GEOLOGICAL SURVEY OF KENTUCKY.

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DESCRIPTION

OF THE

PRELIMINARY TOPOGRAPHICAL AND GEOLOGICAL

MAPS OF KENTUCKY,

EDITION OF 1877,

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DESCRIPTION OF THE PRELIMINARY TOPOGRAPHICAL MAP OF KENTUCKY, EDITION OF 1877.

INTRODUCTION.

This map is designed especially as a record map for the use of the Kentucky Geological Survey, and in order to fit it for that use contains some peculiarities which require explanation. It will be noticed that the names of towns are, in some cases, limited to the county town and other important towns of each county. This has been done in order to leave more space for the notes of the officers of the Survey. Subsequent editions of this map will give more of these local names. Special efforts have been made to secure the names and direction of flow of all the streams. Their relative size is also given, with an approximation to accuracy, by the width of the lines which designate them. The several river systems are distinguished from each other by the shading of the surface.

It will be observed that there has been no effort made to represent the relative level of different parts of the State by indications showing the hills and mountains. The reason for this is, that, except in about five thousand square miles of the surface where the special topographical work of the Survey has been completed, no data exist for making such a map. In this, as in all other topographical work, the Geological Survey is at a very great disadvantage, compared with similar undertakings in other States. Kentucky never received a survey after the plan of the other States whose public lands belonged to the General Government, but has remained to this day without any other basis for a map than has been furnished by various surveys made for railways and other public improvements, together with the various military

surveys made during the late civil war. These were combined during the later years of the war by the orders of the generals commanding in succession this department, and from this military map of Kentucky and Tennessee the topography of the appended map has in good part been taken. The railroads are laid down from their several surveys, and the rivers are from the surveys that have been made at sundry times. It is intended that this map shall be supplemented by successive editions, giving the connections and improvements which may be made from year to year, during the time required to accumulate the materials necessary to form a larger and better map of the State.

It will be seen that the map is made on the projection known as the projection on the cone, the meridians being drawn parallel to each other. This arrangement, though objectionable on some accounts, is the most convenient for all purposes: the distortion it brings about is not worthy of notice in an approximative map such as this. It is the projection adopted in the military map which has furnished the general plan of this. The indication of the meridians are not to be taken as definite, or by any means certain for their positions. They are doubtless nearly true where they cross the Tennessee line; and the base lines furnished by the old Survey serve to help the adjustments; but, on the whole, they are only rude approximations. In order to facilitate reference to the map, it will be seen that the spaces of fifteen inches each have been numbered for the meridians and lettered for the parallels. This will make the designation of any particular spot a matter of comparative facility.

The average error of the geological position of the points given on this map is great. The triangulation work under way has proven, that for the southeastern part of the area the error of position of points in relation to each other is so great, that any two points given as one hundred miles apart on the map may be no further than ninety-seven, or as much as one hundred and three miles from each other. The error in compass course of the lines joining any two points is proportion-

ately quite as great. Successive editions of this map will progressively eliminate these errors.

PRELIMINARY DESCRIPTION OF THE TOPOGRAPHY OF KENTUCKY.

To aid in the understanding of this map, as well as to give a general idea of the features of the country that are not represented by it, I shall give a brief account of the surface features of the country, and some explanation of their connection with the underlying rocks. This will require a short statement of the geology of this district. In this statement all details not necessary to a general understanding of the subject will be carefully omitted.

The whole of the State of Kentucky lies within the valley of the Mississippi river, and about all of it within that section drained by the Ohio and its tributaries. Scarce any other State in this country has a drainage so entirely limited to one direction of flow. Every part of it, save a small strip along the Mississippi, lies on the southern tributaries of the Ohio river, the meanders of which river form nearly seven hundred miles of its northern boundary. This river, one hundred and forty miles of the Big Sandy, and about fifty miles of the Mississippi, below its confluence with the Ohio, constitute the river boundary of the State, and form the whole of its west, northwest, north, and northeast lines. The southeast face is formed by Cumberland Mountain and some of its associated ridges, and the south face by an arbitrary east and west line, extending from Cumberland Gap to the Mississippi river, with a few irregularities in its course. Thus the forty thousand square miles of area is inclosed in an irregular pentagon, four sides of which are natural boundaries of river or mountain range, and only the fifth is a conventional boundary. The topography of the State is as simple as its outline. The Ohio river, so prominent a feature in its map, is the key to most of its surface. All except about one eighth of its area, situated in the southeast corner of the State, lying within a line extending from the north end of Floyd county to the southwest side of Whitley county, may be regarded as a part of the

valley table-lands of the Ohio, varying in character according to their underlying rock, but owing their form almost entirely to the cutting action of the rivers, acting upon rock which has never been thrown into great mountain folds. In the formation of this surface there have been, with slight exceptions, no other factors than the hardness of the rocks and the energy of the wearing agents—running water and frost. This has given a surface in general rather level, but elevated high above the plane of the main streams, which cut for themselves deep valleys with precipitous sides, often true cañons in their form. The height of these elevated plains above the sea, and above the drainage, varies a good deal, according to their position in the State and the nature of the rock in which they have been excavated. At Hickman, the base of the topography may be placed at about two hundred and fifty feet above the sea; rising from twenty feet in the lowlands to one hundred feet in the small area of Tertiary deposits in the Chickasaw plateau. From this section, towards the eastward, there is a continual increase of height. This may best be represented by drawing radiating lines from the mountain area of Southeastern Kentucky in every direction to the Ohio, this mountain section being the stream centre of the South Ohio area, all its southern tributaries pointing towards that region. The drainage levels rise with great uniformity in that direction; the only great differences of level being caused by the change in the height of the plateau between the streams. Whenever these lines cross the line of outcrop of the different formations, there is apt to be a sudden change in the character of the surface, and often a distinct cliff-like ridge occurs. Muldraugh's Hill and Big Hill are good examples of this structure. Many of these lines of escarpment or outcrop are commonly represented as mountains on the several maps which have been published. They differ from ordinary hills, inasmuch as they are sloped on only one side; their face may be cut so as to make many steep valleys and isolated hills; but as a whole the outlines are only accidents connected with the wasting of the escarpment. They also differ from the ordinary hills in

being steep-faced on one side only, while ordinary mountain ridges are steep-faced on their several sides. These escarpments, again, differ from mountains of elevation in having the rocks that compose them lying in essentially horizontal positions, while in the mountains the disturbance to which the rocks have been subjected have done much to give them their form and elevation.

The surface of the greater part of Kentucky having been in the main the product of erosion, quite without the complication given by the various abrupt tiltings occurring in the mountainous regions of the globe, it is naturally found to lie in these comparatively level table-lands, which always mark horizontal strata. The data does not yet exist for determining the height of every part of the State; but, from the before-described base at the northwest corner, we rise to about five hundred feet for the table-land of the Carboniferous of Western Kentucky, between the Cumberland river and the Louisville and Nashville road. Going still further east, the gain in height is continued to a line drawn from Lexington southwesterly to the Kentucky boundary, where the surface attains to a height of about one thousand feet above tide-water; but the table-land rises more rapidly than the stream-beds, so that the valleys of the stream-courses are deeper as we go towards this central region. Passing this line, extending south from Lexington, we come into a region where, except near the Ohio, the rise in the stream-beds continues, while the table-lands rather lose in height. The cause of this is found in an important though comparatively slight change in the position of the rocks beneath this line, extending from Lexington towards Nashville. This line extends along the top of a low ridge, formed at a very early date by a broad folding of the rocks of the earth's crust. This ridge seems to have been more than four hundred miles long, about a hundred miles in its east and west transverse measurement, and rising to a height of from three to eight hundred feet. At Cincinnati and at Nashville this ridge had its greatest height. In the country through which the Green river passes lies the lowest part of the ridge.

The ridge extends some hundred miles or more to the north and south of the highest points at Cincinnati and Nashville. In general character it closely resembles the other mountain ridges of the Allegheny system: its course is the same, and the greater elevation of the ridge near either extremity is also a character in which it resembles the mountains on the east.*

This Cincinnati-Nashville axis causes the central part of the State to rise above the level it would otherwise occupy. East, south, and west of the Lexington summit is a semi-circular trough, extending from the Ohio river, in Mason and Lewis counties, around the outcrop of the soft beds of the Devonian shale, which lie just over the Cincinnati Group, through the counties of Lewis, Fleming, Bath, Montgomery, Estill, Madison, Lincoln, Marion, Nelson, Bullitt, and Jefferson, to West Point, on the Ohio river. This depression is due to the wearing out of the soft beds of the Devonian shale, and, in a less degree, to the erosion of the soft beds which lie at the top of the underlying Silurian beds, and the base of the overlying Waverly shale. The depression of this valley is very slight, provided we reckon from the top of the highest hills to the bottom of the lowest valleys. The hill-tops are almost as high as those of the Silurian district, and the river valleys fall, on the average, but little below the level of those which lie over the broad Nashville-Cincinnati mountain; but the hills in this section are apt to be mere knobs, capped by a plate of the hard beds of the superior rocks which have worn away. The valleys are relatively very broad. It often happens that a small rivulet that can not be ranked more than a sixth-rate stream—one too small to require bridging on ordinary roads—comes to have a broader valley than a stream like the Kentucky river, where it cuts through hard rock.

In general we may say that the table-land district of Kentucky, which includes all its area except the small mountain district before described, has its hill-tops about conformable

* For a fuller account of this ridge, see notes on the question developed in the explorations of the Geological Survey, in this volume.

to an inclined plane sloping from the Ohio and Mississippi upward towards Cumberland Gap, and only varies from this uniformity of structure in the width and depth of its valleys.

The distribution of the main rivers of Kentucky, though simple and conformable to the general slopes of the country, has some points of special interest which deserve mention. It will be noticed that they all head in or near the mountain mass in the southeast corner of the State, and pass on more or less distinctly radiating lines towards the Ohio river, falling into it at right-angles to its direction of flow. Extending our view beyond the limits of the State, so as to take in the whole system of tributaries of the Ohio, we then see that the main drainage centre of that basin is found in the great system of mountains and valleys belonging to the Appalachian chain, within the boundaries of Eastern Tennessee and Virginia. The Tennessee and the Cumberland originate well within those mountain walls, and, limited by their barriers, flow to the southwest, but, guided by the general slope of the rocks, always pressing against their walls on the west, and taking advantage of every weak place in the line to gain something on their western journey. In this westward advance they are aided by two elements in the structure of these mountains: First, the frequent transverse breaks in the rocks of the mountains caused by faults. Second, the successive lowering in the height of the valleys as we go to the westward. Generally a good part of these mountain ridges consist of limestones which caverns easily, and so readily begins a break from one level to another. As the Tennessee begins far within the central valleys of the Alleghenies, it has a long wrestle with the mountains as it follows their general slope southward, and their cross-slope to the westward, until it has quite crossed the mountain. It then turns at once to follow the general trend of the valley of the Ohio. The upper Cumberland makes but one break across a mountain—that at the gorge where it passes Pine Mountain. It then has to encounter the Cincinnati-Nashville axis, which causes it to keep away

from its normal course until it passes that ridge, when it turns towards the Ohio and becomes parallel to the Tennessee.

The Green river does not get far enough east to feel any influence from the Cumberland Mountains, and so follows the normal course of the valley tributaries of the Ohio. The same may be said of Salt river and of the Kentucky, save at its very head. A few of the upper tributaries of the last-named river lie within the disturbed region of the Cumberland Mountains. As shown on the map, the courses of these mountain-bordered tributaries depart sharply from the trends of the other branches. These tributaries of the Kentucky, which fall within the mountain lines, are all quite small, none of them exceeding twenty miles in length. The Licking river, which occupies only a limited area between the Kentucky and the Little Sandy and the Chatterawha or Big Sandy, does not attain to the disturbed belt of the mountains, and the other smaller streams between the Licking and the eastern border of the State are also limited to the table-land region. The Chatterawha or Big Sandy river differs in some important regards from the other Kentucky rivers, and from most of the main tributaries of the Ohio, especially in the peculiar feature of having one branching, where the stream is divided into two equal forks. This unusual arrangement is not readily explained, from our present inadequate information as to the structure of the rocks in that region. Only the westernmost of these branches has its head waters within Kentucky. The uppermost tributaries of this branch turn abruptly into the trends of the Cumberland Mountains, flowing to the northeast until they escape from the mountain troughs.

We have now considered the relation of the Kentucky rivers, and seen that, while their head waters are to a certain extent involved within the mountain valleys of the Appalachian system, these streams as a whole, at least within her borders, are quite purely table-land rivers, and conform to the same laws as those tributaries which flow into the Ohio from the north. We may now pass to the details of their structure.

There are some peculiarities of the Kentucky streams which, though not evident on the map, are quite important, both in an economic as well as in a scientific way. The most important point is the rate of fall observable in the course of the streams. The average fall of the Ohio, Tennessee, and Cumberland, within the limits of Kentucky, is probably less than six inches to the mile. The strictly Kentucky rivers have much greater rate of descent, on account of their relatively shorter courses. The Big Sandy river, for instance, falls half as much in its short course as the Tennessee in its course of thrice as many miles. The average fall of the Kentucky, Licking, and Sandy rivers is about one foot to the mile; but this is distributed in a very unequal way—the fall ranging from an average of three feet on the upper half to six inches or less on the lower half. The northern tributaries of the Ohio have about double the rate of fall of its southern affluents. This less rapid inclination in the southern tributaries of the Ohio is a curious feature, and one not readily explained, save in a general way. It is, in good part at least, due to the fact that the drainage slope on the south is far wider than on the north; so that, while the rivers have a greater height for their descent, they have also a much greater proportionate distance in which to accomplish their journey from their source to the main stream. Besides this, they come from a region having a much greater rainfall than those on the north of the Ohio, and thus, being larger streams, have in time cut their beds deeper into the rock foundations.

These features give to our Kentucky rivers a great economic value—a value not possessed by any of the northern tributaries of the Ohio, and by none other of its southern streams, except the Kanawha and Monongahela rivers, which have the same features. Of all the tributaries of the Mississippi, these rivers which pass through Kentucky are the most susceptible of improvement, and, when rendered navigable, the most likely to be the means of developing important industries. Their channels are well defended by rocky banks, which afford excellent foundations for dams, and their head waters are

admirably suited for the storage of water to insure a constant navigation. When they have received that improvement of which they are so susceptible, they will afford at least two thousand miles of slack-water navigation, of which more than one half will be through the richest field of coal, iron, and timber that is afforded by any part of this country. They are the natural avenues to a vast store of the most important bases of industry.

Before leaving the consideration of our rivers, it is well to notice the way in which the evenness of their distribution shows the uniformity of the geological structure of Kentucky. They, one and all, originate in the beds which belong in the Carboniferous series of rocks. With the exception of Green river, all of them have their sources in the rocks containing the coal beds. This river has its head waters in the Sub-carboniferous limestone; but, as if to make amends for the loss the river has received from the wearing away of the coal beds through which its head waters once flowed, its course is so laid as to pass through the important coal basin of the western half of the State, where, for a hundred miles or more, it is bordered by an admirable coal field.

Close consideration of the map will show that there are considerable areas in the district it represents where there is a curious absence of streams: one of these, and the largest, lies within the limits of the counties of Warren, Edmonson, Barren, and Hart. In one direction the traveler may pass for about fifty miles without encountering a single surface stream. The whole drainage of the country is underground, through the vast and interminable system of caverns which honeycomb the whole area. The water falling on the surface courses for a few hundred feet, and then plunges downward through a sink-hole into the subterranean ways below. On the surface we have either a plain pitted all over by these sink-hole entrances into the caverns below, or else a system of ridges and valleys which have survived the loss of the streams that once flowed through them, and their water-courses are now replaced by rows of sink-holes, which swallow the streams

before they become more than trifling rills. For each of the extinguished surface streams which, as the sandstones of the coal period in which they once flowed were cut away, disappeared in limestones below, there is an answering cavern line, or rather a set of caverns, tier on tier, which mark the successive down-working of the stream in the different levels of the mountain limestone. There are several other regions in the State where there are very extensive caverns, but none so important as this. Generally the lesser streams alone have their courses subterranean, while the considerable creeks flow in the open air, occasionally sinking for a certain distance. Breckinridge and a part of the adjoining counties have this character, and near all the outcrops of the Sub-carboniferous limestone it is generally found; so that the caverned area of the State, or the region where the streams generally work for much of their course underground, probably exceeds five thousand square miles, or about one eighth of the whole surface of the State. In some sections, as in the cavern district of Carter county, the caves have been deeply worn down, so that they have had their roofs much stripped away, leaving fragments of the arches in the shape of natural bridges, which here, as elsewhere, are always but the ruins of cavern vaults.

The rivers of Kentucky, with few exceptions, and those mainly in the mountain regions, occupy deep sunken valleys with very steep walls. Within and below these walls we have marks of the recent action of the rivers at various points above their present plane. Above their level the surface gives us evidence that the rocks have been decaying in their places for a very great time. Yet, upon these upper levels, at a height of one, two, or even three hundred feet, we sometimes find river gravels, showing that the streams have worked for great lengths of time in their present neighborhood; and showing further, that, in the vast time that has elapsed since the rivers flowed on these ancient beds, there have been no agents at work which could efface their work. This, in itself,

is evidence enough that the surface of Kentucky was not swept by glaciers during the last geological period.

The accompanying map of the river basins of Kentucky will show the irregular way in which the surface of the State is shared among the rivers. It is not easy to account for this irregularity in the disposition of the streams away from the mountain regions. Away from those disturbed regions there are only slight irregularities in the rocks, which do not seem to have any power of determining the range of a river basin. Other explanations being wanting, it seems worth while to suggest that the topography we have here may be inherited from the conditions given by the beds in which it was formed. Each generation of rivers is like a generation of living beings. Its character depends not only on its own existing conditions, but on the condition of those that have gone before. When our streams were running on levels that are now hundreds, or may be thousands, of feet above their present level, the rocks they were cutting may have been disposed so as to give them their present arrangement, and their present order may have been inherited with little change.

At certain points these local peculiarities of distribution of streams are so great as to baffle conjecture. The drainage opposite the mouth of the Sciota, in Lewis and Greenup counties, is a case in point. This drainage area is all sloped away from the river for a considerable stretch along its banks, the hills, six hundred feet high, shedding their water to streams that only find their way to the main river after very devious courses. Another puzzling case is that of the drainage on the south side of the Kentucky river from Frankfort to Dick's river. The head waters of Salt river take nearly all the water of the region bordering the Kentucky on this part of its course. A glance at the map will show that for nearly thirty miles the head waters of Salt river run parallel with the Kentucky, and at an average of less than ten miles from that stream. It is not improbable that the fault system which crosses the Cincinnati axis at this point is in some way connected with this peculiar system of drainage, though I have

not yet been able to determine this point in a satisfactory manner. It seems likely that the rivers have flowed for a long time in the same general position where we now find them. This is proved, not only by the ancient gravels at a great height above the present high-water levels, but by such case of clearly parallel channels as those of the Cumberland and the Tennessee rivers. These run near each other for over seventy miles of their course, the average distance apart in this part of their course not exceeding ten miles, and being for about a score of miles reduced to half that distance. If either of these rivers had wandered greatly since they became parallel to each other, the result would necessarily be their union in one stream.

The same limitations may be put to the wandering of the upper Cumberland where it flows through Knox county. As will be seen from the notes on the surveys made at the time, it was proposed to direct the waters of the upper Cumberland into Goose creek and thence into the Kentucky, the valley of Goose creek lies considerably lower than the valley of the upper Cumberland; so that the natural passage of the Cumberland would have been directly to the southwest after it passes through Pine Mountain and into the upper Kentucky. If the Cumberland had ever swung to the north as much as fifteen miles, since the establishment of the relative height in their valleys, then it would necessarily have been diverted from its present course into the channel of the Kentucky. As this difference in height in the Cumberland and Kentucky river valleys is due to the greater thickness of the Conglomerate in this section, it dates back to a very early time. I am disposed to believe that the relative levels of these valleys have been about what they are now for a very long time; so the probability is that the Cumberland has never wandered far enough to break into the slope of the Kentucky.

Although not one half the actual sinuosities of our rivers are indicated in this preliminary map, it will be seen that their course is exceedingly tortuous; far more so than the course of

the average American streams. Their comparatively gradual descent is accounted for by this winding character. It is not so easy to account for the windings themselves. It is likely that this is the normal character of streams whose valleys have never felt the tread of the glacial rivers, which necessarily tend to take out the windings of the river in a very summary fashion. Throughout New England and all other extensively glaciated regions known to me, the general character of the valleys is just what it is in those parts of the Ohio river system, lying north of the Ohio, which have been subjected to glacial action. An ice stream working in the Kentucky or Licking valleys would have made a broad U-shaped valley, instead of the narrow V or cañon-shaped gorge. This existing structure of our Kentucky valleys is a strong proof that, since they began to occupy their present beds—that is to say, for the last four hundred feet of their cutting—there has been no ice action in their valleys.

The tortuous character of our Kentucky rivers gives the State more river front than occurs on any other region where I have had the opportunity of making measurements. As there is usually only about four hundred feet of fall to be accomplished from the smallest tributaries to the main Ohio, it is readily seen that the head waters of the larger streams have a very gradual fall. It also follows that the average rule of fall of any stream is generally proportionate to the distance it has to flow to find the Ohio. Many of the small tributaries which fall into the Ohio, after a course of twenty miles or less, fall more than half the distance that the Kentucky river does from its uppermost head waters to its mouth, though the actual distance traversed in all its windings is not less than four hundred miles. As the amount of descent in the case of the Kentucky river cannot be more than twice that of the shorter stream, it is evident that its average fall is not over one tenth that of the shorter stream. I believe it will be found that the same length, measured on the head waters of the Kentucky or other principal rivers, and on the small tributaries of the Ohio, say those less than a score of miles in

length, will show a less rate of fall than on the shorter stream. Although there is no evidence in the way of measurement to show this fact, it may be inferred from the consideration that, though the Kentucky at the Three Forks is over five hundred feet higher than the Ohio at its mouth, the tributaries for a great distance above that point fall at the gradual rate of less than one and a half feet per mile. The length of the confluents of the stream seems to increase, on the whole,as we ascend the river, though the general level of the uppermost waters does not rise. This compels us to the opinion that the upper branches must fall less than the lower. This gives these rivers the essential features that fit them to be used for canals, and fits them for the passage out to the main river of the great stores of coal and iron which are found about their head waters.

The fact that the lowest points in Kentucky are about two hundred and fifty feet above the sea, and that nine tenths of its surface is at least two hundred feet above its nearest river, makes it on the whole free from swamp land. Except along some of the smaller rivers and creeks, where accidental obstructions have clogged the passage of the streams, the actual permanent swamp land is limited to the region west of the Cumberland river. This extreme westerly section will probably average fifty feet above the level of the extreme high water, and at least two thirds of its surface will, when the natural drainage is improved by clearing out the streams, be found to have sufficient surface drainage. About one thousand square miles of the surface west of the Tennessee, lying below the river bluffs, and representing regions recently abandoned by the streams, is subject to continued flooding to such an extent as to make cultivation hazardous or impossible.

These lowlands are probably due to the wandering action of the rivers, but may be, in part, owing to the subsidence of this region, or rather the elevation of the region to the southward by a few feet. The problem of the drainage of this low area has been elsewhere considered; but the actual value of the drainage problem to the State at large is relatively small.

The swamp section is not over the fortieth part of its surface. Small though it is in area, this belt of low-lying land is the richest in the State, and the floods, which damage it in their uncontrolled form, would, if their visitation could be limited to the winter, be of immense advantage from the continued fertility they bring in their train.

A large part of this occasional flooding has been brought about by the reckless mismanagement of our rivers, and may be overcome in the progress of improvement of their conditions.

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