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N. S. SHALER, DIRECTOR.

REPORT ON

A GEOLOGICAL RECONNOISSANCE

OF THE REGION ADJACENT TO THE

KENTUCKY & VIRGINIA STATE LINE,

FROM CUMBERLAND GAP TO THE CHATTERAWHA OR
BIG SANDY RIVER.

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The State line between Kentucky and Virginia, beginning at a point a few hundred yards from Cumberland Gap, where the three States of Kentucky, Tennessee, and Virginia corner, follows the crest of the Cumberland Mountain, which is also the dividing ridge between the waters of the Cumberland and Tennessee rivers, for about thirty-five to forty miles,* to the head of Crank's creek, a branch of Martin's Fork of Cumberland river. It here leaves the Cumberland Mountain, which turns more to the east; and follows the crest of the Little Black Mountains, which now form the dividing ridge between the just mentioned rivers, having on one side the head branches of Martin's and Clover Forks of the Cumberland, and on the other those of the North Fork of Powell's river.

The State line follows the crest of the Little Black Mountains to their junction with the Big Black Mountains, at the head of Clover Fork of Cumberland, when it turns to the top of the Big Black Mountains, which it follows to the head of Poor Fork of Cumberland river, where the Big Black Mountains abut against the Pine Mountain. The Big Black Mountains lie partly between the Clover and Poor Forks of Cumberland, and partly between the Poor Fork of Cumberland and the North Fork of Powell's river.

At the head of Poor Fork the State line crosses to Pine Mountain, which is here sometimes called the Laurel and

*There is no accurate map of this region, and, in consequence, the distances given are only approximations, as nearly accurate as could be obtained.

sometimes the Cumberland Mountain, and follows its crest to the end of the mountain, at Russel Fork of Chatterawha or Big Sandy river, a distance of about thirty-five miles or more.

It will be seen, therefore, that the discussion of the geology of the region adjacent to the State line involves the examination and description of three mountain ranges—the Cumberland, Black, and Pine.

THE CUMBERLAND MOUNTAIN.

The Cumberland Mountain, along which the Kentucky-Virginia State line runs for such a distance, is identical with the mountain of the same name in Tennessee, which forms for some distance the upturned rim or edge of the "Cumberland Table Land" of Prof. Safford's Tennessee Geological Report.

It is a long narrow ridge, running in an east northeast and west southwest direction, and varying in height from nine hundred to two thousand feet above the adjoining valley. The crest line of the mountain does not follow a straight line; there are many minor curves and changes in direction, but it preserves a general course about as stated.

The mountain is formed of the tilted rocks of the Carboniferous, Sub-carboniferous, Devonian, and Silurian periods, dipping to the northwest at angles from fifteen to ninety degrees, varying for almost every separate mile of its length. The direction of the dip is also subject to local changes, which are the cause of the changes in the course of the crest line of the mountain. The crest line represents approximately the strike of the rocks, for the mountain recedes or wears away along a line at right-angles to the dip. A change, therefore, in the direction of the dip, results in a change in the direction of the crest line.

The determining rock which forms the crest of the mountain, and gives character to its topography, is always one of the Conglomerate sandstones of the lower coal measures.

Of these sandstones, there are a number, from seventy-five to three hundred feet in thickness, separated by shales or shaly sandstones, carrying beds of coal. These Conglomerates are

roughly divided into two series, an upper and lower. This division, at places, is well marked; at others, it cannot be traced. There is a considerable thickness of shale or shaly sandstone between the lowest of these Conglomerates, and the underlying Sub-carboniferous limestone. These Conglomerates represent the single sandstone, which near the Ohio river lies at the base of the coal measures. This increases in thickness toward the south, and separates into several members, while the space between, filled with shale and shaly sandstone, grows thicker in proportion to the increase in the thickness of the Conglomerates, and contains a number of coals.

The total thickness of these Conglomerates and the inter-conglomerate beds, all of which may be embraced under the term Conglomerate series, is in the neighborhood of two thousand feet. These Conglomerates can no longer, therefore, be strictly said to mark the base of the coal measures.

The crest of the ridge is formed sometimes by the upper and sometimes by the lower Conglomerates, depending largely on the degree at which the rocks dip. Where the dip is gentle, the upper Conglomerates come to the top, and the mountain attains its maximum height; but where the dip becomes steep, these retreat back on the northwest or Kentucky slope, and the lower come to the crest, the mountain decreasing at the same time until it is at its minimum, when the dip of the rocks is steepest.

These Conglomerates are usually quite pebbly, massive, cliff-forming sandstones, yielding to erosion slowly, and, in consequence, forming by far the most conspicuous feature in the topography of the mountain. Fine exposures, in the shape of splendid cliffs, from one hundred to four hundred feet high, are seen all along the mountain face. The shales between and below the Conglomerates are much more rarely exposed, as they are usually covered by the talus from the overlying sandstones. In fact, no complete exposure of these beds has yet been obtained in this region, and it is unknown, at this time, how many and what thickness of coal seams they contain. The place of one coal is well ascertained; but, as

it is nowhere opened for mining purposes, its thickness and quality are as yet unknown. The "stain" of other coals has been seen occasionally between the Conglomerates, but their exact positions are not yet determined.

The next most prominent member of the rock series of the Cumberland Mountain, after the Conglomerate series, is the Sub-carboniferous or St. Louis limestone. This limestone is from four hundred to five hundred feet thick. It is seen at many prominent outcrops on the mountain, the most notable of which is the cliff at the "Pinnacle," Cumberland Gap. It is by no means so often exposed as the Conglomerate, for the reason that, like the shales, it is covered by the talus, or the broken weathered fragments from that sandstone. Its place can, however, usually be determined by the bench which it forms in the hill slope.

Below the limestone, a fine-grained, greenish shaly sandstone, about one hundred and fifty feet in thickness, occurs. It is the sandstone variously known as the Knob stone, in the old series Kentucky Geological Reports, the Silicious, of Prof. Safford's Tennessee Geological Report, and the Waverly, of the Ohio Reports, which latter name has been adopted by the present Survey. From its shaly structure, it is eroded so easily and rapidly that it is usually covered either with its own weathered fragments, or material from the rocks above. It is only seen, therefore, in position where it is cut into by the rapid streams on the mountain side.

Immediately below the Waverly, and passing into it without any distinctly marked line of change, is the Devonian black shale. This shale is too widely extended and too well known to need any special description here. It is from one hundred to one hundred and fifty feet in thickness, with perhaps an average of one hundred and twenty-five. Like the Waverly, it is soft, and wears rapidly; so that it is usually covered, and it is difficult to obtain exposures where its whole thickness can be measured with accuracy.

At places where the dip of the rocks is very steep, and the mountain consequently low and narrow, the black shale is its

lowest rock. In this case, it is cut away to form the "Poor Valley," which uniformly occurs at the foot of the mountain, between it and the range of foot-hills, called the "Poor Valley Ridge," formed of the rocks of the Clinton or Dyestone and the Medina Groups. Usually, however, there is a thickness of from one hundred to three hundred feet of shales and shaly sandstones, containing thin bands of limestone, at the base of the mountain below the black shale, and in these the valley is cut. These rocks overlie the Clinton or Dyestone iron ores of this region, which are usually found in the Poor Valley Ridge. For a portion of the distance these ores are found at the foot of the mountain; but, as a rule, they lie in the uppermost beds of the foot-hill range.

These ores occur with great regularity along the foot of the mountain for many miles, constituting in the aggregate an enormous store of mineral wealth, that is as yet almost untouched. Their quality is good, their thickness and position such that they can be mined cheaply, and this region only lacks facilities for cheap transportation to make it one of the most prosperous and extensive iron manufacturing districts of the country.

These ores will be described more fully in another report, devoted especially to them.

The Clinton or Dyestone Group, which forms so large a portion of the rock structure of the Poor Valley Ridge, is from three hundred to five hundred feet in thickness. It is composed of shales and thin-bedded sandstones, with occasional limestones. Below these rocks of the Dyestone Group, the heavier-bedded Medina sandstone occurs, and, with the upper part of the Cincinnati limestone, which is sometimes present, completes the list of the rocks of the foot-hills of the Cumberland Mountain.

All of the above described rocks, with the exception of the Conglomerate, are seen only on the southeast or Virginia face of the mountain; but they have been thus fully described, as a knowledge of them is absolutely essential to any clear comprehension of its structure. On the northwest or Kentucky

slope of the mountain, only the Conglomerate, and the beds of sandstone and shale of the coal measures immediately overlying it, are seen. The slope on this side is much more gentle than on the other. It is usually a little less than the dip of the rocks, or nearly the same; so that but a slight thickness of rock above the Conglomerate is found on the mountain.

At the base of the mountain, on this side, is a line of fault or fold, as yet undetermined, which lies between the tilted rocks of the mountain and the overlying horizontal coal-measure rocks.

These rocks form the hills lying between the Pine and the Cumberland Mountains, variously known as the Log and the Black Mountains. They are formed wholly of coal-measure rocks, lying nearly horizontally, and show a greater thickness than in any other portion of Kentucky.

Along this line of fault or fold, between the horizontal and tilted rocks, there is usually a stream flowing, with a course parallel to the line of the mountain. A series of such streams is found along its whole length. They usually head against one another at very low gaps, run in opposite directions until they meet other streams flowing toward them, when they leave the mountain and flow across into Cumberland river.

Between Cumberland Gap and the point where the State line leaves the Cumberland Mountain there are five principal streams flowing at the foot of the mountain on the Kentucky side. They are: Clear Fork of Yellow creek, Cabbage and Browney's creeks, Martin's Fork and Crank's creek. Of these, Martin's Fork is the longest and largest, being some twenty miles in length before it unites with Crank's creek and turns away from the mountain. Unlike the others, it heads at the top of the mountain, at the point where Brush Mountain, an outlier of the Cumberland range, the structure of which has not been well determined, separates from it.

Shillaley creek, a branch of Clear Fork of Yellow creek, heads against Martin's Fork, at the top of the mountain, and the two streams divide the Brush from the Cumberland Moun-

tain. Cabbage and Browney's creeks flow at the base of Brush Mountain.

Brush Mountain, as we now know it, seems to be a duplication of the Cumberland, caused by a fault in the Conglomerate beds. It runs parallel with the Cumberland Mountain, and for a portion of its distance is about the same height; but it falls away at the upper end to a little more than half. It seems to be formed entirely of the Conglomerate and interconglomerate beds; at least, no lower rocks than these were found at its upper end, where Martin's Fork cuts deep between it and the main ridge. At this end, however, we have the Conglomerate, probably the upper member, nearly horizontal, or at least not dipping more than five degrees, showing splendid cliffs two hundred and thirty feet high, while on the other side of Martin's Fork, on the Cumberland Mountain, the sandstones dip fifteen degrees or more. The position of the rocks on the northwest face of Brush Mountain has not been ascertained as yet. The rocks of the mountain have evidently been raised to their present position by an uplift in the same manner as those of the main ridge; but it is remarkable that they should be so raised and still be so little inclined. Our knowledge of the structure of this mountain is, however, so imperfect as yet, that little can be told with accuracy regarding it.

The height of Cumberland Gap above tide is stated, in Prof. Safford's Tennessee Report, as one thousand six hundred and thirty-six feet. The height of the "Pinnacle," the mountain just above the Gap, as ascertained by repeated measurements with mercurial barometer, by Mr. William B. Page, of the United States Coast Survey service, is two thousand five hundred and one feet above tide. This measurement was made from a bench-mark of a railroad survey in the valley, on the Tennessee side. The height of the Pinnacle above this valley is one thousand two hundred and ten feet, while it is one thousand three hundred and seventy-three feet above the Yellow Creek valley, on the Kentucky side, showing this valley to be one hundred and sixty-five feet

lower than the other—a relation which the valleys on both sides of the mountain hold wherever observations have been taken all along it, until after the State line leaves it.

The Fort Hill, a knob a short distance above the Pinnacle, rises considerably higher, and is the highest point in the mountain for several miles in both directions. The mountain then falls away toward the northeast, and at Lewis' Hollow, one mile above, is about three hundred feet lower. It soon recovers its usual height of about one thousand three hundred feet, which it gradually increases towards the northeast. For the first fifteen miles above the Gap the usual dip is from twenty to twenty-five degrees to the northwest, although on the slope of the mountain local dips as high as forty-seven degrees are noticed. Gibson's Gap, four miles from the Pinnacle, is about one thousand one hundred feet above the Powell valley, while the average height of the mountain is some two hundred feet higher.

Chadwell's Gap, about thirteen miles from the Pinnacle, by way of the mountain crest, is between one thousand five hundred and one thousand six hundred feet above the Powell valley, with the general level of the mountain not more than two hundred and fifty feet above. This gap is opposite the centre of Brush Mountain, at the head of Martin's Fork.

For the next five miles the mountain continues steadily to gain in height, turning at the same time in a grand sweep round to the east, until a point is reached which is known as the White Rocks, so called from the conspicuous and precipitous cliffs of Conglomerate crowning the summit of the mountain. This is the most prominent point in the whole mountain, viewed from either above or below, extending so far out to the east as it does, and at the same time holding so great a height. The abrupt bastion-like front which this point presents, outlined against the sky, can be seen for many miles on either side. The mountain is here nearly two thousand feet above the Powell valley, and, by barometrical measurements by Mr. W. B. Page, United States Coast Survey, is shown to be three thousand four hundred and sixty

feet above sea level. The sweep of the mountain round to the east is due to a change in the direction of the dip of the rocks, which gradually change from northwest to north, and from north to north twenty degrees east, which is the direction at this point, while the angle of dip is quite gentle, being only from thirteen to fifteen degrees.

The Conglomerate capping the ridge forms at one place a cliff nearly four hundred feet in height, which is a little more than perpendicular, overhanging a few degrees. These cliffs are unusually prominent along the face of the mountain for the next three or four miles.

Soon after passing the White Rocks point the dip of the rocks once more changes to the west of north, and the course of the mountain range turns in sympathy back toward the northeast.

The dip of the rocks becomes much steeper, and the mountain loses proportionally in height. At Britton's Gap, about seven miles above, where the mountain was crossed on this journey, the rocks are vertical, or, in some cases, overthrown and dipping to the southeast about eighty degrees. The height here, by aneroid barometer, is only nine hundred and fifty feet above the Powell valley, or about half the height at the last point of observation.

At Brierfield's Gap, three miles above this, the height of the top of the mountain is only nine hundred feet above the valley. The Poor and the Powell valleys, on the Virginia side of the mountain, grow narrow with this change in the dip, as only the edges of the rocks are presented for erosion. The range of foot-hills, called the Poor Valley Ridge, follows in miniature the changes in elevation of the mountain, rising to about four hundred feet at the White Rocks, sinking away to about two thirds this height at the last described places, and then rising again to nearly five hundred feet at the next elevation in the mountain at Crank's Gap, which is about ten miles above. Here the dip of the rocks has once more become very gentle, from eighteen to twenty-five degrees, and the mountain is about one thousand five hundred to one thou-

sand six hundred feet above the valley. Its elevation above sea level is not known, but it is probably somewhat less than the White Rocks point. The mountain at this point is very broad—fully twice its usual breadth. Where the rocks were steeply inclined, or vertical, no rocks higher than the Conglomerate seem to have shared in the disturbance, or, if they did, all traces of them have been worn away. The mountain is consequently narrow, and Martin's Fork, the stream at the base of the mountain, flows close to the top of the Conglomerate in a very narrow valley, so narrow that there is but little arable land in it. The mountain along here shows, from the Kentucky side, a succession of splendid outcrops of Conglomerate, standing on edge, or very steeply inclined. It holds this character along the lower part of Crank's creek also, where that stream is almost exactly similar to Martin's Fork; but along its upper portion the valley is wider, and is cut in rocks geologically higher, the shales and shaly sandstones above the Conglomerate. A considerable thickness of these rocks, here, share in the elevation of the Cumberland Mountain, and it is owing to this fact, together with the slight degree of dip, that the mountain at Crank's Gap is so broad. The road from Mt. Pleasant, Kentucky, to Jonesville, Virginia, crosses at this gap. It is in reality no gap at all, but simply a place where the road crosses the mountain, and that at one of its highest points. This point runs well out to the east, and from the summit the Cumberland range can be seen down to Speedwell, in Tennessee, twenty miles below Cumberland Gap, a total distance of forty or fifty miles.

About four miles above this point the State line leaves the Cumberland Mountain, and crosses at a low gap at the head of Crank's creek, between that stream and one of the branches of Powell's river, to the Little Black Mountains.

The Cumberland Mountain turns still further to the east, and is henceforward known as the Stone Mountain. The so-called gaps, which have been mentioned, are usually only slight depressions in the crest of the ridge, through which the

mountain paths or trails cross. For thirty-five miles above Cumberland Gap there is no gap of more than three hundred feet depression below the general level of the crest, nor is there in this distance any wagon road across the mountain. Between thirty-five and forty miles above, however, the North Fork of Powell's river has cut through the mountain and made a water-way known as Pennington's Gap. The mountain, here, is only about one thousand feet high, and the rocks, from the Silurian to the Carboniferous, are nearly vertical, with a strike north 30° east. The North Fork of Powell's river, which cuts through here, drains a considerable area lying between the Little Black and the Cumberland Mountains, known as the "Pocket." The line of disturbance does not, here, seem to reach the rocks much higher than the Conglomerate. In this gap a coal is exposed, standing vertical, about thirty-five feet below the upper Conglomerate. The coal is reported thirty inches thick. It is said that there are two other coals found vertical near this point, but they were not seen by the writer.

The scenery at Pennington's Gap is grand in the extreme. The river has made a narrow cut through the mountain, in which the walls of vertical Conglomerate are seen hundreds of feet high, rising far above the rocks on either side, rugged and bare.

Eighteen miles above, at the Big Stone Gap, in the Cumberland or Stone Mountain, another fork of Powell's river, called also the North Fork, and sometimes the Roaring Fork, has cut a similar water-gap through the mountain, which is here about the same height as at the last place; but the rocks are not quite so steeply inclined, dipping only about sixty degrees. The stream at this gap drains a considerable area, lying between the Big Black and the Stone Mountains, and the divide between the waters of the Powell and Guest's rivers, the latter a tributary of the Clinch.

This is the last water-gap cut through the Cumberland Mountain, which extends about twenty miles further to the

east, and finally ends near Guest's river, in Wise county, Virginia.

These two gaps are the natural ways to give access to the boundless stores of coal which lie north of the Cumberland Mountain. Through them, with little expense, the coal can be brought, which will, in the future, supply fuel to the great non-coal-bearing country to the south. Above the Big Stone Gap the Powell valley gradually narrows, the Powell Mountain or range approaches the Cumberland, and finally unites with it above Little Stone Gap, at the extreme head of Powell's river.

From Big Stone Gap the Cumberland Mountain is low, rarely over one thousand feet in height above the valley. About ten miles from this last mentioned point the wagon road to Gladesville crosses the mountain at Little Stone Gap, which is cut about three hundred to four hundred feet below the general level of the crest, and is about six hundred feet above the valley.

The lowest rock seen on the south face of the mountain is the Devonian black shale. It is the surface rock for a considerable area near the head of the valley. It dips to the north very slightly; but above it we have the Waverly and the St. Louis limestone, increasing in steepness of dip as we ascend. The limestone dips about forty-five degrees nearly due north, while on the north slope of the mountain, a few hundred yards after passing the gap, the Conglomerate and inter-Conglomerate beds are standing vertical, or dipping to the north from eighty to eighty-five degrees. Between the Conglomerates there is a coal exposed by the roadside, standing nearly vertical. It was seen about thirty inches thick.

The only published information in regard to the geology of this region which has come to the notice of the writer, is a paper by Prof. J. P. Lesley, the distinguished State Geologist of Pennsylvania, read before the American Philosophical Society, April 21st, 1871, on the geological structure of Tazewell, Russel, and Wise counties, Virginia.

In this valuable and interesting paper, Prof. Lesley gives a section at Little Stone Gap, which he states has not been seen by him, but is published from information given to him. This section correctly shows one vertical Conglomerate with the coal above; but it also shows a fault running lengthwise through the mountain, with the lower Silurian limestone forming the south face of the mountain. From the description given just above, it will be seen that this section is very incorrect.

There is no fault running lengthwise through the mountain; on the contrary, it shows at this place only what may be called the normal structure of the Cumberland Mountain. There is no Silurian limestone exposed on the mountain at this place. The lowest rock seen, both geologically and topographically, is the Devonian black shale.

Prof. Lesley's informant has evidently mistaken the massive St. Louis limestone, which occupies its usual place on the south face of the mountain, for the lower Silurian, and Prof. Lesley himself was the more ready to accept the statement, supposing this to be the westward prolongation of the great Clinch River fault, which terminates the coal field above Guest's river, beyond the end of the Cumberland or Stone Mountain.

The distance from the end of the Cumberland Mountain, at Guest's river, to Cumberland Gap, is about eighty miles. From Cumberland Gap, to the southwestern end of the same mountain in Tennessee, as stated* by Prof. Safford, is about forty miles. Its total length is, therefore, about one hundred and twenty miles, in which distance it is broken by only five gaps, deep enough to be more than serrations in the crest line. These are: Bruce's and Big Creek Gaps, in Tennessee, Cumberland, Pennington's, and Big Stone Gaps. Of these, all except Cumberland Gap are water-gaps, while it is cut three fourths of the distance down from the top of the mountain.

*The reader should keep in mind the distinction between the Cumberland Mountain as described here and the "Cumberland Table Land" which occupies so large a portion of the area of Central Tennessee.

It affords one of the most feasible passages for a railroad, for the reason that, while the other gaps afford a much easier passage through the mountain itself, yet, to get to them, a railroad would be compelled to cross the much higher mountains between the Cumberland river and mountain, while at Cumberland Gap the Yellow Creek valley affords an easy way, with light grades to the very foot of the mountain.

There is, perhaps, a better route for a railroad offered through Pennington's Gap, crossing the divide between the waters of Powell and Cumberland rivers at a very low gap at the head of Crank's creek, which flows at the base of the mountain on the north side; but this is somewhat less direct than via Cumberland Gap.

Above Guest's river, in Virginia, the coal field terminates with a fault which brings the rocks of the Knox series (using the Tennessee nomenclature) up against the coal measures. This fault is unaccompanied by any great topographical elevation, and the disturbance in the rocks of the coal measures is comparatively slight, not extending far back north of the fault. The limestones on the south side of the fault, however, are very much disturbed, showing numerous local flexures and cross-folds close to the line, while further back they dip steeply away to the southeast. From here south to Clinch Mountain, along the road to Abingdon, Virginia, the rocks of the Knox series, and, in a few cases, the Trenton limestone, are seen. The valleys of the small streams are cut in the imbricated edges of these rocks, which are repeatedly faulted, the same series of limestones and shales being crossed a number of times, and usually dipping in the same direction, to the southeast.

At Clinch Mountain the geological series as high as the Devonian shale is represented, while just beyond, south of the Holston river, another fault occurs, which once more brings the lower or middle Knox series to the surface, and we then have a repetition of the features just described: the rocks dipping to the southeast, and occasionally faulted; the upper part of the Knox series and the Trenton limestone

forming, for the most part, the surface rock as far south as Abingdon. The Clinch Mountain here, as further southwest, is capped and shaped by the massive Medina sandstone, which, with the other rocks of the mountain, dips to the southeast. The principal geological and topographical features of this region are well shown in the map accompanying the paper of Prof. J. P. Lesley already referred to.

The fault, which ends the coal measures, lies on the north side of Clinch river, for the most part close to it, and at one point even crosses to the south side of the river. It is shown by Prof. Lesley to extend along the north side of the river to its head and beyond. About twenty miles above Guest's river the fault line runs several miles north of Clinch river, leaving room between it and the river for a fertile valley, known as New Garden. This is principally drained by Lewis creek. The fault line crosses at the very head of this creek, nearly half way up the dividing ridge or the Big Mountain, the divide between the waters of the Clinch and Big Sandy or Chatterawha rivers. The exact height of this mountain was not determined, but it is probably over one thousand five hundred feet above Clinch river, and the fault line occurs about six hundred feet up. Prof. Lesley's map shows the line about three miles too far to the south at this place. It is, however, a region where he states that he has made no detailed examinations.

THE BLACK MOUNTAINS,

Lying between the Cumberland and the Pine Mountain, which will be hereafter described, is a series of hills with the peculiar irregular topography of horizontal rocks, known in Kentucky as the Black and Log Mountains, in Tennessee as the Poplar Mountain, and in its southern continuation as the Cumberland Table Land. Below Yellow creek they are called the Log, and above, the Black Mountains.

They rise to a height greater than either the Pine or Cumberland Mountain, and are formed of the horizontal or nearly horizontal rocks of the coal measures, for the most part sand-

stones or sandy shales. They present a greater thickness of coal-measure rocks, and a greater number of coals, than are known in any other portion of the State. They have not, however, been studied in sufficient detail to enable us to give an accurate general section, showing the position and full number of the coals.

The Log Mountains have been studied at a few places in some detail by Mr. Crandall, of the Survey, who has found a total of seventeen coals, and the section is by no means complete.

Above Yellow creek, the hills which lie between that stream, Browney's and Puckett's creeks, and Martin's Fork of Cumberland river, are first called the Black Mountains. Above Martin's Fork, the ridge between the Cumberland Mountain and Clover Fork of Cumberland river is called the Little Black Mountain, while that between Clover and Poor Forks is named the Big Black. The Little Black, to the head of Clover Fork, is the dividing ridge between the waters of the Cumberland and Tennessee, while the Big Black occupies this position from the head of Clover Fork to the head of Poor Fork of Cumberland.

Beyond the head of Poor Fork a series of irregular hills or mountains are seen between the different branches of Russel Fork of Chatterawha or Big Sandy river, the system and names of which are not yet known. They are by no means so prominent or high as the Black Mountains; but, like them, they are formed of comparatively undisturbed rocks.

Of the Black Mountains below Martin's Fork little was seen. At one place, near Wilson's or Browney's creek, a section of five hundred and sixty feet was measured, containing six coals, ranging from one to three feet in thickness. This section was by no means complete, and it is altogether probable that other coals will be found in the covered space. These hills apparently are about one thousand two hundred feet high. Much thicker coals than seen in this section are reported on good authority near Mt. Pleasant.

The Little Black Mountain, at Child's Creek Gap, where the trail from Pennington's Gap to Clover Fork crosses, is one thousand four hundred feet above the Powell river, and the general average of the range adjacent is from two hundred to three hundred feet higher.

In descending from Child's Creek Gap to Clover Fork, the positions of six coals were seen, but the coals themselves were generally covered; one was seen thirty-seven inches thick, and another is reported to be five feet, but it was not seen.

The Little Black Mountain is said to rise in height until it unites with the Big Black at the head of Clover Fork, at which locality is said to be the highest knob in that region.

The Big Black Mountain, where first crossed at Witt's Gap, is about one thousand nine hundred feet in height, above the Poor Fork of Cumberland river.

At the head of Looney's branch of Poor Fork this mountain reaches the unusual height of two thousand two hundred feet above Poor Fork, measured with an aneroid barometer.

In this mountain and its spurs were seen a number of excellent coals of unusual thickness, sufficient to show that this portion of the State is one of the most richly endowed in stores of mineral fuel.

Near Elijah Creech's, on Looney's branch, in Harlan county, three coals were seen, one forty inches thick, without any parting, and of excellent quality; another one reported the same thickness, but of which the top only was seen, and a third which presented the following section:

Coal	25 inches.
Parting	7 "
Coal	11 "
Shale	22 "
Coal	3 "
Parting	2 "
Coal	11 "
Shale	13 "
Coal	12 "
Parting	4 "
Coal	37 "
Bottom fire-clay	— "

A total of eight feet three inches coal in twelve feet three inches of mingled coal and shale.

About two and one half miles above, near Joseph Blair's, in the bed of the same branch, a coal is washed bare, which shows between five and one half and six feet of clear coal, free from parting. It was inclined a little as it lay in the bed of the stream, so that measurement could not readily be made more exact than given above. It is of excellent quality, a rather "fat" caking coal, and, so far as seen, quite free from pyrites.

On the opposite side of the mountain, on Preacher creek, a coal is exposed in the bank of the creek, six feet three inches thick, with only a thin parting of about one inch. Whether this be the same coal as that last described is uncertain; it is, however, apparently too high.

Near Big Stone Gap, on one of the creeks flowing into the North Fork of Powell's river, a coal is reported nine feet thick; but it was not seen by the writer.

What is the exact geological level of the base of these mountains has not yet been accurately determined. It is probably some distance above the top of the Conglomerate, which we find rising from beneath the surface on both the Pine and Cumberland Mountains. Assuming, however, that this Conglomerate is just at the base of these mountains, and adding the thickness of the Conglomerate and inter-Conglomerate beds to the thickness of rocks on the Black Mountains, we have a total of over four thousand feet of coal measures in this region, which is over twice as great a thickness as is yet known anywhere else in the State, outside of this area between the Pine and Cumberland Mountains.

PINE MOUNTAIN.

In its geological structure and topographical type, Pine Mountain is almost identical with the Cumberland.

It is a long, straight, monoclinical mountain, formed by an uplift of the rocks from the Carboniferous to the Silurian, along a crack or line of fault in the crust of the earth, running in a northeast and southwest direction, parallel with the lower portion of Cumberland Mountain.

On the northwest of this fault lie the comparatively undisturbed coal measures, while on the southeast, the tilted rocks forming the mountain dip steeply away to the southeast. The dip is, therefore, in the opposite direction to that of the rocks of the Cumberland Mountain, and we have reappearing here the same rocks which plunged underground at the base of that mountain.

The two form in reality the two edges of a long basin or valley, with, in the lower part, an average width of about ten miles from crest to crest.

The Pine Mountain is much more regular in its outline than the Cumberland. Its crest is almost a straight line for its whole length, and it presents few great irregularities in height. In its lower part, along the Cumberland river, it has an average height, so far as seen, of about one thousand two hundred feet, which gradually rises to about one thousand four hundred to one thousand five hundred feet at its upper end, where it lies between branches of the Chatterawha or Big Sandy river.

The course of the fault along which the mountain runs is about north 30° east. The mountain extends in Kentucky from the State line, where Clear Fork of Cumberland river cuts a water-gap through it, to the Russell Fork of Chatterawha or Big Sandy river, a distance of about one hundred and ten miles. It extends probably twenty-five miles farther in Tennessee. It is, therefore, longer as well as straighter and more regular in outline than the Cumberland Mountain. At the upper end it is known as the Laurel, and sometimes as the Cumberland Mountain, a circumstance which leads to much confusion, the cause of which has never before been understood.

Pine Mountain is also accompanied by a series of parallel streams flowing at its base on both sides. Beginning where the Russell Fork of Chatterawha river cuts a deep cañon through the massive sandstones at the terminus of the mountain, we find the Pound Fork flowing at its base on the south, with Elkhorn creek on the north. Pound Fork heads in the

Big Black Mountain, against the Poor Fork of Cumberland, which flows at the foot of the mountain, in the opposite direction, until it unites with Clover and Martin's Forks, and forms the Cumberland river. This, in its turn, follows the foot of the mountain, until it cuts through at Pineville and leaves it, flowing to the north and west. At the foot of the mountain on the north, beyond the head of Elkhorn creek, the North Fork of Kentucky river flows for a short distance. It is then succeeded by its branches, Kingdom-come creek, King's creek, and Line Fork, which successively occupy the foot of the mountain for the next twenty-five miles. Beyond the head of Line Fork, Straight creek, a branch of the Cumberland, follows the foot of the mountain for about thirty miles, until it meets the river, just as it emerges from the gap through the mountain at Pineville.

As already stated, the rocks of this mountain are essentially the same as those of the Cumberland. There is this difference, however, that the lowest rocks of the Cumberland Mountain have not yet been found on the Pine. The general dip of the rocks is twenty to twenty-five degrees to the southeast, subject, however, to local variations, which do not seem to be so frequent as in the Cumberland. The crest-forming rock is the Conglomerate, which presents all its peculiar characteristics. Below this the inter and Sub-conglomerate shales, St. Louis limestone, Waverly sandstone, and Devonian black shale, occur in the same order, and approximately the same thickness, as on the Cumberland.

Below the Devonian black shale the rocks are usually covered, so that it is really not yet known what is the thickness and character of the rocks between this shale and the base of the mountain. The distance from the black shale to the drainage level varies from one hundred and fifty to three hundred and fifty or four hundred feet. At a few places exposures of shales and shaly sandstones have been seen, but a complete section has not yet been obtained. These rocks correspond probably to the shales and sandstones above the Clinton or Dyestone ores on the Cumberland Mountain. At

some places it seems probable that the lift of the mountain is sufficient to bring the ores above the drainage; but they are covered by the talus from the rocks above, and will not be found without digging for them. The ores have not been found on Pine Mountain, as yet, by any member of the Survey in Kentucky, nor is there any authentic report of their discovery by others.

In Tennessee, near Elk Gap, Prof. Safford reports the uplift of Pine Mountain to be such as to bring the Cincinnati and Trenton limestone above the drainage, so that the Clinton ore is also above. He reports it at this place three feet thick. There is, therefore, no good reason why, in some localities at least, the ore may not be found in the Pine Mountain in Kentucky, although there are undoubtedly places where the uplift is not sufficiently great to bring it to the drainage level.

There is no series of foot-hills corresponding to the Poor Valley Ridge, at the base of Pine Mountain; on the contrary, the hills of the coal measures, with the peculiar irregular topography of horizontal rocks, approach close to the foot of the mountain. In one case, on Straight creek, a horizontal coal bed three feet thick was seen at the foot of the mountain, between it and the creek. The same thing is reported at several places on Elkhorn creek, in Pike county.

This shows that the stream has run to the north of the fault, and that this is very close to the mountain. It proves also that the retreat of the crest line of the mountain, under the erosive agencies which have been so long at work upon it, has been but a short distance, hardly more than a half mile back from the fault line.

Cumberland Mountain, on the other hand, from the position of the rocks in the Powell valley, bears evidence of having retreated from the southeast several miles. Powell river runs in a wide anticlinal valley, the rocks of which dip away from the river in each direction. The river runs in the Knox Dolomite, and we have the series, from this rock up to the Carboniferous, repeated on both sides without any fault or break of consequence. This affords pretty conclusive evidence that

the whole series originally extended across in a grand anticlinal, about fourteen miles wide, and several thousand feet high. This has been worn away until we have the Cumberland Mountain left, after a retreat of seven miles. Such being the geological history of the two mountains, it follows, since we have no authority to assume a difference of intensity in the action of erosive agencies upon the two, that the Cumberland must have been elevated long before the Pine Mountain.

Pine Mountain, therefore, as it is the farthest to the northwest of the great parallel mountains of the Appalachian system, which are so numerous and characteristic of the East Tennessee and Virginia region, is also the most recent in its elevation.

Pine Mountain is cut through by Clear Fork of Cumberland near the State line, by the Cumberland river at Pineville, and at its upper end by Russell Fork of Chatterawha river. In addition to these water-gaps, the Sounding or Pound Gap, a wind gap, cut about one fourth the way down from the top, affords a passage way across the mountain. There is a wagon road through this gap, and also at Pineville; but in the space between, a distance of about sixty miles, there are nothing but bridle paths crossing the mountain.