, Mr. Pillow sent me a barrel, of that first manufactured, for trial. The barrel was put away in my cellar, und, owing to the troubles which soon came upon us, was left there without being opened. In the meantime, during a very rainy season, water rose in the cellar, and the cement got thoroughly wet. It soon hardened, the hoops and staves fell away, and the cement was left in a solid cylindrical mass—a good cast of the barrel which held it. I have also seen, in the Tennessee River, barrel-shaped masses of the hardened cement, from lots originally lost by the sinking of steamboats.

Some of the exposures of this rock in the Central Basin, as at Franklin and at other points mentioned, present material that it would be well to test practically.

720. The *fossils* of this bed are given in a catalogue at the end of the chapter. Its paleontological relations have been discussed in §§ 703-705, and to these paragraphs, and the catalogue, the reader is referred.

721. (2 & 3.) *The Middle and Upper Members of the Nashville*.—In paragraph 506, the Nashville Formation has been divided into three members, the lowest of which, the Orthis Bed, we have considered. The remaining members, are here thrown together, as, in general features, they are much the same.

These members constitute a group of rather dark blue, highly fossiliferous, often roughly bedded, impure limestones, with a maximum thickness of about 400 feet.* The group occasionally includes shaly, calcareous beds; but these are local. The limestones often contain shaly laminæ, and, in weathering, yield rough, thin, flaggy masses, whose surfaces are often thick with fossils.

722. The greatest thickness of the group is in the northern, and northeastern parts of the Basin, in Wilson, DeKalb, Smith, &c. In the southern, and southeastern counties of the Basin,

*1 have, on previous pages, placed the maximum thickness of the Trenton and Nashville Series, in Middle Tennessee, in round numbers, at 1000 feet. The sections thus measured, would make it something less, and between 900 and 1000.

it is considerably reduced; while, in the western valley, as shown in the Clifton section, where it is only 38 feet, (§ 711,) the group is so much reduced as to be of little or no importance.

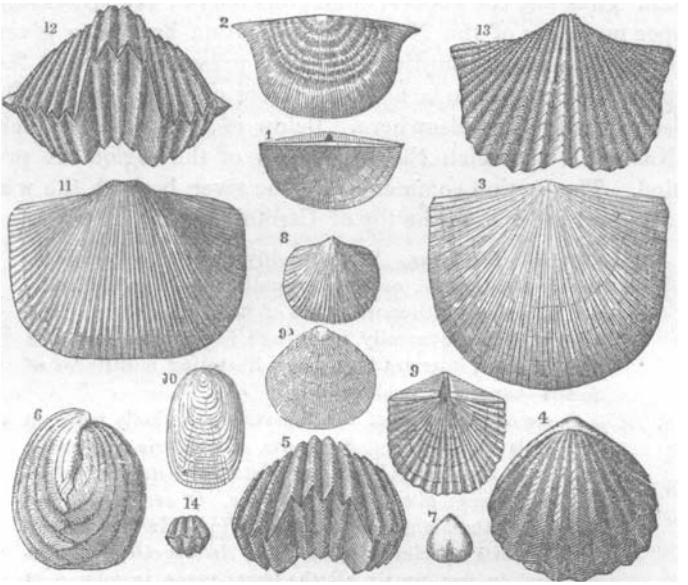
723. These rocks outcrop within the Basin, outside of the areas of the Trenton rocks, and of the Orthis Bed. They make many fine agricultural sections. In addition, their outcrop forms, in general, on all sides, half the slope of the escarpments bounding the Basin. They are the limestone rocks of the rich valleys and hills of Jackson; of the rich hills of Smith, DeKalb, and the eastern part of Wilson; of the western parts of Cannon, and Coffee; the rocks of the rich slopes of Elk Ridge, and of all of its ramifications; those of the hills in the western parts of Maury, Williamson, Davidson, and Sumner. Owing to the dip of the strata, these rocks are brought low on the western side of the Basin, and, hence, underlie, and make, in connection with the Orthis Bed, (§ 713,) in Sumner, Davidson, Williamson and Maury, much fine rolling land, and many choice valleys. In the section south of Elk Ridge, in Giles and Lincoln counties, (§ 237,) all the valleys, (throwing out of them a few areas, in which Trenton rocks outcrop, and to which reference has been made,) are based on these rocks; and, so too, are the slopes of the ridges, at least half way up. The valleys of this section are rich, and many of them beautiful.

724. The rocks of the Nashville Formation, as a whole, yield, by disintegration, the best native soil, (excluding, always, alluvial bottoms,) in the State. This is due to the character of the impurities in the limestone, it being a proper combination of clay and fine sand; and, also, in a measure, I may add, to the organic matter in the rock. Something is due, likewise, to the form the limestone assumes in weathering. I have already spoken of the lands of the Basin, in general, and have compared, briefly, the Trenton and Nashville soils. (See §§ 694 and 695.)

725. Reference has already been made, indirectly, to the paleontology of this part of the Nashville Formation. (§§ 703, 704, 705.) It teems with fossils. Many of its layers are simply beds of corals. Others are made up of sponges. Others again, especially towards the top, are wholly shells, the most common, being *Orthis lynx,* and *Strophomena alternata.* Certain horizons abound in *Cyrtodontæ,* others in *Merchisoniæ,* and others in *Rynchonellæ.* In the catalogue at the end of the chap-

ter, (§ 224,) the best known species, not only of the rocks we are now considering, but of all the *Lower Silurian* strata in Middle Tennessee, are given; and to this the reader is referred.

TRENTON AND NASHVILLE FOSSILS.



1. Leptæna sericea. 2. *Strophomena tenuistriata.* 3. *Strophomena alternata.* 4, 5, 6. *Rynchonella capax.* 7, 14. *Rynchonella bisulcata.* 8. *Orthis testudinaria.* 9. *Orthis tricenaria.* 11. *Orthis occidentalis.* 12, 13. *Orthis lynx.*
9. *Obolus filosus.* 10. *Lingula quadrata.*

On this page is presented a group of the figures of certain shells, which are characteristic of the Trenton and Nashville formations taken together. Familiarity with these and other associated forms, will enable the observer to know when he is on rocks of this geological horizon. (§ 320-1.) Of the species figured, *Orthis lynx, O. occidentalis* and *Rynchonella capax,* are confined to the *Nashville Formation,* and their associates may be seen in the catalogue. (See note under § 704.) *Orthis testudinaria* occurs in both, but is rare, excepting in the Orthis Bed of the Nashville, where, as we have seen, it is found in vast numbers. *Leptæna sericea,* also, appears in both the Trenton and Nashville formations. *Orthis tricenaria,* I have only seen in Trenton rocks in Tennessee. *Strophomena alternata* is in both, but is very rare in the Trenton, and very abundant in

the Nashville, and so much so as to be characteristic. *Strophomena tenuistriata, (rugosa,)* I have only seen in the Nashville. The remaining species are unknown to me as Tennessee forms.

726. Thus far, the general characters only of the Middle and Upper members of the Nashville Formation have been given. There are, in some counties, local beds presenting special features, which remain to be noticed. More of these occur in Davidson County than elsewhere. Below is a section of the rocks at Nashville, in which the local beds of the region are presented. The section commences in the river beneath the wire bridge, and ascends to the top of Capitol Hill.

(6.) *College Hill Limestone.* When freshly quarried, a dark blue, highly fossiliferous, coarsely crystalline and roughly stratified limestone, with more or less of its laminæ shaly. The mass weathers, generally, into rough, flaggy limestones, and shaly matter, interstratified, often liberating multitudes of fossils—especially small corals.

Some of the layers of this limestone are wholly made up of corals and shells. *Stenoporæ, Constellaria antheloidea, Tetradium fibratum, Columnaria stellata, Stromatopora pustulosa, Strophomena alternata, Orthis lynx, O. occidentalis,* and others, are abundantly represented by individuals. *Bellerophon Troosti,* species of *Cyrtodonta, Ambonychia radiata* occur, and, in fact, nearly all the forms given in column M of the catalogue following. This division is well seen on *College Hill,* and in the upper part of the bluff at the *Reservoir.* There is, also, a fine presentation of it on *Capitol Hill,* around the Capitol. Its lowest layers are at the top of the bluff at the *Wire Bridge.*

These rocks pertain to the highest stratum in the vicinity of Nashville. The division, as here presented, may be taken with the upper division, ((2) Middle Member,) of the Columbia Section, (§690,) as typical of the *Nashville Formation* in general.

This division, at *Capitol Hill,* measures 120 feet.

(5.) *Cyrtodonta Bed.* Immediately below the College Hill Limestone, is a remarkable bed of coarsely crystalline, ashen gray, or light yellowish gray limestone, in great part, made up of valves of species of *Cyrtodonta,* individuals of *Bellerophon Lindsleyi,* and *B. Troosti.* (See Pl. G.) Of the *Cyrtodontæ, C. Saffordi* (Pl. F.) is especially abundant.

This bed is best developed in the bluff at the Wire Bridge. It is here, ten or eleven feet thick, and forms one solid layer. The shells are silicified, and pretty generally

have their edges rounded and worn, as if they had been rolled in currents of water, or by waves.

The bed is seen again at the *Engine House* of the Water-works, where it is six feet thick. In tracing it beyond the Engine House, it very soon runs out, and is replaced by a compact, dove-colored limestone, like No.3, below.

Descending the hill on the west side of the Capitol, it is also seen, but it is, for the most part, replaced by the compact limestone spoken of. It is well exposed at other low points about the city, and has been traced, in some directions, a mile or two beyond the city limits. This rock has been used for building purposes, to some extent, and for making corner posts. Maximum thickness, 11 feet.

(4.) *Bed of Limestone* of the common type; much like the College Hill Limestone, coarsely crystalline, fossiliferous, &c. It occurs below No.5, on the west side of the Capitol. In the bluff at the Wire Bridge, it is 23 feet thick. In the bluff above the Engine House of the Water-works, it measures 28 feet.

(3.) *Dove Limestones.* This is a group of three layers, for the most part. The upper layer is a light dove-colored, compact limestone, 4 feet thick, breaking with conchoidal fracture, containing strings (mostly vertical) of crystalline matter, which show points on a horizontal surface. (Birdseye.) The middle layer is, mainly, the common dark blue crystalline limestone, (2 feet.) The lowest layer, (4 feet,) is mostly like the upper, but more or less mixed with blue layers. Such is the group as seen at the foot of *Gay Street*, in a quarry on the river bank. This group presents itself at many points, in and around the City. It is conveniently studied at the quarry mentioned, at the foot of Gay Street. At the end of the bluff beyond the Water-works, it may also be seen, and is here ten or eleven feet thick. The group may also be seen in the region of the Penitentiary, and of the old State quarry, overlying the rock of that quarry. It appears at many points in Davidson County, outside of Nashville. The layers are generally of desirable thickness, and are quarried at numerous points in and about the city, for building and other purposes.

The group contains a number of species. Detached *siphuncles* of *Orthoceras Bigsbyi*, and of an allied species, are numerous at some points, especially in the middle layer. *Tetradium, Bellerophon, Murchisonia, Pleurotomaria,* and other genera are represented. It is in this group, that *Leperditia Morgani* is found. Thickness, 11 feet.

(2.) *Capitol Limestone.* This bed supplied the rock to build the *Capitol,* and was formerly well exposed in the old State

quarry west, and in sight of the building. It is limestone; but has the appearance of a laminated sandstone. It is, in fact, a consolidated bed of calcareous sand, the sand being the comminuted fragments of shells and corals. Originally, the mass was drifted in running water, and arranged in laminæ. As we find the rock now, it is, when quarried, a massive, bluish gray, granular limestone, with a well marked lamellar structure. When cut and ground smooth, a block of it, presented edgewise, shows well, the laminar character. Such a surface is bluish gray, plentifully banded with darker lines. The Capitol is a splendid presentation of this rock as a building material.

The rock often contains rolled fragments of the beaded siphuncles of species of *Orthoceras.* Some specimens of these, are seen in the faces of the blocks in the walls of the Capitol. It exhibits, also, examples of cross stratification, another evidence of the current-action to which it was originally subjected. The mass contains some little siliceous matter, mostly in grains, and in small fragments of silicified shells, so that they do not interfere, materially, with the working of the rock. It is easily quarried, and can be obtained in blocks of any desirable size. In its natural exposures it exfoliates in laminæ by long weathering.

The bed, pretty generally, underlies the city; has been quarried at the foot of Gay Street, on the river; is near the water, under the Wire Bridge; and appears beyond the Water-works, where it has also been quarried, and is 20 feet thick. The lamellar structure of this bed runs into the one just below, to some extent, and it is not always easy to draw a line of separation. Below the Wire Bridge, my measurements make the thickness of the bed 25 feet.

(1.) *The Orthis Bed* underlies the last, and is the lowest member of the Nashville Formation. It is in the water below the Wire Bridge, but rises in going down the river, and may be studied in the bluff below the Railroad Bridge. It may be seen, too, and its *Orthis* gathered, at the first mile-stone on the Murfreesboro turnpike. It rises at the end of the bluff, beyond the Water-works; and still further east, as at Mount Olivet, it may be seen resting on the *Carter's Creek Limestone*—the upper member of the Trenton Formation. It has, however, been described, and its thickness given.

727. The *Capitol Limestone* (No.2, above,) is pretty generally represented in the Basin, outside of Nashville and Davidson County, wherever its proper horizon is presented. It is generally not as good a building material as in Davidson, but is, more or less, laminated and current-formed. The whole area

of Middle Tennessee appears to have been swept over by a current, at the closing of the epoch of the *Orthis Bed.* As far south as Upper Elkton, in Giles County, I have seen this bed well characterized. It here also takes the place, for the most part, of the Orthis Bed, the *Carter's Creek Limestone,* on the opposite side of the river, and about a mile from Elkton, coming up from beneath it, with but little intervening rock.

728. The *Dove Limestone,* (No.3,) also, is frequently seen in different parts of the Basin, though by no means as persistent as the other bed. At Elkton, it is well exhibited in place, resting on the laminated bed.

It is well, perhaps, to note, that there are, at some localities, other layers of this variety of rock, (Birdseye,) occupying horizons, different from that of No.3. They are, however, local, and need no especial mention. The *Cyrtodonta Bed* east of the Water-works at Nashville, is, as we have seen, replaced by similar limestone.

729. In order to exhibit the relation the Nashville Formation sustains to the overlying groups, I present below, two sections, taken, respectively, on opposite sides of the *Central Basin.* The first is the section at *Snow's Hill,* in DeKalb County, a few miles east of Liberty, the point at which the Lebanon and Sparta road leaves the *Basin,* and ascends upon the *Highlands.* (p. 81.) It brings us up to the *Black Shale* and the *Lower Carboniferous* formations.

LOWER SILURIAN. DEVONIAN. LOW. CARBONIFEROUS

(*c.*) THE SILICEOUS. (*Formation* 8,*a.*)
Topmost. A leached mass of earthy, buff siliceous shales, containing interstratified layers of chert, or flint, (many of them heavy.) The mass, more or less dotted with small, siliceous geodes, or hollow concretions. At the bottom 3 or 4 feet of grayish, argillaceous shale.
Thickness of the whole,..... 140 feet.

(*b.*) THE BLACK SHALE. (*Formation* 7.)
A thin, fissile, black, or bluish-black, rather tough, bituminous shale. A foot of the shale at the top, contains kidney-shaped nodules.
Thickness,..... 45 feet.

(*a.*) THE NASHVILLE. (*Formation* 4.)
This immediately follows the *Black Shale* in descending order. It is a great series of limestones, containing many fossils, and having the general characters already given as belonging to the formation. At the base of the hill is the current-formed bed spoken of above.
Entire thickness to the bottom of the hill, ... 303 feet.

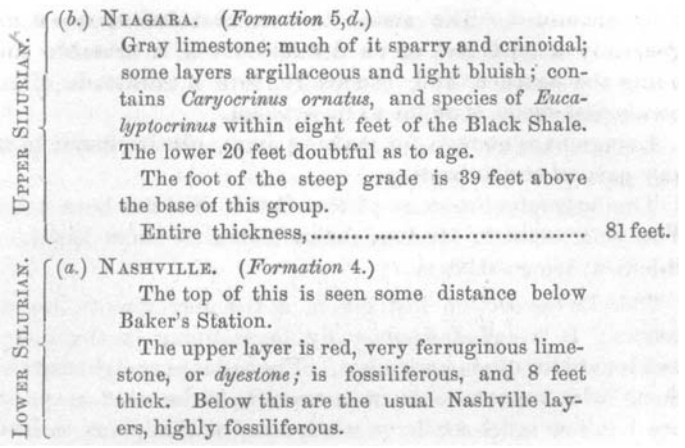
730. Leaving the foot of Snow's Hill, and passing down the valley towards Liberty, the Orthis Bed is soon intersected, and the upper member of the Trenton Formation, met with.

The entire absence of formations 5 and 6, in this section, the Black Shale resting immediately upon the Nashville, is to be noted, as well as the high position of the shale.

731. In passing across the Basin, to the point presenting the section below, a high peak is met with—*Mount Lindsley*—which is topped off with the Black Shale and the Siliceous Formation. This peak is about a mile from Greenwood Seminary, and about five miles from Lebanon. It rises 500 feet above the general surface of the country, and presents a section very much like that of Snow's Hill. The Shale and the Nashville are still in contact. The siliceous rocks of this peak contain carboniferous fossils.

732. Below is the section of formations presented along the *steep grade* of the Edgefield and Kentucky Railroad. The foot of this grade is at Baker's Station, on or near the line between Davidson and Robertson counties. By this grade the railroad ascends from the Basin to the Highlands. (§ 230.)

Low. Carboniferous.	(*d.*) Siliceous. (*Formation* 8,*a.*) *Upper part*, soil and leached shaly matter, with some layers of chert; contains, also, some beds of fossiliferous limestone. *Middle part*, bluish silico-calcareous rock, weathering to shale; contains small siliceous geodes. *Lower part*, shales bluish above, and pea-green below. Two feet from the base of this is a layer of ferruginous and argillo-calcareous rock, a foot and-a-half thick, containing carboniferous fossils. Entire thickness, ... 268 feet.	
Devonian.	(*c.*) Black Shale. (*Formation* 7.) Black shale like that in the Snow's Hill section; contains *Lingulæ*. The upper foot of this contains the kidney-shaped nodules, or the *kidneys*,—argillaceous bodies, very fetid,..... 28 feet.	



733. Two points are to be observed in comparing this section with that of Snow's Hill: the first, that one of the missing formations is present, and that the Black Shale no longer rests on Nashville rocks; the other, that the Shale is low in the hills, and the Nashville at their base. This is in accordance with the fact already stated, that the strata of the Basin dip to the west. (Compare section in chapter X.)

734. The Nashville Formation sinks below the Cumberland River before reaching Harpeth Shoals; below Duck River, at the mouth of Bear Creek, several miles beyond Centreville, in Hickman County; and below the Elk, in Alabama, before reaching the Tennessee River. (§ 229.) It re-appears locally, as we have seen, in the southern part of the Western Valley, and in the Well's Creek Basin. (§ 364.)

735. *Rocks of Special Use, and the Minerals of the Nashville Formation.*—The agricultural features of this formation have already been spoken of. Its beds supplying rock-material for building purposes, have also been noticed. (See especially § 726.) In addition to the beds noticed, there are many solid layers of the formation which may be, and are, used in masonry. There is, in fact, no lack of material of this sort. But there is, on the other hand, much that is not durable, as the rocks in the walls of some old buildings about Nashville will testify. There is not a little room for discrimination. The *natural outcrop* of a bed proposed to be used in masonry ought

to be examined. The action the weather has upon a rock, is generally a good test of its durability. If it crumble easily, under the weather, and, especially, into a multitude of small corals and shells, it ought to be avoided.

Layers pure enough for making lime, can be found in most any part of the formation.

The *hydraulic limestone* of the Orthis Bed has been noticed. The thin, smooth, laminar rocks, found at some localities in this bed, are good *flags.*

736. In the section last given, a red, ferruginous limestone occurs. It is called *dyestone* by those living in the vicinity, and is used for dyeing purposes. The bed is here eight feet thick. Some of it appears to be rich enough to be used as an iron-ore. A few miles south, or southwest, of this point, in Davidson County, this, or a similar bed of red, calcareous rock, rich in iron, occurs. The hills containing it are of a deep red color. This rock resembles, in some respects, the *dyestone* of East Tennessee. It rests upon rocks of the Nashville Formation, to which it is referred. Its fossils, however, although having a Lower Silurian aspect, have not been carefully studied; and it may be found necessary hereafter to include it in the Niagara Group, of which, in this region, it would then form the base. These remarks apply especially to the rock represented in the section. Another dyestone layer occurs on the waters of Harpeth River, in the southwestern part of Davidson.

737. A bed of brownish red, coralline *marble,* occurs in this formation, on the waters of Elk River, in Franklin County, seven or eight miles west of Winchester. The bed is quite extensive, and was formerly worked, to a limited extent, at the county-seat. Other beds, some of them gray, are found in Franklin.

738. On Leiper's Creek, at the *Oil Spring,* in Maury County, and about half a mile below the Williamson line, is another bed of *marble.* This is a gray crinoidal, and coralline rock, spotted with red, and having a flesh-colored appearance. Associated with it are other layers, with red, gray, and green colors. Slabs cut from these rocks, and polished, present a handsome appearance. The main bed is ten feet thick, and quite massive. This marble is at the top of the Nashville Formation, and is followed, in ascending order, by the Niagara, which is here,

50 feet thick; and this, again, by the Black Shale, (8 feet,) above which is about 60 feet of the rocks of the Siliceous Formation.

739. In Sumner County, a few miles north of Hartsville, immediately below the Black Shale, is a bed, from which *millstones* were formerly extensively manufactured. This bed is a mass of shells, closely packed, and silicified. The bed is several feet thick, and contains Nashville species.

The shells are so packed as to make the rock, in due degree, cellular. The weathered portions, near the outcrop, are preferred, for the reason that, within, the spaces between the shells are filled with calcareous matter, which, by exposure, is leached out. (§ 559.) The millstones manufactured here, were highly esteemed. I do not know that any have been made of late years.

740. The following is a list of minerals occurring in the Nashville Formation. A number of them are given in Troost's enumeration of the minerals of Davidson County. (7th Rep., p. 8.) The most of them occur in all the counties in which the formation exists, and are most frequently met with in railroad cuts, and at points where the rocks are quarried.

1. *Calcite,* (carbonate of lime;) common in small veins, and in crystals in small cavities of the limestone.
2. *Siderite,* (carbonate of iron;) in part, the dyestone rock noticed in § 736.
3. *Dolomite,* (carbonate of lime and magnesia;) occurs in cavities.
4. *Celestite,* (sulphate of strontia;) in small veins and cavities, associated with *barite.* In crystals in a small vein at Nashville, and in limestone seven miles from Nashville, on the Nolensville road. (Troost.)
5. *Barite,* (sulphate of baryta;) in many small veins associated with *galenite,* and in cavities alone, or with other minerals; Haysboro', near Nashville, is an important locality.
6. *Gypsum,* (hydrous sulphate of lime;) common at many points in cavities; fibrous, massive, and crystalline.
7. *Anhydrite,* (anhydrous sulphate of lime;) occurs, occasionally, in limestone, as above.
8. *Galenite,* (galena, sulphide of lead;) found in veins, mostly small and unimportant. Haysboro' an exception.
9. *Sphalerite,* (blende, sulphide of zinc;) found in small quantity, associated with the last.

10. *Fluorite,* (fluoride of lime;) in veins with *barite* and *calcite,* or alone in cavities.
11. *Pyrite,* (iron pyrites, sulphide of iron;) in small quantity, frequently seen in limestone.
12. Quartz*;* in a variety of forms; in crystals lining cavities, &c.
13. *Hematite,* (red oxide of iron;) abundant, in ochreous condition, in the soil overlying dyestone. (§ 736.)
14. *Petroleum,* This oozes, and has been doing so for many years, from the Nashville Formation at a number of points; at the Oil Spring on Leiper's Creek, in Maury County, the petroleum coming out of the marble; (§ 738;) at a point near the Cumberland River, on Mill Creek in Jackson County; and at several points on Obey's River, in Overton County.
15. *Pittasphalt,* (mineral tar;) often in the cavities in the limestone, the cavities being frequently lined with crystals of calcite; in a narrow fissure on Wm. Watkins' place, two miles north of Mount Pleasant in Maury County.
16. *Asphaltum,* (mineral pitch;) occurs like the last, in cavities and fissures.

741. *Catalogue of Fossils found in the Trenton and Nashville Formations.*—The following species are known by the author to occur in the Trenton and Nashville rocks of Middle Tennessee. In addition to these, there are many forms not made out, most of which, doubtless, are new. Much care has been taken in identifying the described species. Figures and descriptions have not been wholly relied on. With but very few exceptions, the fossils have been compared directly with New York or Canada specimens, and have been under the eye either of Prof. James Hall or of Mr. E. Billings. To these distinguished paleontologists I am under obligations for many favors.

A few of the new species are named for the first time, some of which are accompanied with a brief descriptive note. Full descriptions will be given hereafter. See, also, Appendix A. The table has the general form of that in the "Geology of Canada," p. 936.

The letters stand for the subdivisions of the formations as follows:

1st. TRENTON; C., *Central Limestone;* P., *Pierce Bed;* R, *Ridley Limestone;* G., *Glade Limestone;* Cr., *Carter's Creek Limestone.*

2d. NASHVILLE; O., *Orthis Bed*; M., *Middle Nashville;* U., *Upper Nashville.*

CATALOGUE OF TRENTON AND NASHVILLE SPECIES OCCURRING IN THE CENTRAL BASIN.

	Genera and Species.	Authors and Notes.	Trenton.					Nashville.		
			C.	P.	R.	G.	Cr.	O.	M.	U.
	PLANTÆ.									
	Buthotrephis?									
1	B. cæspetosa,	Hall, 3d Reg. Rep.	...	...	...	*				
	AMORPHOZOA.									
	Stromatopora.									
2	S. rugosa,	Hall's Sp.	✲	...	*	✲	✲			
3	— pustulosa,	Safford. (n. sp.) Differs in having conical pimple-like elevations on its surface, otherwise much like *rugosa*	...	...	...	...	...	...	✲	✲
	ZOOPHYTA.									
	Stenopora.	*Chætetes.*								
4	S. fibrosa,	Goldfuss.	✲	✲	✲	✲	✲	✲	✲	*
5	— petropolitana,	Pander.	...	...	...	✲	...		✲	*
6	— Libana,	Safford. Like *fibrosa* but with cell-tubes much larger.	...	...	...	✲				
7	— ramosa,	D'Orbigny's sp.	...	...	...	...	...	...	*	*
8	— frondosa,	"	...	...	...	...	...	...	✲	✲
	Constellaria.									
9	C. antheloidea,	Hall's sp.	...	...	...	...	...	...	✲	✲
	Tetradium.									
10	T. fibratum,	Safford.	...	...	*	...	*	...	✲	*
11	— columnare,	Hall's sp.	...	...	...	...	*			
	Columnaria.									
12	C. alveolata,	Goldfuss.	...	...	✲	...	✲			
13	— stellata,	*Favistella stellata*, Hall. I do not think this the same as *alveolata*.	...	...	...	...	...	...	*	*
14	— Carterensis,	Safford, (n. sp.) Hemispherical masses, tubes five and six sided, about one line in diameter.	...	...	...	...	*			
	Petraia.									
15	P. profunda,	Hall's sp.	...	...	...	*	*			
	CRINOIDEÆ.									
	Cleiocrinus.									
16	C. Libanus,	Safford. (n. sp.)	...	...	...	*				
	Dendocrinus.									
17	D. modestus,	Safford. (n. sp.)	...	...	...	✲				

	Genera and Species.	Authors and Notes.	Trenton. C.	P.	R.	G.	Cr.	Nashville. O.	M.	U.
	Glyptocrinus.									
18	G. Libanus,	Safford. (n. sp.)	...	...	...	✲				
	Palæocrinus.									
19	P. sulcatus,	Safford. Allied to *P. striatus*. Billings	...	✲						
	ATERIADÆ.									
	Petraster.									
20	P. ? antiqua,	Troost's Sp. ; 5th Rep., pp. 11 and 58	...	...	...	...	...	...	✲	...
	BRYOZOA.									
	Ptilodictya.									
21	P. acuta?	Hall's sp.	...	✲	...	✲				
22	— symmetra,	Safford. (n. sp.)	...	✲	...	✲				
23	— explicans,	" (")	...	...	...	✲				
24	— multiramis,	" (")	...	...	...	✲				
25	—? Libana,	" (") A simple ribbon-like species, from three to five inches long, and from seven to eleven lines wide	...	...	...	✲				
	Retepora.									
26	R. fenestrata,	Hall. 3d Reg. Rep.	...	✲	...	✲				
	Graptolithus.									
27	G. amplexicaule,	Hall.	...	...	...	✲				
	BRACHIOPODA.									
	Leptæna.									
28	L. sericea,	Sowerby.	...	...	...	✲	...	...	✲	✲
	Strophomena.									
29	S. alternata,	Conrad.	...	✲	...	...	...	✲	✲	✲
30	— incrassata,	Hall,	...	✲	✲	✲				
31	— filitexta,	"	...	✲	...	✲	✲			
32	— planumbona,	"	...	...	...	...	...	..	✲	✲
33	— planoconvexa,	"	...	...	...	...	...	...	✲	✲
34	— tenuistriata,	Sowerby.	...	...	...	...	...	...	✲	
	Orthis.									
35	O lynx,	Eichwald.	...	...	...	...	...	✲	✲	✲
36	— occidentalis,	Hall.	...	...	...	...	...	...	✲	✲
37	— pectinella?	Conrad.	...	...	...	...	...	...	✲	...
38	— testudinaria,	Dalman.		✲			...	✲	✲	✲
39	— deflecta,	Conrad. *Lep. deflecta* Pal. N. Y., Vol. I, p. 113.	...	...	✲	✲	✲			
40	— perverta,	Conrad.	...	✲	...	✲				
41	— subæquata,	"	...	...	...	✲	...	✲		
42	— Stonensis,	Safford. (n. sp.) Resembling the last in form, but the fine radiating ridges thrown into groups by stronger ones, much as in *S. alternata*.	...	✲						

	Genera and Species.	Authors and Notes.	Trenton.					Nashville.		
			C.	P.	R.	G.	Cr.	O.	M.	U.
43	— bellarugosa,	Conrad.	...	...	*	*	*			
44	— tricenaria,	"	...	...	*	*				
	Skenidium.									
45	S. Halli,	Safford. (n. sp.) 12th Reg. Rep. p. 70. This is the Tennessee species spoken of in the above Rep.	...	...	...	*				
	Rhynchonella.									
46	R. capax,	Conrad. *R. increbescens*, pars	...	...	...	...	...	*	*	*
47	— modesta,	Say,	...	...	...	...	...	*	*	*
48	— recurvirostra,	Hall.	...	...	...	*	*			
49	— Ridleyana,	Safford. (n. sp.)	...	*	*					
50	— altilis,	Hall.	*							
51	— orientalis,	Billings.	...	...	...	*				
52	— dentata,	Hall.	...	...	...	...	...	...	*	
	Triplesia.	*Camerella*, Billings.								
53	T. varians?	More globose than the Canada specimens.	...	...	*	*	...			
54	— extans,	Hall.	...	...	...	...	...	...	*	
	CONCHIFERA.									
	Avicula.									
55	A. demissa,	Conrad.	...	...	...	...	...	...	*	
	Ambonychia.									
56	A. radiata,	Hall.	...	...	...	...	...	*	*	*
57	— maxima,	Safford. (n. sp.) From three to five inches long.	...	...	...	...	...	...	*	
58	— Swanana,	Safford. (n. sp.)	...	...	...	...	...	...	...	*
	Crytodonta.	*Palæarca*, Hall.								
59	C. Hayniana,	Safford. (n. sp.) Pl. F. Fig. 1.	...	...	...	...	...	...	*	
60	— Saffordi,	Hall. sp. 12th Reg. Rep. p. 11. This Rep. Pl. F. Fig. 2.	...	...	...	...	...	...	*	
61	— obtusa,	Hall.	...	...	...	*				
62	— ventricosa?	"	...	...	...	*				
63	— Canadensis,	Billings.	...	...	*	*				
64	— amygdalina,	Hall.	...	...	...	*	*			
65	— Normanensis,	Safford. (n. sp.)	..	...	...	...	*			
66	— Winchelli,	" (") Pl. E. Fig. 2.	...	...	...	...	...	*	*	
67	— Gantii,	" (") Pl. E. Fig. 1.	...	...	...	...	...	*		
	Ctenodonta.	*Tellinomya*, Hall.								
68	C. nasuta,	Hall.	*	...	...	*	*			
69	— contracta,	Salter.	*	...	...	...	*			
70	— Logani?	"	*							
71	— Hartsvillensis,	Safford. (n. sp.) Pl. F. Fig. 3.	...	...	...	...	...	...	*	

	Genera and Species.	Authors and Notes.	Trenton.					Nashville.		
			C.	P.	R.	G.	Cr.	O.	M.	U.
	Modiolopsis.									
72	M. modiolaris,	Conrad.	...	...	...	...	...	*	*	
	GASTEROPODA.									
	Holopea.									
73	H. obliqua,	Hall.	*	...	...	*				
	Cyclonema.									
74	C. bilix,	Conrad.	...	...	...	...	...	...	*	*
	Subulites.									
75	S. subfusiformis,	Hall.	...	...	..	...	...	...	*	
76	— vittata,	"	...	...	...	*	*			
77	— elongata,	Conrad.	...	...	...	*				
	Eunema.									
78	E. prisca,	Billings.	*							
	Helicotoma.									
79	H. Tennesseensis,	Safford. (n. sp.)	*	...	...	...	*			
80	— declivis,	" (")	*							
	Maclurea.									
81	M. magna,	Lesueur.	*	...	...	*				
	Trochonema.									
82	T. umbilicata,	Hall's sp. The individuals found in *Bed C.* may belong to a distinct species.	*	...	...	*	*			
	Pleurotomaria.									
83	P. subconica,	Hall.	*	...	...	*	*			
84	— Americana,	Billings.	*	...	...	*	*			
85	— rotuloides?	Hall.	...	...	...	...	*			
86	— lapicida,	Salter.	...	...	...	*	*			
87	— Progne,	Billings.	...	...	...	...	...	...	*	
88	— staminea?	Hall.	...	...	...	*				
	Murchisonia.									
89	M. ventricosa,	Hall.	...	...	...	*	*			
90	— gracilis,	"	...	...	...	*	*			
91	— Sumnerensis,	Safford. (n. sp.) Pl. G. Fig. 1.	...	...	...	...	...	...	*	*
92	— bicincta,	Hall.	*	*	*	*	*	*	*	*
93	— serrulata,	Salter.	...	...	...	...	*			
94	— aspera?	Billings.	...	...	...	*				
95	— Bowdeni,	Safford. (n. sp.) Pl. G. Fig. 2.	...	...	...	...	...	...	*	*
	HETEROPODA.									
	Crytolites.									
96	C. ornatus,	Conrad.	...	...	...	...	...	*	*	*
97	— compressus,	"	...	...	...	*				

	Genera and Species.	Authors and Notes.	Trenton. C.	P.	R.	G.	Cr.	Nashville. O.	M.	U.
98	— cristatus,	Safford. (n. sp.) Surface without waves or imbrications.							✲	*
	Bellerophon.	*Bucania*, Hall in part.								
99	B. bidorsatus,	Hall,	✲	...	...	✲	*			
100	— expansus,	"	...	...	...	*				
101	— punctifrons,	Emmons.	...	...	...	...	...	✲		
102	— Lindsleyi,	Safford. (n. sp.) Pl. G. Fig. 4.	...	...	...	...	...	...	✲	
103	— Troosti,	Pl. G. Fig. 3.	...	...	...	...	...	..	✲	
	Carinaropsis.									
104	C. carinata,	Hall.	...	...	...	...	...	✲	✲	
	PTEROPODA.									
	Cliioderma.									
105	C. Saffordi,	Hall. 14th Reg. Rep.	...	...	...	*	✲			
	Conularia.									
106	C. Gattingeri,	Safford. This may be *C. Trentonensis*, which it much resembles. A specimen found in excavating the cellar of Dr. Gattinger's house, in Nashville, is greatly larger than any of the figures of *Trentonensis* that I have seen. The original was about ten inches long.	...	...	...	...	...	...	✲	
107	— Trentonensis?	Hall.	...	...	...	...	...	...	...	✲
	Salterella.	*Billings. Pal. Foss. p.* 17.								
108	S. Billingsi,	Safford. (n. sp.) From one and a half to two inches long, straight, large end of longest specimens about one-sixth of an inch in diameter, tapering to a point, striated longitudinally, cross-section circular. A beautiful and abundant species; at least three cones, one within the other.	*	...	...	✲				
	CEPHALOPODA.									
	Orthoceras.									
109	O. bilineatum,	Hall.	...	...	...	...	...	...	✲	
110	— fusiforme,	"	✲	...	...	✲				
111	— multicameratum?	"	...	...	...	...	...	...	✲	*
112	— strigatum,	"	...	...	...	...	...	...	✲	✲
113	— amplicameratum,	"	...	...	...	...	...	...	*	
114	— decrescens,	Billings.	...	...	...	✲	*			
115	— pertinax,	"	...	...	...	*	*	*		
116	— Allumettense,	"	...	...	...	...	✲			
117	— Huronense,	"	...	...	...	...	✲			
118	— rapax,	"	...	...	...	✲	...	✲		
119	— Bigsbyi,	Stokes.	✲	✲	*	✲	*		✲	
120	— anceps,	Hall.	*	...	*	✲				

	Genera and Species.	Authors and Notes.	Trenton.					Nashville.		
			C.	P.	R.	G.	Cr.	O.	M.	U.
121	— capitolinum.	Safford. (n. sp.) Intermediate in character between *Bigsbyi* and *anceps*. Plate G. 3, Fig. 1.	...	...	...	...	...	...	*	
122	— Foxense,	Safford. (n. sp.)	...	...	...	*	✲			
	Cyrtoceras.									
123	C. Bondi,	Safford. (n. sp.) Pl. G. 3, Fig. 3.	✲	...	...	...	✲			
124	— constrictum,	Hall.	...	...	...	✲				
125	— " ?	"	...	...	...	...	...	..	✲	
126	— macrostomum,	"	...	...	...	...	...	...	✲	
127	—? Stonense,	Safford. (n. sp.) Pl. G. 3, Fig. 2.	✲							
128	— Massiense,	" " Pl. G. 3, Fig. 4.	...	...	...	...	...	...	✲	
	Lituites.									
129	L. undatus,	Conrad.	...	...	...	✲				
	Trocholites.									
130	T. ammonius,	Conrad.	...	...	...	*				
	CRUSTACEA.									
	Asaphus.									
131	A. Barrandi?	Hall. Foster and Whitney's Rep. Part 2d, p. 210.	...	...	...	*				
132	— canalis,	Conrad.	...	...	...	*	✲		✲	
	Calymene.									
133	C. Blumenbachii,	Brongniart. *C. senaria.*	...	...	...	*	...	...	✲	*
	Cheirurus.									
134	C. pleurexanthemus,	Green.	*	...	...	*				
	Encrinurus,									
135	E. excedrinus,	Safford. (n. sp.	...	...	...	*				
	Illaenus.									
136	I. Americanus,	Billings.	...	...	...	✲				
137	— ovatus,	Conrad.	...	...	...	✲				
	Lichas.									
138	L. Trentonensis,	Conrad.	...	...	...	...	...	...	✲	
	Phacops.									
139	P. callicephalus,	Hall.	...	...		✲				
	Dalmanites.									
140	D. Troosti,	Safford. (n. sp.)	✲	*						
	ENTOMOSTRACA.									
	Leperditia.									
141	L. fabulitus,	Conrad. Very abundant.	*	...	...	*	✲			
142	— capax,	Safford. (n. sp.)	...	...	...	...	...	...	*	*
143	— Morgani,	" "							*	