CHAPTER VII.

THE POTSDAM GROUP; SERIES II.

420, *a.* This group includes three great subdivisions, each of which, may be regarded, as a Formation. They are as follows, in ascending order:

2, *a. The Ocoee Conglomerate and Slates.*

2, *b. The Chilhowee Sandstone,* and

2, *c. The Knox Group of Shales; Dolomites, and Limestones.*

The equivalents of these, in other States, and in Canada, are given in the tables, in chapter V. The table on page 169, presents the synonymes in one view.

421. The group corresponds to Dana's *Potsdam Period,* and, in the above arrangement, my purpose has been to follow him. It is not easy to separate, lithologically, the *Ocoee sub-group* from the *Chilhowee,* as they often run into each other. The distinction between the latter and the *Knox* is much more apparent.

Perhaps a better arrangement would have been, to throw the *Ocoee* and *Chilhowee* together, as the Potsdam, the *Knox* remaining as an individual group. We may, hereafter, find *Paradoxides* in the slates of the Ocoee, and a fauna, which will justify us in separating it from the Chilhowee permanently. But, be the grouping what it may, in this Report the sub-divisions above will be treated of as separate formations, so that there can be no misunderstanding. Each sub-division will be the subject of a section.

422. *Formations of the Unakas.*—Before considering the sub-divisions, or formations above, specifically, it will be well to state that the first two—the Ocoee and Chilhowee Formations, in conjunction with the Metamorphic Group already described — embrace all the rocks of the Unaka ridges. These are, emphatically, mountain-making formations. The Metamorphic, with the Ocoee, build up the greater more easterly range with its subordinate parts; (§§ 46, 66 ;) the Chilhowee sandstone makes the bold isolated outliers which so singularly skirt, in a long broken line from Virginia to Georgia, the base of the

greater range. The former are the formations of White Top, Stone Mountain, the Roan, the Great Bald, the Big Butt, the Great Smoky, the Frog, &c. The latter is the formation of the Holston, the Buffalo, the Meadow Creek, the Chilhowee, the Star's Mountain, and a number of others which are links in this outlying chain.

SECTION I.

THE OCOEE CONGLOMERATE AND SLATES; FORMATION 2,*a.* SECTION ON THE OCOEE RIVER—EXTENT AND TOPOGRAPHY—CROSS SECTIONS; LITHOLOGICAL AND OTHER CHARACTERS; *(a)* TELLICO SECTION; *(b)* LITTLE TENNESSEE SECTION ; (*c)* SECTION OF THE VALLEY OF EAST TENNESSEE ; *(d)* LITTLE PIGEON SECTION ; *(e)* THE GROUP ON BIG PIGEON; *(f)* FRENCH BROAD SECTION ; *(g)* BIG BUTT; *(h)* GREASY COVE SECTION; (i) JOHNSON COVE SECTION—USEFUL ROCKS AND MINERALS—AGRICULTURAL FEATURES.

423. *The Section on the Ocoee River.*—It has been stated as a remarkable fact, (§§ 6, 41, and note, p. 21,) that the Unaka Chain, though higher and more massive than the Blue Ridge, in North Carolina, is intersected by the tributaries of the Holston and Tennessee Rivers, that rise upon the western slope of the latter ridge.

In passing the Unakas the tributaries flow through narrow rock-bound valleys, or gorges. The Ocoee is one of the tributary streams, and its gorge is the longest and grandest of all. In its tortuous course, the gorge is twelve or thirteen miles long, and is cut through the strata of the Ocoee Group. The belt of these rocks presented here, has a direct width of about twelve miles. The strata, from one end of the gorge to the other, are generally highly inclined, and, on both sides of the river, rise up from the water's edge in precipitous cliffs. There are but few bottoms in the whole distance, and these are very narrow—not wider than is necessary for the wagon road which has been constructed along the stream. Although, in general, the strata are highly inclined, with a dip to the southeast, yet they occur at all angles, and are frequently presented in great flexures, or are broken in faults.

424. In the route from Cleveland to the Copper Mines, we first pass over several wide belts of dolomite limestones and shales, (belonging mostly to

the Knox Formation) to the southern extremity of Star's Mountain. (See the section.) Passing around this extremity, and traveling for a few miles up the valley lying along the eastern base of the mountain mentioned, we at length turn eastward, and enter the great gorge of the Ocoee. Traveling through this, and making a considerable ascent at the same time, we finally reach the metamorphic rocks, and the elevated basin of the Ducktown region. A few miles further on, and the mines are in sight.

425. The section presented in the *gorge* of the Ocoee, is a very interesting one. The strata are well displayed. They are, in general, coarse gray conglomerates, talcose, chlorite and clay slates repeatedly interstratified, all having a semi-metamorphic aspect. The slates predominate, and of these, the greenish and light bluish gray, or the chloritic and talcose varieties, are the most abundant. At one point, more than half way through the gorge, at a place called *Mundic Bluff*, the slates are filled with beautiful cubes of pyrites, some of which are an inch through. At other points, weathered slates contain cubical cavities, from which the pyrites have disappeared.

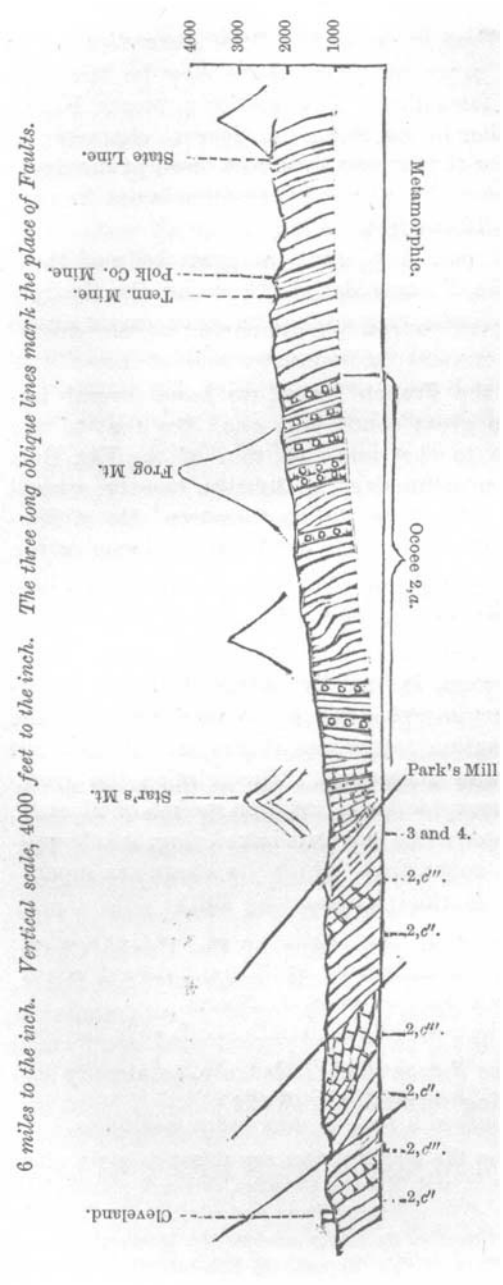
426. The middle part of the section presents little conglomerate, but in the upper part, it abounds. Along the road, it will be seen exclusively for half-a-mile, or more; then, again, in great beds, alternating repeatedly with chloritic and clay slates. The lower part of the gorge has several heavy bands of conglomerate.

427. The conglomerate is sometimes coarse, the pebbles being as large as hen's eggs, or larger. Generally, however, they are smaller. Occasionally the rock becomes a sandstone. The pebbles are quartz and feldspar, mainly, generally rounded, but sometimes more or less angular. In addition to these, fragments of clay slate, and other varieties of slate, are often seen in the rock. The conglomerate usually contains more or less chloritic and talcose matter in its interstices.

Veins of quartz are occasionally seen in the cliffs of the Ocoee. They are often interpolated in the strata, so as to be conformable, but sometimes occur as fissure veins, especially the smaller ones. But very few exceed a foot in maximum thickness.

428. The following diagram exhibits the general section of the formations from Cleveland to the State line beyond Ducktown, and will serve to show the extent and the position of the Ocoee sub-group in this region.

The section is made along a straight line, running from Cleveland



through the gap at Park's Mill, on the Ocoee, and the Tennessee Mine, in Ducktown, to the North Carolina boundary. Observations made in the gorge of the Ocoee are referred to this line.

429. The rocks passed over from Cleveland to Star's Mountain, or to Park's Mill, have been mentioned. (§424.) In addition, it may be noticed, that one band of 3 and 4, (Trenton and Nashville rocks,) is intersected.

430. At the mill, a nearly vertical ledge of whitish quartzose sandstone, (Chilhowee sandstone, 2,*b*,) is met with. This ledge is all that is here seen of the great formation, which, further to the northeast, makes the massive Star's Mountain. At this point, there has been great displacement. Nearly all the sandstone is gone, and all the lower part of the Knox; and, moreover, some of the dolomite of the upper Knox has been thrown to the east of the sandstone ledge. Immediate1y east of this displacement, the Ocoee rocks begin, and continue through the belt of rough mountains to the Ducktown metamorphic basin.

431. *Extent and Topography of the Ocoee Formation.*—The strata of the Ocoee gorge, as given above, may be taken as types of the whole formation. This section presents, better, perhaps, than any other in the State, the general character of the formation, and, for that reason, has been more particularly noticed. The thickness of the Ocoee Formation is not known. It may be more than 10,000 feet.

It will be observed, (see Map,) that the great body of these rocks lie between the French Broad River and the Georgia line. Between these limits, they make a massive mountainous belt.

432. Northeast of the French Broad, we have several important belts, but no great continuous one, like that to the southwest. Of those to the northeast, that of the Big Butt Range, (§ 62,) is the most massive. In Johnson County, several belts are seen; one lying along the southeastern side of Iron Mountain; another, at the extreme northeastern corner of the State, adjacent to the strata forming Beech Summit, Cat Face, and Slate Face Peaks, on the State line; and another, southeast of Taylorsville.

433. The Ocoee Group, is, usually, adjacent, on its southeastern side, to the metamorphic rocks. Where this is not the case, and a later formation intervenes, it has been thrown out of place by a fault and dislocation. The relation the group sustains to the metamorphic beds, has been spoken of already. (§ 408.) On the western side, no fault interfering, it is bounded by the Chilhowee rocks, from which its strata are separated, often, by no well marked horizon. (§ 421.)

434. Some of the highest mountains of the Unaka Chain, as for instance, the Great Smoky, in Sevier County, the Balds, in Monroe, and the Big Frog, in Polk, together with others in the northern part of the State, already mentioned, are formed of strata of the Ocoee Formation. It is truly, as already stated, a mountain-making formation. (§ 422.)

435. Nevertheless, when the conglomerates are absent, it gives, often, especially in Sevier, Blount, and Monroe Counties, elevated plateau-like regions, and high valleys of some interest in an agricultural way. (§437.) In Blount and Sevier Counties, its strata enclose the interesting coves described in the First Part of this Report, (§§ 133-135,) but these do

not properly belong to this formation. They are based, mostly, on the rocks of the Knox Formation, and owe their origin to the fact that great patches of the Knox strata, were, during the period of disturbance, (§ 344,) cut off, and entangled among the Ocoee beds. These patches of softer rocks, by subsequent denudation, have been hollowed out into the coves, as we now find them.

436. *Cross Sections; Lithological, and other Characters, (a.)*—The section presented in the gorge of the Ocoee has been given. Passing northeastward, *that, from the old Tellico Iron Works in Monroe County, southward to the State line, may be noticed.* The old works are located on Tellico River, just within the edge of the Ocoee Group, a belt of Knox dolomites and shales, lying but a little distance to the northwest, about the Furnace, and commencing below at the edge of the Knox, the rocks are mostly, pale greenish or bluish, semi-talcose slates, containing, occasionally, bands of sandstone and conglomerate. Some of these slates are fissile, and might furnish roofing slates. Passing from the Furnace, southeastward, the same rocks continue for about two miles, and, within this distance, rise up into a considerable mountain, over which the North Carolina road passes. Ascending the Tellico River, from the Furnace into the gorge through which the river passes the above mountain, the slates, including at intervals, bands of sandstone and conglomerate, are well seen. At the upper rapids, three-fourths of a mile from the Furnace, the conglomerate is well characterized.

437. Crossing the mountain, we reach an elevated and wide belt of mountain country, almost wholly made up of slates. This belt, viewed from high points, appears like a wide, shallow trough, lying between the great mountains on the line, and the mountain, or range, just crossed, the rocks of which we have considered.* The width of the belt is from four to five miles. It extends, longitudinally, to the northeast and southwest, nearly as far as the eye can reach. In a direct line, we enter it about two miles from the Iron Works. It includes the gold region of Coqua, or Coca Creek, a circumstance which attaches much interest to it as a metaliferous region.

* I have spoken of this mountain as a single range; it consists, really, of two ranges near together, with no great depression between. The site of Tellico Iron Works, is at the western base of the double range.

438. The slates of this belt, dip, as usual, to the southeast, at varying angles, but generally, with steep inclinations. They are talcose aud chloritic slates; of pale blue and greenish colors, much like those about the Tellico works. Many of them present a silvery aspect, and a semi-micaceous appearance. In crossing the country, veins of quartz are frequently met with, intercolated between the layers of slate. Among these, some are gold-bearing, the special consideration of which belongs to the Third Part of this Report.

439. Passing to the southeast, beyond the belt just considered, and reaching the foot of the mountain on the line, we again come up with conglomerates and slates. Beyond, in North Carolina, these are succeeded by the metamorphic strata.

440. (*b.*) The *Section of the Ocoee Group presented along the Little Tennessee* from the end of Chilhowee Mountain to the State line, is now to be considered.

This section shows more conglomerate, alternating with the slates, than the last. It also exhibits, entangled in Ocoee strata, several patches and bands of limestone, or dolomite. Several of these are extensive enough to have formed by denudation, coves of some interest, the river intersecting them; Chilhowee and Tallassee Coves, are the principal ones. The limestones and dolomites of Tallassee, the uppermost cove, show, by fossils, that they belong to the lower part of the Nashville Formation, (the Nash,) and the upper part of the Knox. The other bands of limestone, belong, perhaps, to the Knox. But it is uncertain. From their relations to the conglomerate, one would almost be ready to locate them in the Ocoee Group. And to this we would be more inclined, were it not for the fossiliferous character of the Tallassee rocks.

A few layers of limestone are met with, which are made up of angular fragments and pebbles of calcareous matter forming breccias and calcareous pudding-stones. Some of these, have been worked as marble.

441. Chilhowee Mountain, and with it, for the most part, its special group of sandstones, runs out, before quite reaching the Tennessee River. On the river, in a line with the mountain, therefore, the Chilhowee sandstones are absent. There is, here, much displacement of the formations. A band of conglomerate forming a considerable ridge, is seen on the northwest side of the point of Chilhowee. It is too, separated from the greater body of conglomerate, by a narrow band of Nash rocks.

442. Passing the range of Chilhowee Mountain, and traveling the road up the river, we intersect, for the first three miles, heavy beds of conglomerate and slates interstratified. Much of the conglomerate is very coarse. In the first mile, a narrow band of breccia limestone is seen. In the fourth mile, Chilhowee Cove is entered. This is, for the most part, surrounded by slates.

From the cove mentioned, to Tallassee, the road does not run directly across the strata. The belt of rocks intersected is between two and three miles wide. They are, mainly, pale greenish talcose slates, and contain but few beds of conglomerate. A second bed of breccia limestone is seen in this division.

443. Passing the limestones of Tallassee Cove, slates and conglomerates appear again, and continue to be the rocks on to the State line, a direct distance of about seven miles. The line runs on the top of a mountain ridge, and as we approach this, the relative amount of conglomerate increases, becoming finally greater in volume than the slates.*

The slates and conglomerates have the same general character that they have on the Ocoee. Of the slates, the pale greenish, or bluish, predominate. About half-way between Tallassee and the State line, a considerable bed of clay slate is seen. All the way between these points, veins of quartz are occasionally met with.

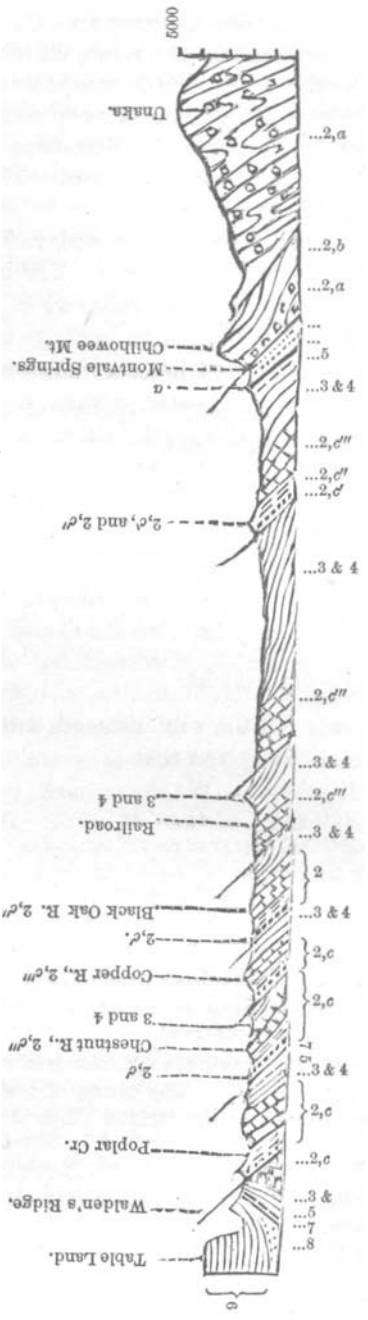
444. (*c.*) I introduce on the next page, *a section taken directly across the middle and narrowest part of the Valley of East Tennessee.* **It** was constructed for the purpose of illustrating the geological peculiarities of the Great Valley. **It** extends from the Cumberland Table-land, in a southeasterly direction, to the Mountain on the North Carolina line, striking the latter in the region of the two Balds a few miles to the northeast of the Little Tennessee River. The Ocoee Group is seen in this section, at its southeastern end. The relation it sustains to the Chilhowee sandstone, and to the other formations, will be observed.

445. The length of the section is 52 miles. Eight great faults are crossed. (§§ 344, 359, 360.) The places of these are indicated by the oblique lines reaching above the surface. **It** is to be observed that no great flexures

* In the mountain gorges near the line, are frequently observed great isolated blocks of conglomerate, as large as good-sized cabins. These the mountain-men call "graybacks," a name reminding one of the old *graywacke.* These gray backs have rolled from above, into the gorges.

occur. This is the most crowded part of the Valley. The incipient folds were split open longitudinally, and the southwestern side of each heaved up and over the northwestern. The older formation is on the southeastern side of a fault. In passing from one fault, in a southeasterly direction, to another, the successive formations are met with in ascending order until the second fault is reached; passing this, an older formation occurs again, to be followed, as before, by newer ones. The formations are thus arranged by the faults into successive series, the series being much alike, in fact, to a great extent, repetitions of the same thing. In the section there are eight of these series between Walden's Ridge and Chilhowee Mountain.

The formations mostly concerned in these repetitions, remain to be described. In connection with them, there will be frequent occasion to refer again to this section.



446. The section shows how Ocoee strata may occur along the northwestern base of a Chilhowee sandstone mountain. Several of these mountains have a strip of Ocoee rocks in this position. To this, however, we will refer, when we come to speak of the Chilhowee sandstones.

447. (*d*.) In *the route from Sevierville up the West Fork of the Little Pigeon, to the State line*, the rocks are well displayed. The road runs to the southeast and across the strata.

Sevierville is located on the *Graptolite Shale.* Leaving this point and proceeding on our route to the southeast, this shale continues for nearly two miles, when a band of Trenton limestone, with fossils, is encountered. This limestone is the top of a fold, and is soon followed by the shale. The latter, however, does not continue far. In half a mile after its first appearance, the limestone comes to the surface the second time, and is then followed by Knox limestones and dolomites, which are traveled over for the next mile and a half. Four miles from Sevierville, the Trenton reappears, and is followed by the Graptolite Shale.

448. At six miles, and following the shale mentioned, a series of slates commence, which have a semi-metamorphic aspect. They are clay and talcose, or semi-talcose, and blue slates. Further on, they become more marked as talcose slates, of pale bluish and greenish colors. They dip generally at high angles, and are the rocks along the road as far as to the fifteenth mile, when they begin to be interstratified with bands of conglomerate. The belt is about nine miles wide. They enclose, occasionally, harder layers, approaching sandstone in texture, and, near the southeastern side of the belt, several bands of clay, or roofing slates.

449. Passing the fifteenth mile, the slates continue much the same, excepting that they are interstratified with bands of conglomerate. We have now reached the base of the great mountains of the State line. (§ 434.) From the fifteenth mile (the distance being estimated directly) to the line, is about eight miles. In the ascent, the alternating slates and conglomerates are crossed all the way. The bands of conglomerate are massive, and its "gray backs" fill the mountain ravines. (§ 443, note.) Reaching the summit, no true metamorphic rocks are seen, these being beyond, in North Carolina.

450. The slates of these mountains are often silvery, or semi-micaceous in appearance. At points they are dark bluish, and contain much pyrites, which, in sheltered places under the rocks, decomposes and forms, with alumina and magnesia, from the decomposing rocks, alum and Epsom salt. There is a noted locality of this kind on the side of one of the great ridges near the line of our section, called *Alum Cave.*

451. The section presented by these mountains, is much like

that between Tallassee Cove, on the Little Tennessee, and the State line. (§ 443.) Veins of quartz occur at intervals in it.

452. I have placed the western limit of the Ocoee Group at the point six miles from Sevierville. (§ 448.) Some of the slates included, may, however) belong to superior formations, as, for instance, to the *Graptolite Shale.* Further investigations are required to settle the question. For the present, the change in the character of the slates, together with the fact that, along this line of division, following the strike of the rocks, two or three miles to the northeast, (E. N. E.,) a band of characteristic coarse conglomerate occurs, justifies the arrangement adopted.

453. At a point on the Big East Fork of Little Pigeon, from seven to eight miles from Sevierville, the line of division, as adopted, between the Graptolite shale and the Ocoee slate, crosses this stream. East of this line is the band of conglomerate spoken of. The conglomerate is half a mile, or more, wide, includes two or three narrow belts of slate, and forms a sharp, conspicuous ridge. Beyond this ridge, to the east, are found the same talcose slates that occur in the line of section on the West Fork.

454. Below the ridge, on the west, is slate, or shale, for one mile, some of it certainly Graptolite Shale; then comes the Trenton, with *Leptæna sericea,* and other fossils, and then the Knox. This corresponds to the parallel part of the West Fork section.

455. It will be observed that the West Fork section of the Ocoee rocks, interpolating the conglomerate ridge of the Big East Fork, is like the Tellico section, in having a wide belt of slates between the two ranges of mixed rocks, conglomerates as well as slates, the greater range on the southeast, and the less on the northwest. The same feature, though not so well marked, is seen on the Ocoee River.

The Little Tennessee section differs in presenting bands of limestone and dolomite.

456. (*e.*) Advancing northeastward, *to the waters of the Big Pigeon,* in Cocke County, we find the conglomerates and slates of the Ocoee Group, in great part, giving way to the strata of superior formation. The great belt we have been considering becomes very much narrowed. It widens) to some extent, in the valley of the French Broad, but north of this, its strata are reduced to comparatively narrow, and more or less detached

strips. As a consequence of this, the northeasterly counties along the North Carolina border have not great areas of mountain country, like Sevier, Monroe and Polk.

457. (*f*) *Newport,* the county seat of Cocke, is located immediately on the junction of the *Nash Graptolite Shale* and the *Trenton.* The latter rocks form here a comparatively narrow band. *Passing these, and traveling up the French Broad River,* a great section of Knox limestones and dolomites is seen. These Knox rocks extend up the river to a point about six miles (five direct) from Newport. The prevailing color is blue, though many layers are gray. In this section are several minor flexures and faults. (See section on the map.)

458. Succeeding these, we next cross a belt of Knox red shales, more or less calcareous, the belt being narrow on the road, but reaching one fourth of a mile in width, at a point not far off to the northeast.

459. Following the shales is a fine display of Chilhowee sandstones, which are the rocks for about one-fourth of a mile, or more. The first part of the mass is gray quartzose sandstone, some of it with green grains; the second part whitish and quartzose. Some of the layers contain *Scolithus linearis.*

460. Passing the sandstones, we meet with the Ocoee Group, and for eight miles (seven direct) travel upon it. The Group, here, is mostly shale or slate, the bands of conglomerate occurring at intervals. At one point a few layers of dolomite are seen.

The first shales met with, are more or less sandy, and have not so much the usual metamorphic aspect. The country, too, is comparatively open. The shales of the eastern part of the belt, however, present the semi-metamorphic appearance, are greenish talcose, and weather, at some points, to a chestnut brown. With the conglomerates they form a mountainous region.

461. After the Ocoee, the Chilhowee sandstones re-appear and continue, for several miles, up the river to the State line at the "Painted Rock." Just below Painted Rock, the river makes a short horse-shoe bend as it passes in a deep gorge through the sandstones. On the north side, the strata are nearly horizontal, and are piled up in a magnificent section, exposing a thousand feet of rocks. (§ 63.)

462. In North Carolina, a short distance beyond the line, the Ocoee Group sets in again, and is the formation to within a mile of the Warm Springs. Then follows a Knox belt. The Springs are located on Knox dolomite, and the belt to which it

belongs runs westward into Tennessee, terminating just within the line. Beyond the Springs follow Chilhowee sandstones, then Ocoee rocks, and finally, gneiss.

463. The *Valley of Paint Creek,* a stream which empties into the French Broad at Painted Rock, is within Tennessee, and lies between two Chilhowee sandstone ranges, Paint Mountain on the northwest, and the line range on the east. (§ 63.) The rocks of this mountain-valley belong to the Ocoee Group, and are talcose slates, with dark clay, or roofing slates, and a few bands of conglomerate.

464. (*g*) The *Big Butt,* so conspicuous from Greeneville, (§ 62,) is, as to its principal range, made up of the conglomerates and slates of the Ocoee Group. The latter are pale greenish, mostly, but include some purple slates. Much of the conglomerate is coarse; pebbles, as large as pigeon's eggs, are abundant, but they are often larger. The general appearance of these rocks recall portions of the Ocoee River section.

465. Along the northwestern base of the mountain, and terminating its spurs in a line of knobs, is a belt of Chilhowee sandstones. The belt is not massive enough to have formed an independent mountain.

466. It may be remarked here, that several strata of hard reddish ferruginous sandstone were observed on one of the spurs. At one point, on one of these strata, iron ore has been obtained, the ore resulting, doubtless, from the weathering of the red rock.

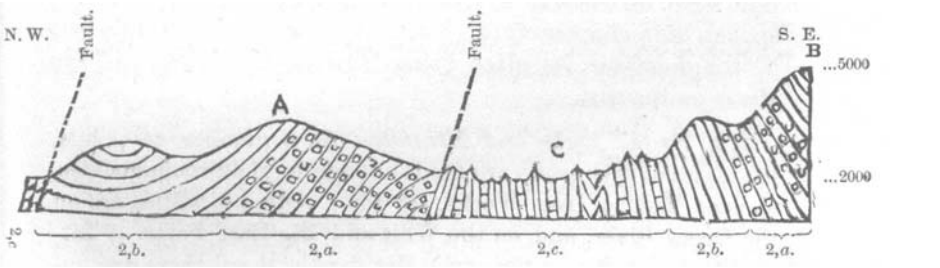
466½. (*h*) The diagram given further on, (§ 490,) represents, in a general way, the arrangement of the rocks about *Bumpass and Greasy Coves, in Washington County.* In this section, the outcrop of the Ocoee Group, (II.,) presents no large areas like those it gives in Sevier and the other southern Unaka Counties.

Between II. and IV., on the left of the section, which numbers correspond respectively to 2,*a* and 2,*c* of the classification adopted, is a great fault, presenting another instance of the kind of displacement occurring along the western bases of most of the Chilhowee Sandstone Mountains. (§ 446.)

467. From this region, towards the Virginia line, strips of Ocoee rocks are found, as before mentioned, (§ 432,) but the group in general, in this part of the State, is, by no means so important, topographically, as a mountain-maker, or otherwise, as the Chilhowee sandstones, or as the gneissoid rocks.

468. (*i.*) Approaching the Virginia line, however, the group shows itself in considerable masses, and forms, in part, the great ridge between Tennessee and North Carolina. This ridge is the northern part of the Stone Mountain range, (§§ 47 and 48,) the more southern part of which is wholly metamorphic.

468½. In the First Part of this Report, I have spoken of the *Johnson County Cove*, (§ 125,) in which name I proposed to include all the valley-lands of Johnson. These lands lie together, in a long trough, and are completely surrounded by great mountains. The route out of this trough, or cove, to the northwest, into Virginia, is through a gorge in Iron Mountain, (§ 49,) the same through which the South Fork of Laurel runs. In this gorge, a fine section of rocks is exhibited. I have constructed a section running through this gorge, and extending, in a southeasterly course, across the upper end of the Johnson Cove, to the North Carolina line. The gorge lies both in Virginia and Tennessee, so that the northwest end of the section is in Virginia.



468¾. The length of this section is eight miles, and its vertical scale is 5000 feet to the inch. A, is Iron Mountain; B, the Stone Mountain Range, on the North Carolina line, the point being 5000 feet above the sea; C, is the Cove between, commencing at the left end of the section. The first formation is Knox dolomite, dipping as represented; then comes a great mass of Chilhowee sandstones, nearly horizontal, and separated from the Knox by a fault; next follows a great volume of conglomerate. The conglomerate is cut off by a fault, and is then followed by Knox strata—hard, red shales, with dolomite, but mostly the former—which occupy the cove.

469. Crossing these, we reach the foot of the mountain, and, in ascending, pass over a heavy belt of Chilhowee sandstones, and then two massive

belts of conglomerate, separated by a narrow belt of pale greenish talcose slates; after the conglomerate, slates come in again, and continue to the summit.

Many of the slates mentioned, contain small knots of quartz. Those on the summit run so gradually into the truly metamorphic rocks, that it is not easy to draw the line of separation. (§ 385.)

470. The belt of conglomerate in Iron Mountain, at A, is, together with the sandstones, grandly exposed in the gorge of the mountain. According to my measurement, the *direct* thickness of the conglomerate alone, at this point, is 6600 feet. As to whether this is the true thickness, we cannot be certain, though in this case, I believe, it is a near approximation. In a region like this, are minor faults and displacements, which render measurements uncertain.

This conglomerate is often coarse; the pebbles are quartz, feldspar, and slate, but mainly quartz. They are held in a siliceous and talcose matrix. The rock, when freshly broken, has often a pale greenish color. This belt contains no slate.

471. Near its western side, the belt holds two trap dikes.

No truly metamorphic rocks were observed. The metamorphic strip, on the side of Iron Mountain, opposite Taylorsville, spoken of in chapter sixth, (§ 398,) appears to go with this belt of conglomerate, its place being between the latter and the Knox on the east.

472. *Useful Rocks and Minerals.*—At a number of points, the slates of this group are fissile enough to yield roofing-slates, as near Tellico Iron Works. (§ 436.) Other localities are on the Ocoee River, and on the West and Big East Forks of Little Pigeon, in Sevier County. But, beside these, there are numerous localities within the areas occupied by the Ocoee Group, where the strata present the features of roofing-slates, and are well worthy of a trial. To be good for this purpose, they must contain no pyrites; must split easily, with smooth surfaces, into thin plates; must not readily absorb water, and ought to be firm and tough.

473. Those slates which contain pyrites—a mineral composed of iron and sulphur, and often decomposing easily—can be used for making alum, sulphur, sulphuric acid, copperas, and, when magnesia is present, epsom salts. A noted instance of the

natural formation of alum and epsom salts is furnished in Alum Cove, in Sevier County, a locality of which I have already spoken. (§ 450.) This is an open place, under a shelving rock—such a place as in this country is often called a *rockhouse*. The slates around and above this contain much pyrites, in fine particles, and even in rough layers. They also contain reniform masses of dark gray sandstone and conglomerate. The salts are formed above, and are brought down by trickling streams of water. There was a wagon load of each of the salts on the floor of the cave, when visited by the writer—the epsom salts being at one end, and the alum at the other. Fine cabinet specimens could be obtained, white and pure, a cubic foot in volume.*

474. Pyritiferous slates of this kind, are frequently met with, and their presence is often indicated by a line of iron ore on the surface. The slates at Mundic Bluff, on the Ocoee, have been mentioned. (§ 425.)

475. It is in this formation that the most important gold-bearing quartz veins of the State are found. Gold can be, and in fact the most of it has been, washed out of the gravel and sand found in the beds of the streams, occurring in the region of the veins; but it originally came from these veins. The quartz has crumbled down with the adjacent rocks, and liberated the gold, which, with the rocky fragments, has been washed into the streams. There are several regions in McMinn, Monroe, and Blount, where gold has been found. In the Third Part of the Report, the facts bearing on the occurrence and yield of gold in Tennessee, will be more fully presented.

476. I have spoken of the conglomerate and breccia limestones found in association with the Ocoee rocks. Such occur on the Little Tennessee River, and in other regions. (§ 440.) These are interesting as supplying frequently a beautiful marble. The fragments making up the rock have different colors,

* This cove, or rather "rockhouse," I visited, in company with Dr. B. C. Jillson, in the summer of 1855. After walking twelve miles, or more, over the rough mountains of this region, our guide led us to the cave, where we remained for the night. Although in August, our elevation was so great that we suffered with cold, and had but little rest. This cave is not easily accessible, a circumstance which accounts for the fact that the alum and "salts" had not been carried off. Since that time, the war has been upon us, and both may have disappeared. They are, however, constantly forming.

and a block, having no hard pebbles or places in it, can be polished, and will then present an agreeable checkered or blotched appearance.

477. *Agricultural Features*.—These are, in the main, much like those of the Metamorphic Group. (pp. 180-81). Like that, the Ocoee Group has its great mountains, on many of which are open woods, and even bald places, suitable for grazing. Other mountains of the group are covered with balsam, spruce, and small evergreens, so thickly set as to form a mass of wild vegetation, almost impenetrable. (§ 82.) From my own observations, I feel safe in saying that the open-wooded, or the grazing mountains, are far more numerous than the others. Such points and ridges, as are covered with balsam and its associates, are very high. The lower ridges are nearly all open and easily accessible, presenting free and desirable "ranges" for cattle, well appreciated by "stock raisers."

478. The high valleys and plateaus of this Group, (§ 435), present many areas which can be, and are, cultivated. The elevation makes such places well adapted to the growth of fruit.

SECTION II.

THE CHILHOWEE SANDSTONE; FORMATION, 2,*b.*

LITHOLOGICAL CHARACTER; FOSSILS; THICKNESS—TOPOGRAPHICAL RELATIONS—SECTIONS; (*a*) LAUREL SECTION; (*b*) IRON MOUNTAIN SECTION; (*c*) ROMPASS AND GREASY COVE SECTION; (*d*) PAINTED ROCK; (*e*) CHILHOWEE MOUNTAIN; (*f*) HIWASSEE GAP—MINERALS AND USEFUL ROCKS—AGRICULTURAL FEATURES.

479. Following the Ocoee Group, in ascending order, is a series of sandstones constituting the *Chilhowee Formation.* I have given this name to these sandstones for the reason that they are finely displayed in the well-known and conspicuous Chilhowee Mountain. (§ 70.) It has been stated that the rocks of this formation are not always easily separated from those of the Ocoee series. (§ 421.) In the main, the distinction is well marked, for the characteristic rocks of one are sandstones, often including whitish quartzose beds, while those of the other are dark, coarse conglomerates, and semi-metamorphic slates.

480. *Lithological Character; Fossils; Thickness*.—The lithological character has been, in part, given. It is a great group

of heavy-bedded sandstones, often dark, but generally weathering to a grayish white, and containing great beds of whitish quartzose sandstone, or quartzite. Interstratified with the heavy-bedded rocks are, at some points, sandy shales, and thin flags, often containing scales of mica. Some of the sandstones are coarse and approach fine conglomerate. It may be mentioned, too, that not unfrequently the strata have green grains (glauconite) disseminated through them.

481. The sandstones of this Group very often show the worm-holes, and the sandy rods within them, belonging to Hall's species *scolithus linearis.* It is the exception not to meet with them. In addition to these, the surfaces of the strata sometimes show impressions of fucoids. No other fossils, that I know of, have been found in this horizon of Tennessee.

482. This formation is by no means as thick as the Ocoee series; yet it has volume enough to form conspicuous mountain ridges. It is not easy to determine its thickness; its maximum is not less, however, than 2,000 feet, and it may be considerably more. The sections to be given will aid us in estimating the thickness.

483. *Topographical Relations.*—The Chilhowee is the third, and the last of the Unaka Formations. As stated, it is the formation of the great outliers. (§ 422). Of the mountains mentioned under "Unaka Chain," (pages 22 to 28,) the following are, for the most part, made of these rocks:

Forge Mountain	§ 28	*Johnson County.*
Iron Mountain	§ 49	*Johnson and Carter.*
Holston Mountain	§ 50	*Johnson, Carter and Sullivan.*
Doe Mountain	§ 51	*Johnson.*
Flint Range	§ 53	*Johnson and Carter.*
Buffalo and Cherokee Mountains	§ 60	*Washington.*
Rich Mountain	§ 60	*Washington.*
Paint Mountain	§ 63	*Greene.*
Meadow Creek Mountain	§ 64	*Greene and Cocke.*
English's Mountain	§ 69	*Cocke and Sevier.*
Chilhowee Mountain	§ 70	*Sevier and Blount.*
Guide Mountain	§ 71	*Monroe.*
Star's Mountain	§ 72	*McMinn and Polk.*

There are a few others, but these are the principal ones. Most of them are remarkable for their isolated positions, and for the

bold and abrupt manner in which they rise up from the valleys or low lands.

484. At the ends of these mountains, the sandstones, which form them, are suddenly and curiously cut off and wholly disappear. The mountains, and their rocks of course, lie generally, immediately on the southeast side of a fault. The sandstones broken in wide blades appear to have been thrust up endwise, to the northwest, through the overlying formations. The displacement is, in some cases, very great. In the case of Chilhowee Mountain, (see section, page 190,) the sandstones, or rather Ocoee conglomerates, have been brought up and abutted against *carboniferous limestone.*

485. The mountains of the formation have elevations varying from less than 1,000 to 2,000 feet above their bases. They have but very few or no great spurs. These, when they exist, are short.

486. *Sections.*— (*a*) I will first notice the Chilhowee sandstones of the Laurel or Johnson Cove; section already given on page 190. Here is a great presentation of these sandstones. The direct thickness cannot be much, if any less, than 2000 feet. This estimate is based upon a partial measurement.

The strata are mostly heavy-bedded gray sandstones, often quartzose. The uppermost beds are sandy shales.

487. It will be observed that these rocks form on the left of the section, a shallow depression. We have in this depression the commencement, or apex, of a great V-shaped synclinal valley, or trough, that extends, widening as it goes, to the southwest and nearly to the Watauga River. It is a trough of Chilhowee sandstones, the northwestern edge of which is Holston Mountain, and the southeastern, Iron Mountain. (See Map.) It is one of the best marked synclinals in East Tennessee. The sandstones of its two edges are thrown up within the lines respectively, of two great faults, one at the northwestern base of the Holston, the other at the southeastern base of Iron Mountain. In the Holston the rocks dip to the southeast, in Iron Mountain to the northwest.

488. This trough of Chilhowee sandstones holds within it the hard variegated shales, and the dolomites of the overlying

Knox Group. High in its angle is the basin called Shady; its lower, wider portion is the Stony Creek Valley.

The elevation of the edges of the sandstone is sufficiently great to bring up more or less of the conglomerate, especially on the southeastern side.

489. (*b*) The Iron Mountain just spoken of, is intersected in Carter County by Doe River. In the Gap is a good section of the Chilhowee strata.

Below I give the section and the results of measurement made by myself. The thickness in each case, is direct. The strata dip to the northwest in angles varying from 36° to 55°. The series commences at the fault on the southeastern side of the mountain, and advances to the northwest, or, in other words, it is given in ascending order. The rocks on the southeastern side of the fault, are Knox Shales.

Sandstones with fine conglomerate; some of the sandstones hard and quartzose	472 feet.
Heavy gray quartzose rock mostly	60 "
Sandstones with conglomerate, dark and even bedded	44 "
Heavy gray quartzose sandstone, with unimportant layers of fine conglomerate	60 "
Sandstones not well seen	180 "
Heavy bedded quartzose sandstones	38 "
Sandstones and fine conglomerate with two quartzose bands	275 "
Thin sandstones and sandy shales	320 "
Quartzose sandstone	40 "
Thick and thin bedded sandstones, generally dark colored, occasionally sandy shales, but little fine conglomerate	1,720 "
Quartzose sandstone	40 "
Sandstones and sandy shales	370 "
Quartzose sandstones	35 "
Sandstones and sandy shales	250 "
Quartzose sandstones	10 "
Sandstones and shales as above	70 "
Quartzose sandstone	55 "
	4,039 feet.

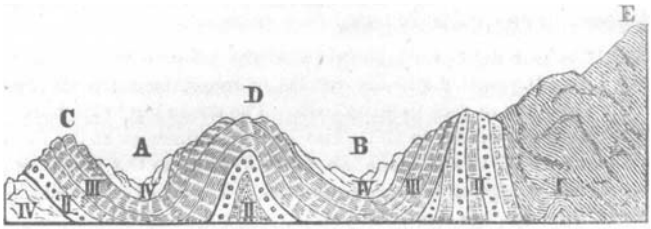
The last bed above is followed by Knox Shales, which continue on to Elizabethton and beyond. The conglomerate given in the section, is simply coarse sandstone. It is probable that the great aggregate thickness of the strata is due in part to recurrence by faulting and displacement.

490. (*c*) The following is a general section through Bompass and Greasy Cove, in Washington County. It is not intended

to be accurate in detail. It presents the general arrangement of the formations along a line running, in a northwesterly and southeasterly course, near the intersection of the Buffalo and Rich Mountain Range, by the Nolichucky River. (§ 60.)

SECTION ACROSS BOMPASS AND GREASY COVE, IN WASHINGTON.

(*Length eight miles.*)



A, Bompass Cove. B, Greasy Cove. D, Rich Mountain. E, Summit of the main Mountain and the North Carolina Line.

I. Metamorphic; II. Ocoee Conglomerates and Slates; III. Chilhowee Sandstones; IV. Knox Shales, Dolomites and Limestone.

Between II. and IV, on the left, is a fault. On the northwest side of this, are Knox Dolomites and Limestones.

The Chilhowee rocks of this section are dark sandstones and sandy shales, with lighter bands of quartzose sandstones. Two or three of the latter are conspicuous in the vicinity of the Iron works at the northwestern end of the section. Some of the shales are fine, and have a semi-metamorphic appearance.

491. (*d*) A grand section of the rocks under review, are seen on the French Broad River at and below the "Painted Rock." In the great amphitheater that the river and the cliffs form here, not less than a thousand feet of sandstones are seen. (§§ 63 and 461.) They are heavy bedded layers, hard and quartzose often containing *scolithus,* and are interstratified with thin sandy flags and shales. In a portion of the section the rocks are nearly horizontal. Many of the sandstones are dark colored; some contain green points. The shales show scales of mica. On the top of Paint Mountain the weathered strata might be taken for the sandstones and sandy shales of the Coal Measures. On many of the mountains, in fact, enumerated on page 199, the rocks have such an aspect.

492. (*e*) The section on page 190 crosses Chilhowee Mountain,

which is represented at one point in the diagram. The sandstones, as well as the Ocoee conglomerates, are seen to be the rocks of the mountain. The sandstones have the same features here that they have in the mountains further north.

493. (*f*) Star's Mountain is cut in two by the Hiwassee River; in the gap thus formed is a fine exhibition of Chilhowee sandstones. The strata are nearly horizontal and show great thickness. They include some fine conglomerate.

494. It is not necessary to give more examples. The truth is, the lithological features of this formation are much the same in all of its presentations, from Virginia to Georgia.

495. *Minerals and Useful Rocks*.—I have not met with any minerals of special interest in this formation.

It abounds in excellent building material. Many of its sandstones are in smooth layers of suitable thickness, and could be quarried easily. The hard quartzose rocks are not desirable for such purposes, but they are interstratified with beds having a more open sandy texture, which can be worked. Even the harder rocks, when partially weathered, become often pretty good freestone. At some points, good flags might be obtained.

496. *Agricultural Features*.—This formation is confined to mountain ridges, and the areas suitable for cultivation it presents, are very limited. On the tops of some of its mountains are small areas which can be cultivated. The soil of these is frequently quite strong, and makes good garden spots. But it is as pasture ground mainly that these Chilhowee Mountains have any special agricultural interest; and, in this respect, they are much like the other Unaka ridges, of which I have spoken. They have none of the characteristic bald places of the latter. (§§ 416 and 477.)

SECTION III.

THE KNOX, OR KNOXVILLE GROUP; FORMATION, 2,*c*.

THE KNOXVILLE AND WEBB'S RIDGE SECTION, PRELIMINARY ; SUBDIVISIONS; GEOGRAPHICAL DISTRIBUTION, BELTS AND FAULTS; SYNCLINALS AND ANTICLINALS.

2c′. KNOX SANDSTONE; LITHOLOGICAL CHARACTER; TOPOGRAPHY; MINERALS.

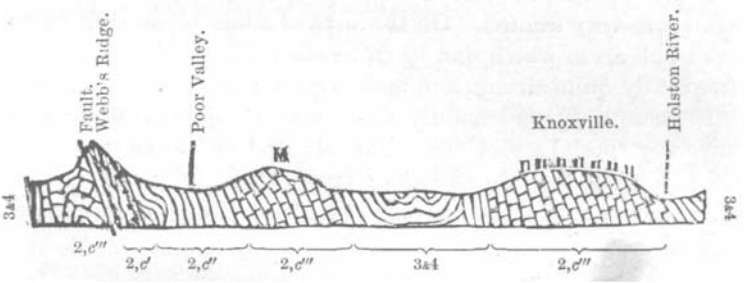
2c″. KNOX SHALE; LITHOLOGICAL CHARACTER; PALEONTOLOGY; VALLEYS; AGRICULTURAL FEATURES.

2c‴. KNOX DOLOMITE; LITHOLOGICAL CHARACTER; PALEONTOLOGY; TOPOGRAPHY; USEFUL ROCKS AND MINERALS; AGRICULTURAL FEATURES.

497. This great series of sandstones and shales, dolomites and limestones, forms, by its outcrops; the greater part of the surface of the East Tennessee Valley. With the exception of a single spot in Stewart County, (§ 364,) its strata are confined to East Tennessee.

The city of Knoxville is located on a ridge made up of its limestones and dolomites; and this circumstance, together with the fact that the threefold typical character of the series is well developed in Knox County, has induced me to name it the *Knoxville,* or the *Knox Group.*

498. *The Knoxville and Webb's Ridge Section; Preliminary.*— Before entering fully into the consideration of the Group, let ns first notice the following section. This section commences at Webb's (or Rosebury's) Ridge, nearly three miles northwest from Knoxville, and extends to the Holston River. It is about three miles in length, and was taken along Second Creek. In this are seen the three subdivisions of the Group.



499. Commencing at the fault on the left and proceeding towards Knoxville, we have first, in Webb's Ridge, a series of hard, brown, greenish and gray shales, and thin sandstones, interstratified with which are several layers of hard, dark gray sandstone, the whole being 540 feet thick. The hard strata have given origin to the ridge.

500. This series is followed, in Poor Valley, by soft variegated shales. These were, originally, more calcareous than now.

They include, occasionally, thin bands of limestone, which is often oolitic and sometimes fossiliferous. Owing to local folds and displacements, it is next to impossible to ascertain the true thickness of these shales. As an approximation 1,500 feet may be taken; it may be much more. It will be observed that the soft shales lie in a depression between ridges. They have yielded to denuding agencies more readily than the rocks of the ridges, and hence the valley.

501. Next follows a very heavy series of dolomites and limestones. These strata are in the ridge M, and occur, in ascending order, as below:

(*a*) Limestone and Dolomite, mostly blue, but some of the upper strata dark gray and sparry; the blue is partly compact and partly oolitic; the lower part is interstratified with shale, thus running into the shale division below; fossiliferous; entire thickness	650 feet.
(*b*) Dolomite, mostly dark gray and sparry, heavy bedded; contains more or less chert throughout, some of which approaches sandstone; upper part includes gray dolomite; thickness	1,870 "
(*c*) Chert	4 "
(*d*) Dolomite and Limestone, mostly light gray sparry dolomite, with more or less chert throughout; upper part interstratified with blue layers which are fossiliferous; thickness	980 "
Entire thickness	3,504 feet.

502. These rocks make up the ridge M, and are followed on the east by the Trenton series. The ridge owes its existence, in good part, to the chert contained in the dolomites and limestones. This chert in a clear section, such as is seen along the stream in the gap of the ridge, makes but little show comparatively. On the top and sides of the ridge, however, it is very abundant; the surface is covered with its loose angular fragments, so much so as to suggest the name, Flint Ridge.

The Knoxville Ridge is composed of the dolomites that we find in M. Between these ridges the rocks belong to the Trenton and Nashville formations, and will be spoken of in another place.

503. The part of the section between the fault on the left and the eastern, or southeastern, base of the ridge M, is to be taken as typical of the Knox Group. It is seen that the group in the section has a threefold character; its lower division is

characterized by the presence of hard shales and sandstones; its second division by softer shales; and its uppermost, and greatest, by massive dolomites and limestones, containing more or less chert.

504. *Subdivisions*.—In accordance with this, the Group, in general, has been divided, in ascending order, as follows:

2,c′. Knox Sandstone.
2,c″. Knox Shale, and
2,c‴. Knox Dolomite.

505.Each of the above divisions has its especial topography. The first builds up sharp roof-like, or when notched, saw-like ridges. In the typical section Webb's Ridge is one of the roof-like class. The second division is valley-making, and the third gives us a broad, rounded, and generally cherty ridge, like M, and the Knoxville Ridge in the section. These characteristic ridges exist only where the strata dip at a considerable angle. (Compare §§ 103, 104, and on.)

506. The threefold character of the Group is well marked west and south of Knoxville, both as to rocks and topography. In the northeastern part of the Valley, however, as in Sullivan, Greene, Washington, Johnson and Carter, it is not so prominent; the shales of the lower divisions become more calcareous, and often include beds of dolomite and limestone; the topography, too, is different. (See §§ 108 and 109.)

507. The two lower divisions, when exposed in any part of the Valley, show, occasionally, beds of dolomite and limestone, one of the circumstances uniting the three divisions; but in Sullivan, Greene, etc., the rocks mentioned, become more abundant, comparatively, and more mixed with shale. We may, indeed, say that the *Knox Group,* in the northeastern part of the State, is a great series of calcareous rocks, (limestones and dolomites,) the upper part free from shaly admixture; the rocks of the middle and lower parts frequently interstratified with bands of shale, and often striped with thin seams of it; while, at the bottom, the shales predominate, are harder, and sometimes hold sandstones which are variegated, and occasionally jaspery.

508. *Geographical Distribution; Belts and Faults*.—It is not necessary to enumerate here the areas in which the Knox strata outcrop. The map has been prepared for the purpose of showing them, and reference must be made to it. Attention

is called, however, to the occurrence of the Group in long belts or ribbons. There is a most remarkable set of these west of Knoxville. Some of the ribbons run entirely across the State, and, indeed, beyond its limits, in both directions, carrying with them the characteristic ridges and valleys of the Group. (Compare §§ 93, 94 and 108.) The diagram on page 190, presents sections of these ribbons. The spaces between the consecutive faults, as represented in this diagram, are mostly filled up with Knox strata—the northwest and middle portions of each being occupied by them. The southeast sides are usually Trenton and Nashville strata, though sometimes embracing the Niagara, Black Shale and the Siliceous.

509. The ribbons are bounded by the faults. They are long belts of strata, having a northeastern and southwestern trend, that have been split off, tilted and crowded together, the edge of one overlapping the adjacent edge of the other, like slates on a roof. (See also §§ 344 and 359.)

510. A *typical* general section of one of these ribbons, commencing at the fault on the northwest, and ending with that on the southeast, is as follows;

(*a*) Following the fault is a sharp ridge, holding the hard layers of the subdivision, the *Knox Sandstone*. The plane of the fault is often included in the ridge as stated below.

(*b*) Next a Knox Shale valley.

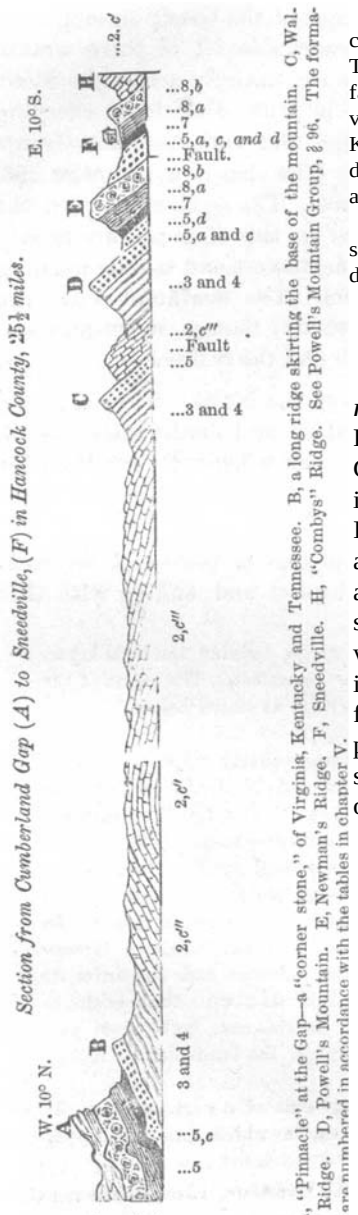
(*c*) Then follows a wide Knox Dolomite cherty ridge.

(*e*) A wide blue limestone (Trenton and Nashville) valley. As we pass into this valley from the chert ridge, the strata are seen to dip at a less angle than further back.

(*f*) Here follows, in many cases, the second fault, cutting off the formations. If such is not the case, the Dyestone Group (Niagara) may come in and terminate the series, or this may be followed by the Black Shale and the Siliceous Group. When this latter formation, the Siliceous, ends the series, its hard chert rocks are brought in contact with the sandstones of the lowest Knox division; in this case both chert and sandstone make the crested ridge, the fault-plane cutting the ridge longitudinally.

The second fault occasionally cuts off a part, or all, of the Trenton and Nashville strata, in which case, the upper Knox terminates the series.

511. The formations just mentioned, the Dyestone, Black Shale and Siliceous Group, are not usually heavy, and are often found with the Knox Sandstone in, or near, the same sharp ridge.



A, "Pinnacle" at the Gap—a "corner stone," of Virginia, Kentucky and Tennessee. B, a long ridge skirting the base of the mountain. C, Wallin's Ridge. D, Powell's Mountain. E, Newman's Ridge. F, Sneedville. H, "Conbys" Ridge. See Powell's Mountain Group, § 96. The formations are numbered in accordance with the tables in chapter V.

512. The section here given, may be compared with the diagram on page 204. The correspondence is seen at once, as far as the two ridges and the intervening valley on the left are concerned. The Knoxville fault is a local one, and soon disappears, the valley between Knoxville and M being a synclinal one.

The typical section is illustrated, also, several times in succession, in the diagram on page 190.

513. *Synclinals and Anticlinals.*—In the region of Powell's River, and lying in the counties of Claiborne, Union, and Campbell, is a broad belt of the Knox Group. It is a well-defined, gently curving arch, or anticlinal, the axis having a northeasterly trend. The annexed section illustrates its features, as well as the relations the Group itself sustains to the other formations. The elevation at some points along Powell's River, is sufficient to bring up the top part of the shale member.

514. Most of the valleys of East Tennessee lie in the outcrops of imbricated formations, like Poor Valley, in the section on page 190, or like the valleys between the mountains C D and D E, in this section. The ridges, too, have a corresponding relation to the strata. This results from the fact that, faulting and imbrication are the rule. (§ 359.) It follows that true synclinal or anticlinal valleys and ridges, are not ordinarily to be looked for.

515. A second important anticlinal exhibiting Knox strata, is that of the Sequatchee Trough. (See Map, and the section on page 139.) An interesting synclinal, holding the rocks of the Group, has been noticed on page 200.

2,*c'*. KNOX SANDSTONE.

516. *Lithological Character*.—The general features of this division have been given. Its principal rocks are hard shales, and thin sandstones, heavier sandstones being interstratified with these. The heavier sandstones are fine or coarse grained, sometimes quartzose. They occasionally abound in green grains. Eastward and southward the heavier beds cease to be conspicuous.

In the section of Webb's Ridge. (§ 499,) the hard, dark, gray sandstone referred to, occurs six times in beds from three to ten feet thick, and weathers into a buff, softer material. In general, the included layers vary much in appearance. As before stated, (§ 507,) beds of dolomite are met with in the division.

The thickness of these rocks cannot be much less than 800 or 1000 feet. In Webb's Ridge, where they are in less force than at many other points, the thickness is 540 feet.

517. The strata are often ripple-marked, and sometimes covered with fucoidal impressions and ridges. Aside from fucoids, I have not met with any fossils in these rocks.

518. In the northeastern counties, Johnson, Carter, Washington, etc., the division becomes more calcareous. (§ 507.)

In these, and in the other mountain counties further south, we sometimes meet with layers of jaspery rock in this horizon, especially when in the vicinity of a Chilhowee sandstone mountain. I have seen beautiful specimens of jasper and chalcedony in these beds.

519. It may be mentioned as a prominent feature of this division and of the Knox Shale overlying it, that they present shales and sandstones of many different colors. The rocks are pale green, brown, and red, chestnut-colored, buff, gray and other colors. Brownish red, greenish and buff, are, perhaps, the prevailing tints. The colors are often bright, and notably agreeable.

520. *Topography*.—The sharp-crested ridge, as stated, is the

characteristic topographical feature of the Knox sandstone when its layers are tilted. (§§ 505 and 510.) *Webb's Ridge* has been spoken of. Other examples are *Beaver, Bull Run,* and *Pine Ridges,* crossed successively in going from Knoxville to Clinton; *Piny,* between Clinton and Walden's Ridge; another is *Comby,* in Hancock and Grainger; another in Grainger skirts the eastern base of Clinch Mountain, the northern extension, in reality, of Webb's Ridge, (§ 530;) the ridge immediately west of Rogersville is an example; of this class, too, is the so called *Bays Mountain,** forming the southeastern boundary of Knox County. These are a few among the most prominent.

The location of most of these ridges is indicated upon the Map. Their normal places in the great rocky ribbons split off by the faults, have been given. (§ 510.) They are not known by the same name throughout. The same local name is applied in some cases, to parts of very different ranges. *Pine,* or *Piny,* is very commonly given to them for the reason that they are often covered with pines.

The ridges are not high, their elevation rarely exceeding 400 feet, and being generally under this.

521. *Minerals.*—Many of the iron-ore (limonite) deposits of the eastern mountain counties rest upon the rocks of this and the succeeding Knox divisions. Of these deposits I will speak hereafter.

In Carter County, seven miles above Elizabethton, on the west side of Stony Creek, is a layer of massive hematite, from one to two feet in thickness. The locality is known as the Cannon bank. The iron-ore is regularly stratified, rests on a thin bed of conglomerate holding small pebbles, and has sandy shales above. The group of rocks appears to belong to the lower part of the division under consideration. It may, however, belong to the upper part of the Chilhowee Formation.

The occurrence of jasper and chalcedony in this division, has already been mentioned. (§ 518.)

2,*c*″. KNOX SHALE.

522; This, the second division of the Knox Group, is the formation of numerous subordinate valleys in the great Val-

*This ridge has no connection with the Bays Mountain between Greene and Hawkins.
(See note p. 43).

ley of East Tennessee. It is eminently the valley-making portion of the group, especially in the north-western, western, and southern portions of this section of the State. It is a formation of great interest in an agricultural way. In connection with the blue limestones of the lower part of the overlying division, it promises an interesting paleontological field.

The general topographical and structural relations of the division have been given, and it will not be necessary to dwell upon them here. (§§ 503 to 512.)

523. *Lithological Character; Thickness.*—Variegated shales are the characteristic rocks of this division.* (§ 519.) Interstratified with these, at intervals, are thin layers of blue limestone, which is often oolitic. These rocks yield the finest specimens of oolitic limestone to be found in the State; the spherules are often as large as the o's on this page, and sometimes larger. The calcareous bands in the lower part of the division are not numerous; toward the top, they generally become more abundant, increasing as we ascend, until finally the shales disappear, and the blue oolitic limestone and dolomites are the only rocks. In this way, the shale division runs into the uppermost one.

524. In the northeastern part of the State the shales, as a division, are not well characterized. As already stated, (§ 507,) they are much mixed with beds of limestone and dolomites, and lose, in good part, their distinctive features. Moreover, in this region there is little oolite rock. A portion of the shale appears to be replaced by a blue limestone containing thin clayey seams, which give the surface, especially when weathered, a striped appearance.† This striped rock, occurs, too, further south, its place being at the top of the shale.

The thickness of the Knox Shale is not easily determined. What is said in reference to the thickness of the strata in Poor Valley, on page 204, applies generally. We may place it as an approximation at 1500 or 2000 feet.

525. *Paleontology.*—At many points the blue limestones, interpolated in the shales of this division, contain fossils, some-

*These, in many valleys, were, perhaps, much more calcareous than they are now, They present the appearance, more or less, of leached material.

†This, in my notes, is designated "Blue banded limestone." Some of it is, doubt less, dolomite.

times abundantly. They occur both in compact and oolitic layers. Toward the top of the division, and in the blue rocks of the succeeding division, they are seen at many points. The shales themselves, are occasionally fossiliferous. (See, also, § 558.) The forms are certainly of an ancient type. Those given on this page recall Dr. Owen's species of the *"Lower Sandstone of the Upper Mississippi."* In fact, one of them may be identical with his *Lonchocephalus Chippewaensis.**

526. The opportunity has not been presented of working out satisfactorily, the fossils of this geological horizon. The following have been described. See Appendix A.

(1.) *Crepicephalus similis;* Safford.
(2.) " *Roanensis;* "
(3.) " *Tennesseensis;* "
(4.) *Lonchocephalus fecundus;* Safford.
(5.) *Agnostus arcanus;* "
(6.) *Lingula prima?* Conrad.

Nos. 1, 2, 4 and 5, occur in a Knox Shale Valley, four and a half miles east of Kingston, on the road to Knoxville. The rock is a thin band of trilobitic limestone, almost, wholly made up of fragments of *Lonchocephalus fecundus.* The others, Nos. 3 & 6, were found in a belt of shale, at a point about a mile and a quarter north of Rogersville. The generic names are after Owen, and are used provisionally·†

It might be mentioned here, that my *O. similis* is much like Mr. Billings' *Bathyurus Cordai,* of the Quebec Group. *(Paleozoic Fossils,* Vol. I., p. 412.) The difference, according to this distinguished paleontologist, who has seen my specimen and has compared it with his, is in the marginal rim of the front of the head, that of his, being more convex on top.

527. *Valleys; Agricultural Features.*—In the section between Knoxville and Clinton, the Knox Shale gives the following valleys, namely, *Poor Valley,* already mentioned; (§ 500;) *Hinds' Valley,* lying west of Black Oak Ridge; *Bull Run Valley,* west of Copper Ridge; and *Wolf Valley,* west of Chestnut Ridge. Between Clinton and Walden's Ridge, is still another.

Some of these, are sections of long valley-ranges, which reach from Virginia to Georgia. (§§ 119 and 508.) That, for

* Geological Survey of Wisconsin, Iowa and Minnesota, page.576, Tab. I and I, A.

† The description of these Species were written in 1860, and have not been revised.

example, of which the Bull Run Valley is a portion, extends, on the one hand, into Virginia, and, on the other, into Georgia. In the southern part of the State, the valleys of Roger's and Candy's Creeks, tributaries of the Hiwassee, are sections of this range. So, also, is most of the valley of Big War Creek, to the northeast, towards Virginia. And still further north, Powell's River runs for a number of miles in it.

528. The range, of which Hinds' Valley is a section, is, also, a long one. Its northern end, is not far from the southern extremity of Clinch Mountain, and its southern is in Georgia. South Mouse Creek, in Bradley County, is in this range.

529. All of the valleys west of Cleveland, to within less than a mile of White Oak Mountain, are Knox Shale Valleys, and this group extends far into Georgia. The shale valley, (Dogwood Valley,) in which Tunnel Hill Depot is situated, belongs here.

About half way between White Oak Mountain and Missionary Ridge, is another wide range. This becomes narrow northward. Kingston is partly located upon it.

530. Midway between Charleston and Benton, a wide belt of the shales is crossed. The two Chestua Creeks are in this belt. Madisonville is located in it. The valley of Dumpling Creek in Sevier and Jefferson Counties, is about its northern termination.

Poor Valley, of the section on page 204, extends, or rather, its range extends, many miles northeastward. It lies on the southeast side of House and Clinch Mountains, from which it is separated by a very narrow valley and a ridge, the latter being the continuation of Webb's Ridge, of the same section. The range in front of Clinch Mountain, becomes a fine rich valley, that of Richland Creek. The town of Rutledge, and Bean's Station are in it.

Rogersville is in one of the Knox Shale valleys. Northward, the range divides into three valleys, Carter's and Stanley valleys being two of them. The range widens out above Rogersville, and is divided by the interpolation of Knox Dolomite ridges. The valleys show more or less limestone with the shales, and are desirable and rich. (See also, § 549.)

531. The agricultural features of the Knox Shale valleys, are, as may be inferred from what has been said, quite varied. Generally, when wide, and not too rough, they present choice farming areas. Some of the most desirable and best improved farming regions, are in the valley-ranges pertaining to this division. The layers of limestone, interstratificd with thc shales, as well as the calcareous matter often found in the shales themselves, contribute much to the strength and favorable condition of the soil. The native growth is mainly made up of different species of oak, with which are often found poplar, dogwood, occasionally walnut, &c. In some regions, yellow pine is not uncommon.

532. Some of the valleys fall below the character given. Several, indeed, have the name "Poor Valley" fixed upon them, as that through which the section in § 498 runs. These valleys are generally narrow, and owe their bad name to local causes.

They are hilly, or contain shale ridges, with but little soil upon them; or else, the soil is thin, with the shales beneath, thoroughly leached and deprived of their calcareous matter. These valleys, however, have portions which come up to the standard, and present the sites of excellent farms. The Richland Creek portion of the Poor Valley range illustrates this.

533. In the northeastern part of East Tennessee, in the counties of Cocke, Greene, Jefferson, Hawkins, Washington, Sullivan, Carter, and Johnson, where the subdivisions of the *Knox Group* are not so well marked, (§ 506,) are many valleys, the rocks of which are alternating bands of dolomite, or limestone and shale. These are, generally, good agricultural belts, and have been in cultivation many years.

534. The soils of the Knox Shales are clayey, but mellowed, more or less, by the debris of thin sandy layers, and by calcareous matter. They are well adapted to the cultivation of small grain, and to the making of meadows.

Some of the iron-ore banks, are, in part, located upon the Knox Shale, but the division has not the interest attached to it, as a mineral-bearer, that belongs to the superior member of the Knox Group.

2, *c'''*. KNOX DOLOMITE.

535. This division is the most massive formation of calcareous strata in Tennessee. In the Eastern Valley, it is very conspicu-

ous, and is the formation of many ridges and valleys. In Middle Tennessee, it does not appear, except, at one remarkable spot, already mentioned. (§ 364.)

536. *Lithological Character; Thickness.*—The section in § 501, presents the general lithological character of this division in the southern part of the East Tennessee Valley, as well as in that portion west of the Holston.

537. The chert in the upper part, is to be noticed, inasmuch as it has supplied the gray, flinty gravel which, so extensively covers the ridges and Knobs of this formation. This chert very generally has minute rhombohedral cavities interspersed through it, a character by which it may be distinguished from similar material in other formations.* The thicker layers are at a number of points, as stated further on, worked into millstones. (See also, §§ 502, 505, and 510, (*c*).) Thin beds of sandstone occur, locally, in the middle and upper parts of this division.

538. Passing to the northeastern part of the valley, we find the gray sparry dolomite less heavy, and the chert less abundant, and the middle and lower portions in good part, made up of blue rocks, with argillaceous seams. The lower part in this region, contains very little oolitic limestone. (See § 507.)

539. In the larger part of the valley, and especially in the portions mentioned in § 536, the upper strata of this division include beds of dull variegated dolomite, which is, at some points, worked as marble, and, in many places, used as a building material. It is a light gray, rather fine-grained rock, variegated with brownish red clouds. At some points, there is between one and two hundred feet of this. Some of it is argillaceous, and weathers to shaly material. Some fossiliferous beds are associated with it. Its upper part runs into Trenton limestones.

* I first observed these cavities many years ago. They present a character which has been of much use. At many points, loose chert is abundant on the surface, when the strata are entirely concealed. Among the dislocations of East Tennessee, it often becomes a question as to whether the rocks belong to the division under consideration, or to the Siliceous Group, the chert of the two being much alike. The presence of the cavities, I have, so far, found characteristic of the Knox chert. They are the empty moulds of crystals of dolomite, once filling them. In rocks freshly quarried, showing chert, the crystals are seen. The chert of the Siliceous Group, is, generally, characterized by the presence of large crinoidal buttons.

540. The gray dolomites of this division often contain fine sand as an impurity. Sometimes, in weathering, especially beneath the soil, they become encrusted with a coat of powdery sand. Weathered surfaces, exposed to the air, often present a hacked appearance, quite different from anything seen on the exposed surfaces of blue limestone.

541. The thickness of this division of the Knox Group, is not far from 4000 feet. It may be less, or more, than this; at any rate this is the nearest approximation I can, at present, make. Taking the aggregate thickness of the first and second divisions at 3000, (§§ 516 and 524,) the entire thickness of the group will be 7000 feet. This, most likely, is a maximum.

542. *Paleontology*.—The lower limestones of this division, are, at some points, quite fossiliferous. Fragments of trilobites are abundant; orthes, and other genera of brachiopods, have been observed. The species, however, have not been worked out. It is an inviting field, and it is to be hoped that its treasures may soon be exhumed. The middle, and larger portion, including the dark and light gray sparry dolomites, rarely show fossils. The uppermost portion, especially the blue layers, contain them, but in general, not abundantly. In this horizon, forms resembling *Pleurotomaria calcifera*, *P. calyx*, and *P. docens*, have been observed at a number of points. The latter, *P. docens*, has been identified.

543. *Topography*.—The Knox Dolomite has been stated to be ridge-making, (§ 505,) and it has been so represented in sections. (§§ 444, 498, &c.) This is eminently so wherever the strata are tilted at a considerable angle, which, by the way, is generally the case.

The following are some of the ridges pertaining to this division, a number of which are remarkable for their length. They are the rounded ridges spoken of in the First Part of this Report, (§ 104,) and are as follows:

(*a*) Intersected in going west from Knoxville:

Black Oak, Copper and Chestnut Ridges; a second *Black Oak* lies west of Clinton.

(*b*) In the eastern part of Claiborne:

Wallin's Ridge.

(*c*) In Sullivan and Greene Counties:

A ridge, running through these counties; in the former, known as *Chestnut Ridge*, and in the latter, as *Big Ridge.*

(*d*) East of Chattanooga:
The war-renowned *Missionary Ridge.*
(*e*) Running through the middle of the East Tennessee Valley:
The *Knoxville and Athens Ridge* $_j$ this, in its southern extension, lies just to the east of Charleston.

There are several of these ridges between Cleveland and Benton. The latter place is located on one of them. Benton, Maryville, and Dandridge, are situated on the same Knox Dolomite range, or ridge. An ill-defined ridge extends from Greeneville to Newport, the former place being on its southeastern side, and the latter on its northwestern. Another, of like character, reaches from Russellville to Virginia, running between Rogersville and the Holston.

Just west of Washington, in Rhea County, is a wide ridge of Knox Dolomites, which runs parallel with the eastern escarpment of the Cumberland Table-land. West of Decatur, is one, which, in its northern extension, lies on the east side of Kingston.

544. These ridges are, more or less, covered with angular gray chert. A number of them are very conspicuous, and well known.

In addition to these, are several important ranges which can hardly be called ridges. One is the belt, forming, for the most part, the wide anti-clinal of Claiborne, Union, and Campbell Counties, a section of which is given in the diagram on page 208. Another is the belt forming the middle part of *Sequatchee Valley.* (§ 349.) In both of these, the Knox dolomites are raised to a considerable elevation, especially in the former; and they would form (as in fact they appear to be, when seen from distant high points) continuous heavy ridges, were it not for the rivers which flow longitudinally through them. Powell's River and its tributaries, cut deeply into the Claiborne and Campbell anti-clinal, dissecting, tortuously and transversely, the would-be ridge. Sequatchee River cuts the range through which it flows, into a belt of knobs.

545. The way these rivers (Powell's and Sequatchee) wind along on the backs of the two anti-clinals, respectively, is curious and noteworthy. The streams have no valleys of consequence. Powell's River flows in a very tortuous course, and is bounded generally, while on the axis of the anticlinal, by rough hills, often four and five hundred feet high, closely hugging the stream, and presenting at nearly all points, either on one side or the other, bold picturesque bluffs. Opposite the bluffs, are small, rich bottoms, or slopes, which, on account of their fertility, are generally in cultivation.

Sequatchee River presents similar features, though not on so large a scale.

Both of the belts mentioned, lie between well-defined blue limestone (Trenton and Nashville) valleys. It is remarkable that the rivers should have cut their beds through the high ridges rather than through one or the other of the valleys.

546. The upper part of the Knox Dolomite, where approximately horizontal and abounding in chert, presents belts of country remarkable for being made up of isolated hills, or "knobs." Such areas are known as *"The Knobs."* One of these belts has been mentioned; (§ 116;) it lies north of' Chattanooga, and reaches northward toward Washington, west of which place it is a tolerably well-defined ridge. (§ 543.) Immediately east of Missionary Ridge and west of Savannah Valley, (the valley skirting the western base of White Oak Mountain,) are ranges of cherty knobs belonging to this formation. Northward, these become ridges.

547. Most of the ridges mentioned, are, as I have said, cherty. On many of them, the chert is mostly confined to the southeast side, the northwest being comparatively free of it, for the reason that the lower blue limestones, oolitic or otherwise, outcrop on this side.* Sometimes, the blue rooks of the northwest slope are separated from the gray strata by a narrow local valley, having the bearing of the ridge. In this case, the range becomes double—one part, more or less, cherty; the other, comparatively, without chert. The latter usually presents rich fertile land. Copper Ridge, in the northern part of the State, is thus, in several regions, divided into two subordinate ranges.

548. The *Richland Knobs,* the range of which lies east of Rutledge, are made up of the blue limestones and dolomites of the lower part of this division. They are rich, and in cultivation. To the east of these, come in the gray cherty rocks.

549. Between two and three miles, northwest of Morristown, commences the range of *Boatman's Ridge.* This is a long and tolerably wide belt, and is the same as the range, already mentioned, lying between Rogersville and the Holston. (§ 543.) On its southeastern side, are the gray, cherty

* It may be stated here, also, that the northwest slope is often steeper than the southeast, the dip of the rocks becoming greater as we approach the Knox Shale valleys. This is true, especially, of Copper Ridge.

dolomites, and on its norlhwestern, blue calcareous rocks, which include, in some parts, as west of Morristown, some of the shales of the Shale Division. West of Boatman's Ridge, on the road from Morristown to Bean's Station, is a narrow Knox Shale valley, which is the southern end of the Rogersville, or Carter Valley, Range. From May's, on the Holston, to Bean's Station, the geological section through Boatman's Ridge, &c., is repeated.

550. The rocks of this division, when horizontal, or nearly so, form plateaus, or valleys, unless, in some way the chert becomes predominant, when "knobby regions," usually are found. (§ 546.)

The wide anti-clinal of Claiborne and Campbell, (§ 544.) may be regarded as a plateau, and the deep bed of Powell's River as a cañon winding through it.

551. There is an interesting plateau of this formation in Jefferson County, between the Holston and the so-called Bay's Mountain, and extending from the vicinity of New Market to Russellville; these towns, and Morristown, being upon it. This area is from 300 to 400 feet above the Holston, and presents some excellent and extensive farming regions. A portion is called the New Market Valley, and is noted for its fertility.

The rocks of this plateau, are at many points, but little inclined. They are, in reality, at the northern disappearing end of a synclinal trough. Below New Market, the synclinal character is more apparent, and but a short distance southwest of this place, commences an important range of Trenton and Nashville rocks. These lie in the synclinal, and on the rocks we are considering.

552. The interesting mountain-hemmed coves, noticed in the First Part of this Report, (§§ 132 to 138,) present areas for the most part of Knox dolomites and limestones. Associated with these, however, there are, at a few points, Trenton and Nashville limestones and shales. Some Knox shales also occur. The rocks of the coves are not unfrequently, nearly or quite, horizontal. They are patches of the great calcareous formations which became entangled, by the folding and faulting to which all the strata in common were subjected, in the mountain masses of the Ocoee and Potsdam Formations. Doubtless, these coves, or basins, were once filled to the tops of the surrounding ridges, with calcareous matter. Water has removed this, and excavated the coves.

553. The exceptional spot, in *Middle Tennessee*, showing outcropping Knox Dolomite, has been noticed. (§ 364.) It may be added, that the part of the basin holding these rocks, rises up (regarding the area generally) in a wide, low dome—a feature consistent with the ridge-making character of the same rocks in East Tennessee. The dome shows upon the surface, in isolated pieces, the characteristic chert of the division. Its agricultural features are good, and the basin in general, is highly valued as a farming region. The dome has a depression all around it—a ring of valleys, in which outcrop the Trenton, Nashville and Niagara rocks.

554. *Useful Rocks and Minerals.*—The following is intended to be, for the most part, simply an enumeration of the rocks and minerals of this formation, which are, or can be, put to practical use. The systematic notice of them belongs to the Third Part of the Report.

The upper portion of the division at very many points, contains beds of a variegated rock, which answers an excellent purpose as a building stone. Its surface presents a gray ground, mottled with reddish brown clouds. This rock has been referred to in § 539. There is a quarry in it at Chattanooga, and the pillars which support the roof of the passenger depot at that place, are built of it. The rock occurs in separable layers of convenient thickness. It is sometimes called a marble, but its colors are rather dull to be much valued as a marble. The material is limestone, more or less dolomitic and argillaceous. It has a wide range occurring in the horizon mentioned as far north as Claiborne County.

Other varieties of building material can be obtained from different portions of this formation.

555. Many of the dark blue layers of this division are, at many points, profusely intersected by small reticulating veins of calcite. This is the case often, where a layer of limestone or dolomite, lies in the compressed angle of a local flexure, the rock having been more or less cracked in the bending. These vein-marked rocks will, at numerous localities, yield a handsome marble, and they are well worthy the attention of those who are interested in such matters. The limestones are sometimes very dark, and their polished surfaces, showing the

reticulating white veins, would be beautiful. Such rocks may be found at nearly all points where the blue layers have been much wrinkled. I have observed them in the vicinity of Jonesboro', Greeneville, Newport, on the Pigeons, in Sevier, in McMinn, Polk, etc.

556. Dark limestones, without veins, forming a good black, or nearly black, marble, are not uncommon, and are associated, more or less, with the preceding; they are the same, in fact, without the veins. Black marbles of this kind from East Tennessee, form the bases of the columns in the Senate Chamber at Nashville.

557. In addition to the above, there are *conglomerate and breccia* limestones and dolomites in East Tennessee, some of which deserve attention. These belong to the different divisions of the Knox Group, in fact, some may belong to the Ocoee Group. (§ 440.) These rocks, when free from siliceous points and masses, can be made to present an agreeable surface. The fragments making up the masses are generally of different shades of color, and the polished surfaces of the breccias resemble mosaic work. Marbles of this sort are found on the Little Tennessee, south of Chilhowee Mountain. I have observed them in Greene, Cocke, Sevier, and, in fact, in all the Unaka counties. On the Little Tennessee, and in Monroe County, some of it has been wrought.

558. In McMinn County, at one point in North Chestua Valley, is a bed of variegated crinoidal limestone, from which marble slabs have been sawn. This rock is interpolated in the Knox Shale, such being the formation of this range. (§ 530.) The point is interesting as a locality of *fossiliferous rock* in the shale.

559. The *chert* so characteristic of the upper part of the Knox Dolomite is manufactured, at several points, into excellent mill-stones. Layers of it, having a suitable cellular structure, occur in Claiborne, Jefferson, Knox, and other counties. It is generally the weathered outcropping portion of these layers that is used. After getting a certain depth, the cavities are found to be more or less filled with crystals of dolomite and other matter.

560. In several counties, among them Jefferson, McMinn, Polk, &c., layers of tough hornstone occur in the blue limestone. These being enclosed in tilted strata outcrop along a line, in some cases, for several miles. Dotted along on such outcrops, in the counties mentioned, are old half-filled pits—ancient "diggins "—originally made by the Indians for the purpose of procuring flint. They are in fact, old *flint mines.* Large trees now grow in these pits.

561. Many *Iron ore* banks are located on the Knox Group. In considering these banks, it is best to take the sub-divisions of the Group together. The special notice, however, will be found in the Third Part of the Report. There are two species of iron ore associated, more or less directly, with the rocks of this Group; these are *limonite* and *hematite.*

562. The first of these, *limonite,* (sometimes called brown iron ore,) is a hydrous oxide of iron, and is of very general occurrence. This ore results from the decomposition of ferruginous minerals, such as pyrite, carbonate of iron, etc., contained in the rocks. Any of the strata of the Knox Group, which contain compounds of iron, such, for instance, as the dark gray dolomites, or the red and green shales, will, when disintegrating under certain conditions, yield limonite. For this reason, more or less of it is to be seen in all regions where such rocks outcrop. It is only, however, at certain localities that the ore accumulates in sufficient quantity to be of practical value. When such a locality is met with it is called a *bank.*

563. Banks of limonite occur in all the mountain counties from Johnson to Polk. Ore from most of them, has been made into iron for many years. The ore is found in isolated masses, in bunches, irregular layers in a matrix of clay, sand, chert and debris of the disintegrated strata, all or part, variously mingled.

For some reason, not well understood, the valuable deposits of limonite are most numerous in the coves and valleys of the Knox Group, near or among the mountain ridges of the Unaka belt. Small unimportant deposits of ore are occasionally met with on all the Knox Dolomite ridges.

564. The other species of ore, *hematite,* is found at one point in a regular bed, and has been already mentioned. (§ 521.) At another locality, Sharp's Bank, in Sullivan County, it occurs

in a vein-like, nearly vertical mass. Much ore has been taken out, and the opening made, is, at one point, forty feet across. This part, however, is wider than the rest of the vein, and includes a columnar mass of rock, or, as the miner would say, a "horse." This mass of ore is associated with light gray dolomite, of the uppermost part of the Knox Group. The rocks dip at a high angle. The hematite most likely dips with them, not being a true vein intersecting the strata.

Other localities of this ore exist in Sullivan County. Hand specimens of *magnetite* (loadstone) are sometimes found at these localities.

565. *Iron Pyrites* is often found in the rocks of the Knox Group. It is a mineral met with, for that matter, in nearly all formations. In the Knox Group it is found associated, pretty generally, with *galena* and *blende*, at the localities of these minerals. A few miles south of Greeneville, in one of the valleys of Greene County, is a heavy body of pyrites in layers more or less mixed with shaly limestones. At the time of my visit the excavation previously made, in search of something better than this mineral, was partly filled with water, so that the character of the deposit could not be made out fully. Much pyrites had been thrown out. The locality deserves attention. At other points, in the same valley, beds of pyrites are found.

566. *Galena* occurs at numerous localities in the Knox Dolomite. It presents itself in true veins, as at the Caldwell Mine, on Powell's River, in Union County, in isolated grains and small lumps, from the size of a pea to that of an orange, or larger, interspersed sparsely through the whole mass of certain beds of dolomite; and in bunches, or deposits, consisting of local accumulations of grains and masses of galena in the rock, mostly as a matrix, as the lead mine in Bompass Cove, in Washington County.

567. The most interesting example of a bed of dolomite, containing scattered grains and lumps of galena, that I have met with, lies in the southwestern part of Claiborne County, near Powell's River. The portion of the bed examined, and seen to contain ore throughout, is about six miles long and two miles wide, and lies between Slate and Camp Creeks, on the hills more or less elevated above the river. Most likely, however, the lead-bearing portion extends beyond these limits. The horizon of the bed in the Knox series is in the upper part of *(b)* in the section. (§ 501.)

The ore occurs in buttons from the size of buckshot to that of a walnut, but occasionally large enough to weigh several pounds. The masses are sparsely scattered through the rock, so much so that its separation is impracticable. At points, where the masses are more abundant than usual the hunters have been in the habit of digging in the soil near the rock, or in the clay filling crevices, for pieces of ore which, in time, have become detached. Frequently their labor is rewarded by the discovery of several pounds of ore, supplying them well with the lead they need.

568. *Cerussite* (carbonate of lead) is found in small gray pieces at a point on the road from Greeneville to the Warm Springs in the valley between Paint and Meadow Creek Mountains. It is dug out of the soil, and is derived, doubtless, by alteration, from galena contained in the rocks of the vicinity. At a number of the galena localities the same mineral may be found.

569. The following ores of zinc, are found at numerous local ties in the Knox Group:

(*a*) *Blende*—sulphide of zinc, associated with galena at many localities;
(*b*) *Smithsonite*—carbonate of zinc; and
(*c*) *Calamine*—hydrous silicate of zinc; the two last associated at Stiner's zinc mine, on Powell's River, in Union County; at the Mossy Creek mine, and at several other points, to be mentioned hereafter.

570. *Black Oxide of Manganese* is of very general occurrence in regions where iron ore is found. Pieces are not uncommon on the Knox chert ridges. In Jones' Valley, in Cocke County, and on Boatman's Ridge, between Morristown and Bean's Station, considerable masses of it have been observed. Localities at which hand specimens can be found, are very numerous.

571. In addition to the minerals mentioned, the following also occur in the rocks of the Knox Group:

(*a*) *Heavy Spar (barite)*—found in veins, as at a point twelve miles from Greeneville, on the road to Chimney Top, etc.; also associated with galena at a number of points, forming, in the main, the gănguе of the ore.

(*b*) *Flour Spar (fluorite*)—associated with the preceding in lead veins, etc.

(*c*) *Calcite (carbonate of lime)*—in crystalline masses and in crystals, associated as the last, and common in small veins—a very common mineral.

(*d*) *Dolomite (carbonate of lime and magnesia*)—occurs in crystals in the cavities of chert, and of the bedded rocks; also, in veins associated with the minerals mentioned above.

(*e*) *Quartz*—in crystals, in the cavities of chert, etc.

572. *Agricultural Features*.—The Knox Dolomite presents some of the best farming regions in East Tennessee. This division, and the Knox Shale, taken together, are the most important formations of this section of the State, so far as agricultural interests are concerned. They present a much greater number of acres of good arable land than all of the other formations combined. In this, the East Tennessee Valley differs widely from the Central Basin. (§ 227, and on.) In the latter the soils overlie, and are derived from the blue limestones of formations next to be described, namely, the *Trenton* and *Nashville Groups.* In the Basin, no strata of the Knox Group are seen at the surface.

573. In East Tennessee there are long valley-ranges, as will be seen, of excellent lands based on the Trenton and Nashville rocks, but the aggregate area they give is far less than that presented by the Knox Dolomites and shale.

574. In noticing the topography of the Knox Dolomite, reference has, several times, been made to agricultural features. (§§ 547, 548, 551, 553.) It may be stated, generally, that, where chert-gravel is not too thick upon the surface, the lands of this formation are good, many of them excellent. The southeastern slopes of many of the characteristic ridges, (§ 543,) like that of Copper Ridge, are well adapted to farming purposes. These slopes run gradually into the valleys, where the blue Trenton and Nashville limestone lands are found. The northeast sides of these ridges are often free from chert and richer; (§ 547;) but they have the disadvantage of being steeper and more broken, besides having a northern exposure.*

575. The principal formations of the northeastern part of the State, (excluding the mountains,) are, as we have seen, Knox dolomites and shales. Upon these are based many ridges and valleys, which, however, are not marked like those

* The northern exposure would be an advantage in some cases. It would be better for fruit, grass, etc.

west of Knoxville. Many of the valleys contain dolomitic rocks and shales interstratified. These are generally good farming belts. In fact, the whole section is a superior one, as to its agricultural features. It has, too, been longer in cultivation than any other portion of the State.

576. The coves referred to in § 552, are, for the most part, desirable farming regions. Cade's Cove is noted as a grass producing area. The coves, generally, are well suited to small grain, grass and fruit. The same remark will apply to all the coves and valleys among, or in the vicinity of, the Unaka Ridges. These coves and valleys deserve more consideration than they have received. They have peculiar attractions. Their elevation, and the presence of mountains around them, make them cool, and, in the summer, delightful. Their very isolation would make them, to some minds, all the more desirable.