CHAPTER VI.

THE METAMORPHIC GROUP; FORMATION I.

CRYSTALLINE ROCKS IN EASTERN PART OF STATE—THE METAMORPHIC CONDITION—GEOGRAPHICAL POSITION, EXTENT AND RANGE—VARIETIES, AND GENERAL DISTRIBUTION—DIP AND RELATIONS TO STRATA, OF OTHER GROUPS—USEFUL PRODUCTS, MINES AND MINERALS—AGRICULTURAL FEATURES.

379. In the last chapter, general tables of the formations were given. I now propose to describe each group, in as much detail as may be desirable. The lowest, or oldest, in the series, will be considered first, and is the subject of this chapter; the others, will be taken up successively, in ascending order, and will be treated of in succeeding chapters.

In describing a formation, reference will, in general, be made to its *geographical position, extent and range;* its *topography;* its *lithological character;* its *fossils,* its *useful ores, minerals and rocks;* its *agricultural features,* and to such other characters and relations belonging to it, as circumstances may make desirable.

380. *Crystalline Rocks in the Eastern Part of the State; the Metamorphic Condition.*—In the extreme eastern part of the State, and forming some of the highest mountains of the Unaka Chain, (§ 41,) are certain rocks, composed for the most part, of the same mineral constituents that make up granite. These rocks are crystalline in structure, occur in stratified beds, and belong mostly to the varieties called by geologists, *gneiss,* (a term equivalent in meaning, to *stratified granite,) talcose slate, and mica slate.* They are *altered,* or, in technical language, *metamorphic* rocks. They were once common sandstones, conglomerates, shales, &c., but have lost their original character, and have become crystalline, through the agency of subterranean heat, or, in other words, through the *steaming* or *baking,* to which they have been subjected.

381. A portion of the strata under consideration, can be traced out, to unaltered beds. The original strata, from which they have been derived,

are, thereby, known. As these will be described hereafter, it might be thought, that their metamorphosed, or altered parts, ought to be noticed then. It must, however, be recollected, that all of our metamorphic rocks, cannot be, all yet, referred back, satisfactorily, to known, unaltered beds; and that, in addition, those which can be, are so thoroughly changed as to be essentially different from their originals. At the same time, they are much the same in kind and form, when taken together, a natural group, which, for practical purposes, it would be inconvenient to break up. It has been thought best, therefore, to include all these rocks—those which have been thoroughly altered, and are truly metamorphic—in one group.

It may, however, be desirable, when speaking hereafter, of the unaltered beds, to notice whenever there may be occasion, how far they have contributed to this group.

382. *Geographical Position; Extent and Range*.—The metaphoric rocks, are wholly confined to East Tennessee. With the exception of two very limited strips, to be mentioned hereafter, they occur in detached areas or sections, immediately along the North Carolina line. (See Map.) These sections, however, are only detached within the limits of Tennessee; they are parts of a continuous and extensive belt of rocks which runs from Virginia to Georgia, having its western limit, alternately, in North Carolina and in Tennessee.

To the west of this belt, and in contact with it, are great beds of conglomerate and slates, and occasionally, of sandstone and limestone.

383. The line separating the rocks just mentioned, from those under consideration, or, in other words, the western limit of the Metamorphic Group, is, sometimes well defined, often, however, but poorly, the rocks gradually losing their crystalline characters, and running insensibly into the adjacent conglomerates and slates. In general direction, the line of separation conforms to the Appalachian, northeastern, and southwestern trend, (§ 18,)—the direction in which the mountain ridges of this portion of the State, for the most part, run.

Such too, is the general course of the boundary line which separates us from North Carolina. This was fixed, in the main, along the range of the highest mountains, west of the Blue Ridge. This range is the principal axis of the Unaka Chain, (§ 41,) which, therefore, not only divides the States, but, is, *approximatively*, as was pointed out by Troost, the western limit of truly metamorphic rocks.

384. The limited and isolated patches of gneiss, mica slate, and allied rocks, that we have in Tennessee, may almost be said to be ours, accidentally, being mere sections cut off from the main North Carolina belt, by the meanderings of the State line, and belonging, *physically*, to our sister State. Nevertheless, we welcome them, adding, as they do, an interesting member to our geological series, and bearing with them, ores for our miners, and majestic grass-covered mountains for our herdsmen.

385. It remains to trace out more in detail our metamorphic areas. Commencing in Johnson County, at the extreme north-eastern corner of the State, the conspicuous White Top Mountain, being our starting point, with its neighbors, the Beech Mountain, Slate Face, &c., (§ 48,) in our track, we find the group represented, (if represented at all,) by a narrow strip, adjacent to the North Carolina line, scarcely within the State, and not well marked at that, the rocks being, apparently, not more than the half-baked layers of the group next to be described. The rocks here, are, in great part, a pale, greenish talcose slates, often abounding in small, rough masses, or knots of quartz, which are, perhaps, remains of pebbles. These slates, might be referred to the Ocoee Group.

386. Progressing southwestward, along the line, however, we find the metamorphic character well defined. Opposite Taylorsville, the county town of Johnson, the group, consisting mostly of gneissoid rocks, spreads out, and becomes several miles wide, reaching to within about three miles of the town. The group is here, at one point, in direct contact with a band of magnesian limestone. Eastward, at the State line, it forms Stone Mountain.

387. In a southeastern direction from Taylorsville, at the distance of a little more than four miles, a narrow band of gneissoid rocks, with greenstone, is met with. This is separated from the main belt by conglomerate, the latter, being not far from a mile wide. After the conglomerate, going southeastward, the gneiss sets in again, and continues up the mountain four or five miles, to the State line.

388 The western limit of the group, in this county, has a nearly direct southwest course. The State line, however, southeast of Taylorsville, makes an elbow eastward, which throws a considerable area of these rocks into Tennessee. In the southern part of the county, the boundary line returns, and, where it crosses the Watauga River, very nearly coincides

with the western limit of the group. The Johnson County portion of our metamorphic rocks, is thus nearly, but not quite, detached.

389. Soon after crossing the Watauga, the rocks of the group extend out rapidly westward, until their western limit in Carter County, (measured along the waters of the Big Doe,) is about fourteen miles from the State line. Here is the greatest width of metamorphic rocks in the State. The area they thus form, is one of much interest.

It includes the group of mountain-hemmed valleys called Crab Orchard. (§ 52.) It has, along its eastern and southern boundary, the Noble Mountains, the Humps, the Big Yellows, and the Roan. (§§ 54 and 55.) Its rocks and minerals, too, are matters of interest, and will be referred to.

390. The State line between the "bluff" of the Roan (§ 55,) and Iron Mountain to the west, is the southern boundary of the metamorphic area. In its course from the Watauga River to Iron Mountain, the State line, forming a great bend, and approaching closely the sandstones and limetones of Limestone Cove, (§ 57,) almost detaches a metamorphic section for Carter, as we have seen it nearly does for Johnson.

391. East of Limestone Cove, the Metamorphic Group has a width of not more than two miles. From this point, it continues in a belt, from three to six miles wide, running in a nearly southwest course, through Washington County, into North Carolina. This portion forms two high and noble mountains, both on the State line, the so-called Unaka, partly in Carter, and the Great Bald, in the southeastern part of Washington. (§ 59.) Soon after leaving the Bald, the State line turns round to the north and west again, and runs a dozen miles or, more, before it resumes its normal direction. It thus forms a great S-shaped bend. (See Map.) This throws the Metamorphic Group wholly within North Carolina, where it remains for many miles, not entering Tennessee again until it passes the French Broad River.

392 The belt of metamorphic rocks, reaching from the northeastern corner of the State through Johnson and Carter Counties, to the extreme southern part of Washington, is the most extensive in Tennessee. It is nearly cut into three detached sections, as we have seen, by the windings of the State line. Its entire length is nearly seventy miles.

393. In Cocke County, near the headwaters of Big Creek, the Metamorphic Group appears again on the mountains of the

line. To follow the group, or rather its western limit, continuously, through North Carolina, let us return to the southern part of Washington. From this point, after leaving Tennessee, it runs southwestward, nearly coinciding with the course of the Laurel, a tributary of the French Broad. A few miles above the Warm Springs, it crosses the French Broad, soon wheels around to the west, all adjacent formations doing the same, and runs to the Tennessee line. Thus, at the point designated above, in Cocke County, the true gneissoid rocks are thrown again upon our boundary, and, for a few miles, within the State. It is only, however, for a short distance comparatively; they soon pass back again into North Carolina.

394. From this region, southwestward a long distance, on down to the headwaters of Tellico River, in Monroe County, there are no important areas of metamorphic rocks, the high mountains of the State line being composed, in the main, of the group next to be described—the Great Conglomerate, and its slates.

395. In passing around the headwaters of Tellico River, the State line throws out an elbow to the southeast, which projects out far enough to have its apex crossed by the metamorphic rocks. This gives another area of these rocks.

396. A few miles further on, in the vicinity of the Hiwassee River, the metamorphic rocks, mostly mica and talcose slates, again enter the State and run across its southeastern corner into Georgia. The area thus formed is one of great interest, and is well known as that in which the Ducktown Copper Mines occur. Five or six miles north of the Hiwassee, the State line, instead of following the highest dividing ridges, takes a straight course, nearly southward, to the Georgia line. (§ 68.) Had the boundary been marked out along what may be regarded as its natural route, the Ducktown region would have been thrown into North Carolina. The area thus, we may say accidentally, given us, lies in Polk County, is triangular in form, has a base along the Georgia line about nine miles in length, and includes altogether, about sixty square miles.

397. Such are our principal metamorphic areas, the most extensive and important being respectively at the northeast and southeast corners of the State. All mentioned are segments of

the North Carolina belt. Together, they occupy comparatively, as may be best appreciated by referring to the Map, a very small part of the State.

As to *thickness*, it is difficult to make an approximation to the truth. It is certain that the volume of the group is great. A mile in thickness may be a small estimate.

398. We have before referred to two limited strips as exceptions, occurring, as they do, entirely detached from the metamorphic group proper. These strips are limited in extent, and are mainly interesting on account of the singular positions they respectively occupy.

The first occurs in Johnson County, about three miles west of Taylorsville, and five or six miles west of the gneissoid rocks, and separated from them by formations not at all metamorphosed. The strip is narrow, but a few rods wide, and is made up of gneissic rocks, which are included between highly-inclined layers of conglomerate on the one hand, and of calcareous slates upon the other—all lying at the base of Iron Mountain.

399. The other strip is of more interest, though, perhaps, not as well characterized as to its metamorphic condition. It is located near Clinch River, on the west side, in Union County. It is from fifty to one hundred feet wide; includes a bed of comparatively homogeneous, bluish or greenish, shale, but is mostly made up of a soft, dark-greenish gray shale, abounding in smoky scales of mica, and in grains of magnetite. Good cabinet specimens of magnetite, often in crystals, and fine masses of grayish-white compact chorite, are found in the shale, and scattered about upon the surface. The strip lies in a line of great dislocation, running in a northeasterly and southwesterly direction. It separates the gray magnesian limestone of the Knox Group, (2,*c*,) upon the southeast, from lower carboniferous strata, upon the northwest.

It is possible that other metamorphic strips may be found in this or neighboring counties. I have occasionally been told of the finding of mica, etc., at different points. In some cases, it has been turned up by the plough. As yet, however, no other areas of metamorphic character than those mentioned, have been observed, If they exist at all, they are certainly of very limited extent, and unimportant.

400. *Varieties, and their General Distribution.*—As already stated, our metamorphic rocks are, in good part, *gneiss* and *mica slate*—rocks which, like granite, are generally aggregates, or mixtures, of three distinct minerals—*quartz*, *feldspar* and *mica.* It must be mentioned, however, that many of them are *syenitic;* that is, they contain the mineral *hornblende* in place of mica. Such rocks are syenitic, or hornblendic, gneiss. In addition to these, chloritic slates are also met with.

401. East and southeast of Taylorsville, in *Johnson County,* where the group is well defined, the rocks are generally gneiss, which is here mostly composed of quartz and feldspar, (often reddish,) with but little mica. They are, for the most part, thick-bedded, sometimes slaty.

402. The large area in *Carter,* mentioned above, (§ 389)—the Crab Orchard region—contains several varieties of gneissoid rocks. These are mostly quartzose and feldspathic, mica not being abundant. At some points, a slaty gray quartzose and hornblendic rock occurs for the most part. The rocks of the Roan Mountain are, in good part, a gray, rather slaty, gneiss, much of it syenitic. In some parts of this region, however, gneiss with mica, is found.

403. In the southern part of *Carter,* east of Limestone Cove, gneiss again prevails; mica slates, however, and, to a limited extent, talcose slates, also occur. Here, too, the gneiss is occasionally more or less syenitic. Such, also, in brief, are the characters of the metamorphic group through *Washington County.*

404. In *Cocke County,* the group, as mentioned above, appears again. (§ 393.) In this section, the rocks are "a granite," (gneiss,) which is composed of quartz, reddish feldspar, a few small spangles of black mica and chloritic talc, which belongs to the *protogine* of the French geologists."* In one portion of this county, near the point at which the group enters the State, a rock has been observed abounding in greenish granular epidote, being in fact, a kind of epidote gneiss. Pebbles of this material frequently occur along some of the small streams, in the northeastern part of the county.

405. Passing to the southern part of the State, and taking the Ducktown region, in *Polk County,* as an example, we find the rocks mostly talcose chloritic and mica slates. Interstratified with these, beds of hornblendic rock are met with.

Such, in general, are our metamorphic rocks. It will be seen that, with the exception of the region last mentioned, gneiss (which is sometimes syenitic) is the prevailing rock.

406. Trap, or *Greenstone dikes,* are occasionally found intersecting the metamorphic strata; they are apparently most numerous in the large area

*Troost; Fifth Report.

of Carter. Here, too, are bands of granite-like materials, which most likely are of volcanic origin. Volcanic rocks, however, as a general thing, are not abundant or conspicuous within the limits of Tennessee. A few dikes have been observed in the Ocoee Group.

Veins of quartz are frequently seen, interstratified with (rarely intersecting) the metamorphic strata. In the Ducktown region they are quite numerous.

407. *Dip and Relations to Strata of other Groups.*—The metamorphic beds, together with those of other groups that are adjacent or neighboring, all appear to follow the same law of dip and strike. The *dip* (or inclination of the beds) is, in the main, at a high angle to the southeast, the *strike* (or direction of their edges along the surface) being northeast and southwest. I have not been able to satisfy myself as to the want of conformableness in the beds of this group, or in these and beds of adjacent groups taken together. They all apparently belong to the same system of upheavals—have been crowded upon their edges by the same forces, and during the same period. At some points there appear to be exceptions, the beds of this group coming abruptly against others not metamorphic, as in Johnson, where the gneiss comes in contact with limestone. (§ 386.) Other similar cases occur. But these unconformable junctions are naturally referable to *local* fractures and displacements. Such displacements are common in Tennessee, even among members of the same group. Moreover, this unconformableness is local, and not the rule; it is generally true that the metamorphic beds run so gradually into adjacent unaltered ones, that it is difficult, within certain limits, to trace out a line of separation.

408. With reference to age, I have no reason for believing that this group, within Tennessee, includes the metamorphosed beds of any formation of more recent date, than the Ocoee Conglomerate and Slates. A portion of the beds are certainly referable to the Ocoee Group; the remainder, although conformable, may be older, and most likely are.

There are sections which show clearly the change of the conglomerate, and its associated rocks, into gneiss and mica, and other slates. In approaching, for instance, the Ducktown region, from the west, the pebbles of the conglomerate gradually lose their forms, becoming more and more, small,

shapeless masses of quartz, and yet discernible, even when the gneissoid or complete metamorphic character is seen. In the northern part of the State, at many points, the passage of the Ocoee beds into gneiss, is gradual and apparent. A considerable part, indeed, of our metamorphic rocks, can be, I think, thus referred to these beds. The question as to the greater age of other parts, is not so easily settled, and must remain open for the present. I know of no sufficient reason for referring any of these rocks to the Huronian or Laurentian series of Canada.

409. *Useful Rocks, Mines and Minerals.*—It is proposed simply to mention here the useful purposes to which some of the rocks under consideration, have been, and may be, applied, and to give a catalogue of the minerals which occur, and have been observed within the limits of the Group. Further details will be found in Part Third of this Report, where the useful rocky material, the ores and minerals of all the formations, are specially and systematically considered.

410. Valuable quarries of *building materials* might be opened in some of the beds of this Group, especially in the more northern counties, where syenitic gneiss is found. I have frequently seen in Johnson, Carter and Washington, beds of gneiss, both gray and flesh colored, from which handsome and durable blocks might easily be quarried. Beds suitable for such purposes, occur, too, in Cocke County, and might be found among the mica beds of Polk. It is to be regretted, that such localities are nowhere intersected by any of our railroads, for, otherwise, we might have *Tennessee* "granite" for our public edifices. As it is, the blocks, if quarried, would have to be hauled twenty-five or thirty miles, even from the most convenient localities, before they could reach a railroad. But this difficulty will, doubtless, be overcome at no distant day.

411. At several points the hard quartzose gneiss has afforded tolerably good *millstones.* In Johnson County, a few miles east of Taylorsville, stones have been cut out of such material, and have answered a good purpose, especially for grinding corn. In Carter, on Little Doe River, about twelve miles from Elizabethton, a syenitic gneiss, or granite, was formerly worked into millstones, some of which were of large size, and were, at one time, highly esteemed, both for grinding corn and wheat. Of late years, however, they have not been manufactured, owing to the introduction of foreign buhr-stone.

White quartz rock, too, from veins in this Group, has been cut into millstones, which have been used with very satisfactory results.

412. The most interesting *mineral regions* within the limits of the Group, are those of Ducktown, in Polk County, and of Crab Orchard, in Carter; the first, very near the extreme southeastern corner of the State, on the Ocoee River, has attracted much attention on account of its "*Copper Mines;*" the second, although by no means having the importance of the first, is interesting as a locality of *Magnetic Oxide of Iron,* (*magnetite.*)

413. The *Copper Mines* will be spoken of hereafter, in sufficient detail. The following are the principal *ores* and *minerals* they afford:

ORES AND MINERALS OF THE COPPER MINES.

1. *Copper Pyrites*, an important ore.
2. *Iron Pyrites*, occurs with the last, abundantly.
3. *Magnetic Pyrites*, associated with 1 and 2 in quantity.
4. *Copper Glance*, in small quantity.
5. *Zinc Blende*, " " "
6. *Galena*, " " "
7. *Orthoclase*,
8. *Albite*,
9. *Tremolite*,
10. *Actinolite*,
11. *Diallage*,
12. *Zoisite*,
13. *Calcite*,
14. *Quartz*,
15. *Rutile*,

Associated with the preceding ores in greater or less quantity, many of them are found in well developed and beautiful crystals.

16. *Garnets*, plentiful in some slates.
17. *Allophane.*
18. *Alisonite*; rare.
19. *Bornite.*
20. *Red Copper*, a rich ore.
21. *Chalcotrichite*, unimportant.
22. *Malachite*, a rich ore.
23. *Azurite*, rare.
24. *Copperas.*
25. *Blue Stone*, valuable.
26. "*Black Oxide,*" a name applied to a mixture of oxides and sulphides of copper and iron. It is of great value as an ore.

27. *Native Copper,* not in quantity.
28. *Harrisite,* rare.
29. *Rahtite,* a doubtful mineral.
30. *Limonite, ("Gossan,")* abundant.

The minerals last enumerated, commencing with No. 17, may be called secondary minerals, as they have been derived by oxidation, and other chemical processes, from the ores at the head of the list.

414. In *Crab Orchard,* (§ 389,) the following minerals occur:

1. *Magnetite,* in workable quantity.
2. *Pyroxene,* (Sahlite,) crystalline associated with magnetite.
3. *Hornblende,* and
4. *Epidote,* associated also with magnetite.

415. Other minerals and localities, are as follows: *Specular Iron,* occasionally in small plates or masses in gneissoid rocks, in Washington, and other counties; *Molybdenite,* occasionally in scales, in Washington; *Epidote* in gneiss, or granite, forming a kind of epidote gneiss abundant in Cocke County.

In § 399, I have mentioned the occurrence of *magnetite* and *chlorite* in the curious metaphoric or semi-metaphoric strip in Union County.

416. *Agricultural Features.*—The rocks of this group form, for the most part, in Tennessee, high, rough mountains, attached to which, we do not expect to find much agricultural interest. These mountains are generally cold and rocky, with a thin, sandy soil. Nevertheless, on the tops of some of the highest ranges, are extensive tracts, which, in summer, are covered with grass, and then are common pasture grounds for the "stock" of the farmers in the valleys. At this season the cool temperature is agreeable, and herd and herdsmen enjoy it.

417. I have already spoken of the *Balds* of the Unakas. (See pages 33-36.) Some of the most noted, those of the Roan, and that of the Great Bald, in Washington County, belong to metamorphic mountains. The soils of these places are often prairie-like, black and rich. On some of the wooded slopes, also, are tracts of considerable fertility, upon which may be found growing, the beech, walnut, wild cherry and poplar.

418. It is rare to meet with a settler located upon these mountains. The summer is too short, and the winter is too

severe. The" settlements" are in the narrow valleys at the bases of the mountains, where the winds are cut off, and spring is early. These valleys sometimes present along the streams, strips of rich, sandy bottoms, which well repay labor, in yielding corn, wheat, rye, potatoes, etc. Crab Orchard, in Carter County, is a group of such valleys, (§ 52,) and the only group on metamorphic rocks, the middle or northern part of the State. (§ 389.)

419. In the Ducktown Basin are also numerous valleys dotted with small farms. The Ocoee, especially, has a number of rich, sandy bottoms. The Ducktown region, including Turtletown, is, indeed, by far the most important agricultural, as well as mineral, area, the metamorphic rocks present.

420. Excepting the alluvial flats of the mountain-hemmed valleys, the agricultural features of the metamorphic group are, upon the whole, of limited interest. Its soils, compared with those of the great limestone formations, take an inferior place. The mountains will be, for the most part, grazing ground for cattle; and, for this purpose, they doubtless have a future.