"KENTUCKY GAP," a Natural Roadway out of the Big Caney Creek Canon.

GEOLOGICAL SURVEY OF KENTUCKY.

JOHN R. PROCTER, DIRECTOR.

REPORT

ON THE

GEOLOGY OF ELLIOTT COUNTY.

BY A. R. CRANDALL.

ALSO,

NOTES

ON THE

TRAP DIKES OF ELLIOTT COUNTY.

BY A. R. CRANDALL AND J. S. DILLER.

STEREOTYPED FOR THE SURVEY BY JOHN D. WOODS, PUBLIC PRINTER AND BINDER, FRANKFORT, KY.

This page in the original text is blank.

INTRODUCTORY LETTER.

J. R. PROCTER, *Director of the Kentucky Geological Survey:*

I herewith transmit to you my report on the Geology of Elliott county. In so doing, perhaps it may be proper for me to state that it has been made up from data gathered together by such brief studies, and at such times during the progress of the work in the upper counties, as the exigencies of the case have permitted. It is therefore more general in some respects than otherwise might have been expected. On the other hand it will, I think, be found to contain such an outline of the geology of the county as will be most serviceable in calling attention to its natural adaptations; leaving some interesting problems in the geological history of the region for discussion in connection with the general geology of Eastern Kentucky as is preferable.

The accompanying map is made up in part from surveys by the Eastern Kentucky Railway Company (the officers of which have also generously facilitated the work in this county in many ways), from the Portsmouth and Pound Gap preliminary line, and from Lesley's outline map; but chiefly from surveys made by Assistants C. G. Blakeley and J. A. Shackleford, under the direction of the present Geological Survey. From the nature of the drainage this work has been unusually difficult, and in consequence the map is not as complete in detail as is desirable. In this connection it should be stated that the county line, as shown on the map, is made to conform only in a general way with the meanders of the county survey as indicated by the notes on record in the clerk's office at Martinsburg. Since the publication of this map, I have been informed that the upper part of Big Sinking creek, from about one-half mile above the Olive

Hill and Martinsburg road, at Dr. Campbell's, should be included in Elliott rather than in Carter. As the map is already printed, this statement must suffice to correct the line as plotted from the notes of the county survey.

Illustrations of the topography of Elliott, by photo-lithography, are added to the general descriptions, both as a matter of economy in space and of accuracy of delineation, which the text alone could not present.

In plate one an illustration is given of the composition of a vertical section from notes of observations in the field. This has been thought desirable in order that the general reader may be the better able to form a correct estimate of the value of geological sections, as introduced in reports generally to show the serial order of beds.

Finally, acknowledgments are due for hospitality and for assistance from the people of Elliott, with whom the members of the survey have come in contact in the prosecution of the work represented by this report.

A. R. CRANDALL, *Assistant.*

REPORT ON THE GEOLOGY OF ELLIOTT COUNTY.

Elliott county is wholly within the coal-field of Eastern Kentucky. Its western boundary is very nearly also the western limit of the coal-measures. Geographically it falls between Rowan county on the north-west, Morgan on the south and south-west, Lawrence on the south-east, and Carter on the north and north-east. In its relation to the drainage it is almost entirely in the valley of the Little Sandy; including the head waters of that river. The county line follows with some deviations the water-shed between the Little Sandy waters and the waters of Big Blaine, Big Paint, Elk Fork, North Fork and Triplet creek—tributaries of the Chatterawha or Big Sandy river and the Licking, which, with the Little Sandy, form a radial drainage from the high land of this region. On the north the line is an arbitrary one, stretching across the valley of the Little Sandy, which also includes most of Carter and Greenup counties.

With such modifications as follow from the geology of this county, its surface features are like those of Carter and Greenup, and in marked contrast with Morgan and Menifee south-westward along the border of the coal-field. The conglomerate escarpment of these counties, broken and irregular from the erosion of streams running for the most part contrary to the dip of the rock formations, disappears to the northward of the Morgan and Elliott line; and the border escarpment is continued as an ordinary ridge, forming an unbroken water-shed through to the Ohio river, the western boundary of Elliott, Carter and Greenup counties. From this water-shed of Lower Carboniferous sandstone and shale (the Waverly beds) the eastward drainage follows the direction of the dip until interrupted, as it is somewhat irregularly, by successive coal-measure escarpments which deflect

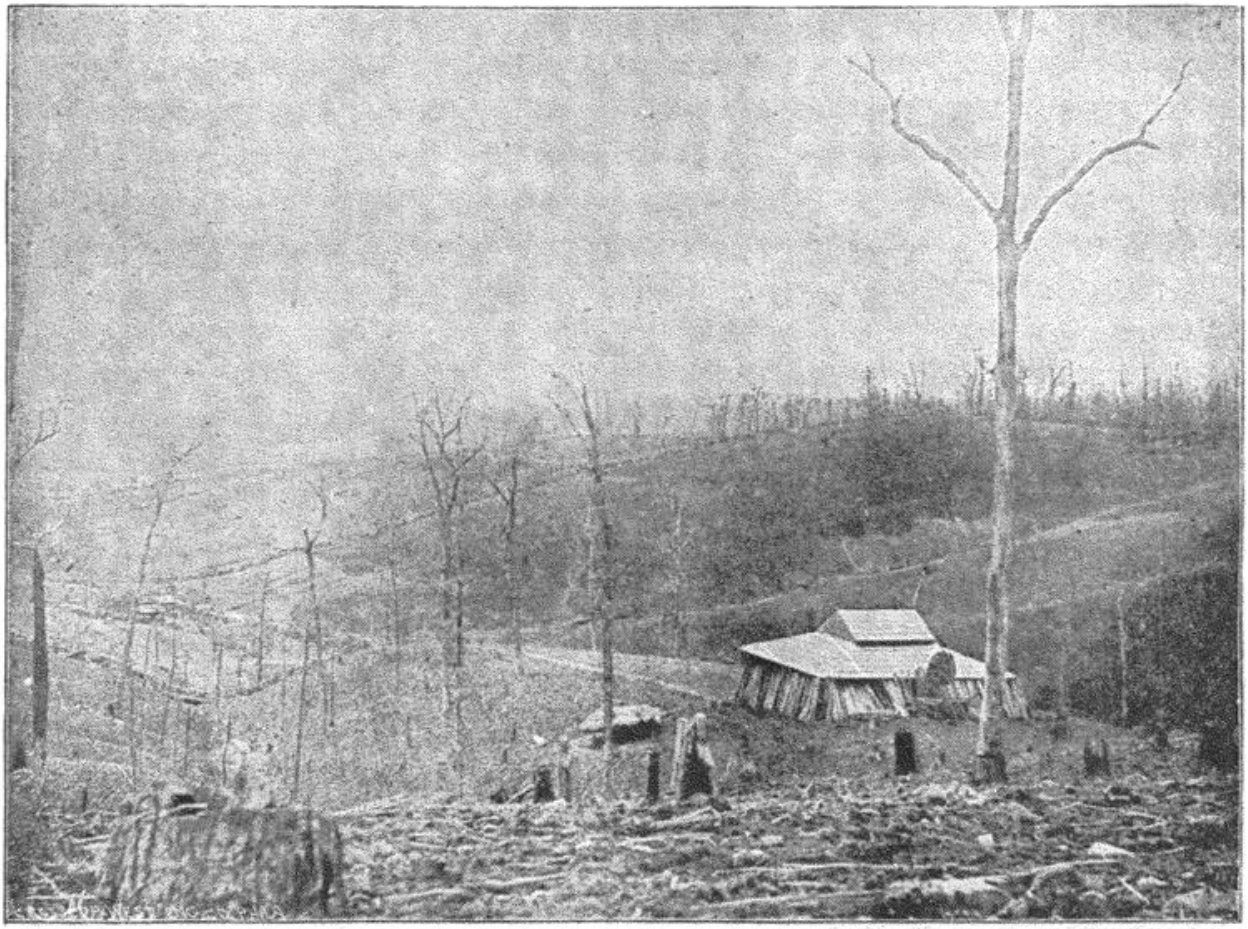
the main streams to the northward through these counties. (See maps with this and previous Report.)

The increased thickness of the conglomerate sand rock to the southwest along the eastward slope of this main watershed gives greater prominence in Elliot to a feature which is one of the characteristic contributions of this formation to the topography of the country, namely, cliff-bound creeks. Travelers on the Chesapeake and Ohio Railway remark the massive walls along the Little Sinking creek in Carter. Here the conglomerate sandstone shows a thickness of seventy to ninety feet. In Elliott the cliffs reach a maximum of one hundred and seventy-five feet. This massive formation has a dip eastward less than the whole fall of the streams. Very little of it remains along the eastern slope of the main ridge at the head of the cliff-bound creeks of Elliott; but it becomes prominent not far from the heads of all the main streams in question, and, by a series of rapids and falls, the whole or the greater part of the formation is exposed in the wall-like cliffs which mark the tortuous courses of the streams below. On Laurel creek and on Caney, as well as on the Little Sandy for some miles, the Subcarboniferous limestone is exposed, rising to a height of twenty-five feet above the bed in places. The conglomerate sand rock here rests upon the limestone, with slight traces of transition beds. As may well be supposed, the natural scenery along these creeks is unusually interesting and varied. (See accompanying photo-lithographic illustrations.)

East of the Little Sandy river the cliffs rapidly disappear; both the dip and the direction of the water-courses conspiring to place the conglomerate sand rock below the beds of the creeks in this direction. Elliott county, therefore, illustrates two types of topography. In the cliff region, as indicated by the shading on the map, the narrow and abrupt valleys are separated by comparatively broad table-lands. As the cliffs disappear to the eastward the valleys become more open, and the hills are reduced to the characteristic narrow ridges and spurs of the productive coal-measures.

The conglomorate table-lands are diversified by drainage slopes of moderate inclination and height, including, near

Topography Near Head of Gimblet Creek.



"CONGLOMERATE CLIFFS" on Little Sandy River, near Mouth of Laurel Creek.
ELLIOTT COUNTY, KY.

This page in the original text is blank.

the river, a considerable thickness of the coal-bearing series of rocks, with coals one and two of the general section. These lands are, however, chiefly agricultural; and as such they offer inducements which are not found in the coal-field generally. (See photo-lithograph illustration.) The soil is of sandy and clayey loam, of medium natural fertility, and susceptible of improvement by judicious cultivation. In extent these lands include nearly one-half of the county, the area of which is about 270 square miles. This region is adjacent to the Chesapeake and Ohio Railway, being from fifteen to twenty-five miles from Morehead, in Rowan county, and eight to twenty-five miles from Olive Hill and Leon in Carter—railway stations.

The avilable farm land in the eastern part of the county is much less in proportion to the whole area than in the western; and it is mostly in the valleys, including the gentler slopes. The steeper hillsides and the narrow ridges should be regarded as timber land, and held as such for the benefit of the valleys, which otherwise will soon pay the penalty by excessive washing. This region is nearer the Eastern Kentucky Railway, being six to twenty miles distant from Willard, the present terminus of that road.

The timber growth of Elliott is largely of the hard woods, including, however, a considerable proportion of yellow poplar (tulip tree) and linn (basswood). Hemlock is the prevailing growth along the conglomerate cliffs, and yellow pine (*P. mitis*) and other pines fringe the table-lands. The most valuable timber lands are found in the eastern half of the county, which is especially noted for its superior white oak timber. The red maple is noticeably prominent in this part of the county. Black walnut and ash are represented by single trees distributed through the heavier forests, while the beech and the sugar tree are more common. No detailed study of the forest growth of this region has been made. Such a study would be of great economic value, if only it could be made to conduce to an intelligent treatment of these natural forest lands. This, it seems to me, should be the aim in respect to the forests of Kentucky, as it is evident that the commercial spirit of the age will need no incentive to

carry its destructive methods wherever desirable timber can be found.

The geology of Elliott county is so much like that of the western portion of Greenup and Carter that treating of it will of necessity seem like repetition. There is one feature of more than ordinary interest, which does not appear, so far as is known at the present time, elsewhere in the State, namely, exposures of trappean rock; the occurrence of profound fractures of the ordinary sedimentary rocks of the region, as indicated by the intrusion of molten rock, forming dikes and producing more or less of metamorphism of the including rocks.

Several of these dikes, or what may prove to be several lateral branches of a single dike, are found apparently radiating from a point on Creeches creek, westward and northward into the valley of Isom creek. This intrusive rock, peridotite, though hard and to ordinary appearance very indestructible, is, in fact, even less so than the including Carboniferous beds; so that it is for the most part covered; and it is not traceable by any effect produced on the topography of the region.

A fuller description of this interesting variation of the geology of Eastern Kentucky will be found in a special report by J. S. Diller, of the United States Geological Survey, and the writer, including the petrology of these crystalline rocks, and the geological features attendant on this eruption.

It is proper here, however, to put on record something of the part which this trap rock has played in the industry and the traditions of the region.

One of the most prominent exposures of this rock is on a branch of Creeches creek. Here is also found the remains of a rude furnace, but one which must have cost considerable labor, judging from the size of the mound which appears to have been thrown up to support it and to serve as a stock bank for ore and fuel. So far as I have been able to learn, the traditions of the immediate region throw no light on the origin of this furnace, further than to attribute it to the aborigines, or to a time anterior to the permanent settlement of the region. Attending this view is also the supposition

"CONGLOMERATE CLIFF" on Laurel Creek.

This page in the original text is blank.

that silver or some of the precious metals was the product of this ancient enterprise. On the other hand, it seems to me quite likely that this old furnace represents an unsuccessful attempt to make iron; and that it should be regarded as one of the incidents in the history of the introduction of the iron industry in the Hanging Rock region. This supposition is consistent with the conditions as noted about the old furnace, although, so far as that goes, there is nothing inconsistent with the supposition that silver or some other metal was the product sought in this bootless enterprise. At all events, it seems to me probable that the precious metal view, responding as it does to the promptings of hope and of fancy, and carrying with it an atmosphere of credulity and of mystery, has so tended to obscure the history of this old furnace and the unfortunate venture which it represents, that it may properly be regarded as having a place in the unwritten chronicles of the settlement of this region, notwithstanding the popular notion to the contrary.

Whatever may have been the specific purpose of this furnace, only the dike rock, exposed near by, appears to have been had in contemplation as a source of ore supply. The weathered rock bears some resemblance to iron ore, and in fact more or less of titaniferous iron is present; besides which, no other metallic ore has been found at any of the exposures of this rock.

As to the probability of the occurrence of the more precious metals, not much can be said, beyond this, that the metamorphism in connection with this dike is probably limited to thin contact walls, with some lateral extensions accompanying horizontal intrusions of limited extent.

COALS AND IRON ORES.

The coal and ore horizons of Elliott county are the same as those of Carter, as will be seen by comparison of sections 1 and 2, plates I and II of this report, with the general section for Greenup, Carter, etc.* Above the ferriferous

* For convenience of comparison and to facilitate the description of the beds in Elliott, the general section for Greenup, Carter and a part of Lawrence is here republished. (See plate.)

limestone, both the coals (6, 7 and 8) and the ores (the kidney ores), with some exceptions, become less and less prominent towards the border of the field. This thinning out of beds of coal and of iron ore is in keeping with the tendency which has been noted generally towards their western limits; a tendency that is accompanied in some instances by a corresponding thickening of the intervening rocks. The limestone beds in the coal measures all disappear towards the Silurian axis on the west.

Towards the southern part of Elliott this diminution of beds westward is coincident with a change in the character of the rocks of this horizon, which has been noted southward from Carter and the middle of Lawrence; a change from the predominating clayey shales which carry these beds, to predominating sand rock, which soon excludes the kidney ores altogether as workable deposits, and makes the identification of coals 7 and 8 difficult and uncertain. Whether this change is from a thinning out of the whole series, so that with its coals and ores it disappears altogether, or from a gradual change in the character of the rock deposits, has not been fully established; the latter seems to be more consistent with the somewhat contradictory data at hand, and more especially with the great thickening of the coal measures, and the increased prominence of sand rock towards the Pine mountain axis. (See report on the Pound Gap region.)

The kidney ores have been mined in the Little Fork valley near the north-east corner of the county. Their presence has been noted to the head of Little Fork, mostly on the east side of the valley, but also westward, with decreasing prominence into the valley of Newcomb creek, and in the ridge between Newcomb and the Middle Fork. In this ridge, near the Martinsburg road, the lower bastard limestone which marks the place of one of the upper kidney ores, of Boyd county, may be seen near the top of the hill. The occurrence of this earthy limestone, the Buff or Shawnee limestone of the Ohio reports, is interesting as showing the extension southward and westward of one of the four earthy limestone beds above coal 7; beds which, in Southern Ohio and in Boyd county,

and parts of Lawrence and Carter, in Kentucky, may be regarded as offering the most reliable horizon marks for the guidance of the geologist. These beds all disappear or lose their characteristic features south of the Little Sandy drainage.*

The coarse sandstone, conglomerate sandstone in places, which often rises in cliffs above the lower bastard limestone in Boyd and Carter counties, caps some of the hills towards the head of Little Fork, on the east side. (See plate I.) Dipping down the valley, as already indicated, it forms a considerable part of the ridge along the northward extension of the county line, and probably caps some of the highest hills on the west side of the valley.

No trace of coal No. 8 has been noted in Elliott county. Its place is twenty feet or more below the earthy limestone above mentioned, and it would be included in all sections of the ridge along the eastern boundary, and of some of the higher points across to the ridge between Newcomb and the Middle Fork.

Coal 7 has been observed at a number of places, along with the kidney ores, as in section 1, plate II. At the head of Brushy creek, near the place of Bryan Boggs, a thickness of forty-two inches is shown, including a thin parting. It is exposed also near Gallions, on Blaine Trace, as a prominent stain. Its western limit is the ridge between Little Fork and Bruin creek, with its continuation against Newcomb creek to near the head of Little Fork, and then across Newcomb to include the higher hills along the Middle Fork to the head. The probabilities are that it will be found of local value only, in this south-western extension.

Coal 6 has been traced in the Little Fork valley as far as Hurricane branch, evidently a thin bed as in Carter county. Its place in the series is shown in section 1, plate II. The greatest thickness noted falls below two feet of good coal.

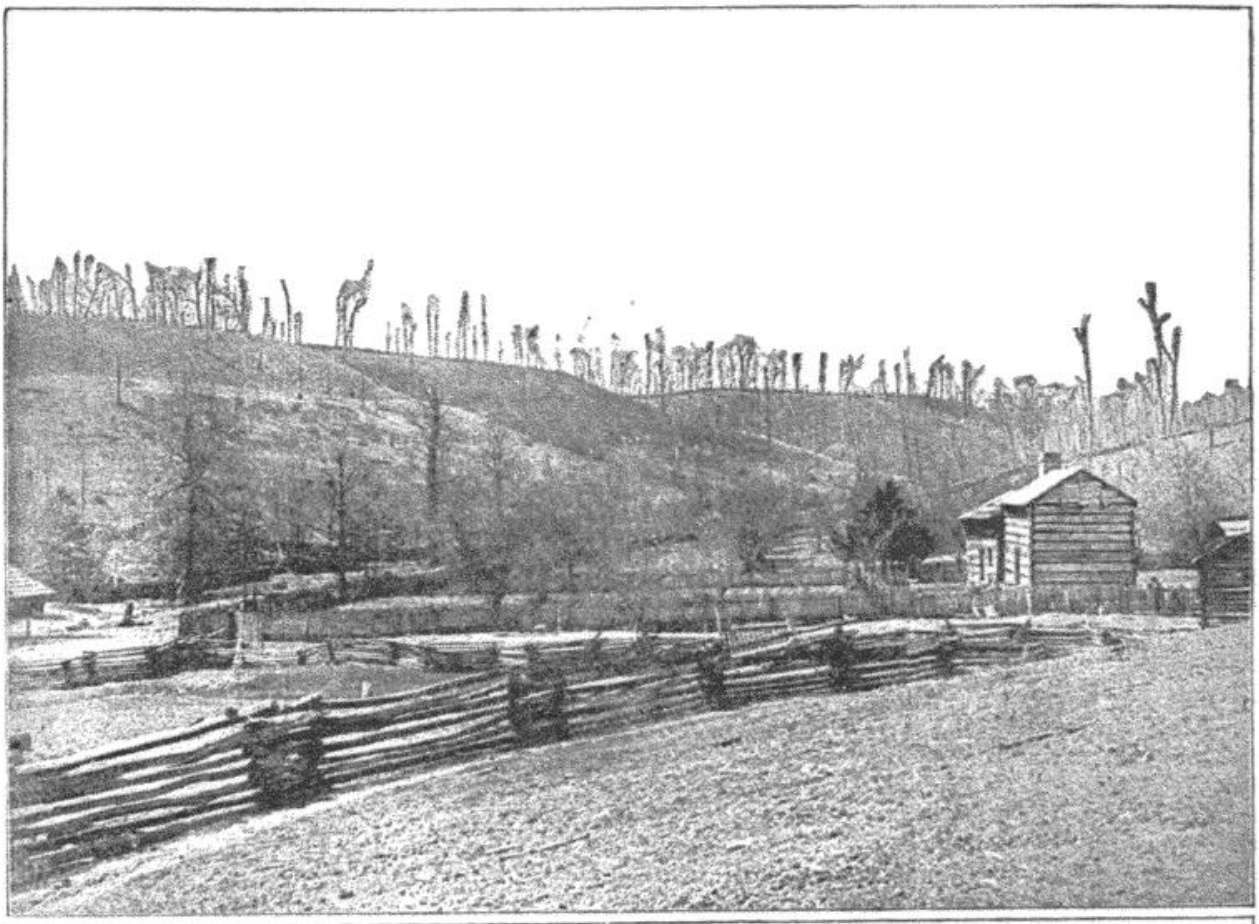
The ferriferous limestone and the so-called limestone ore mark a geological level that is more readily traced than any

*A cherty limestone is found in Breathitt county, extending into Perry and possibly into Letcher, which may prove to be an equivalent of one of these beds. (See report of Assistant Hodge on Perry and the southwestern part of Letcher.)

other above the conglomerate formation. The limestone is limited to isolated pockets, and has been seen at two points only in Elliott—on the head of Isom creek, where it occurs as a fossiliferous bed five feet or more in thickness, and on the head of Elk branch of Newcomb creek, where it is less prominent. It has also been noticed at several points along the ridge west of Elk Fork, in Morgan county. The ore which rests upon this limestone when it is present is more constant, however, and can generally be found weathered out upon the surface at its proper level. At the mouth of Brushy creek it is found about one hundred and fifty feet above the bed of Little Fork, and has been mined for shipment, though the distance from rail and the character of the roads stand in the way of profitable mining as it now stands. On Isom creek it is about two hundred feet above the drainage, showing very little variation from the general dip of the region—an unexpected freedom from disturbance in the immediate region of the dike as previously described. On the head of Little Fork the limestone ore is well up towards the tops of the hills, and often has intermingled with it enough small quartz pebbles to render it worthless for iron-making. Westward the ore has been traced along the ridges from Bruin creek to the head of the Middle Fork. It is especially prominent as a surface exposure on the ridge between the head of the Fannin Fork of Elk, above Hutchinson's store, and the Gilbert Branch of Middle Fork. It is hardly to be expected that this iron ore is present in workable thickness and quality over all of the region where its presence is indicated by contour lines of outcrop. Far more constant than the limestone which gives it its name, this bed is more or less interrupted throughout its whole extension south of the Ohio river. From exposures noted it would not appear to be more so in this region than in those parts where it has been largely relied on for furnace supplies of iron ore. In thickness this bed may also be supposed to be variable—ranging from a few inches to several feet, as in regions where it has been extensively mined.

The "lime kidney ore" found in some parts of Carter, and especially near Willard, fifteen to twenty feet below the

Topography above Conglomerate Cliffs on Little Caney Creek.



"CONGLOMERATE CLIFFS" at Forks of Caney Creek, Elliot Co., Ky.

This page in the original text is blank.

ferriferous limestone, appears to be entirely wanting in Elliott; and the same is true of coal 5 of the general section. No traces of this bed have been observed in the county.

The Little Block ore of the general section and the Hunnewell cannel coal (coal 4) are better represented; the former by many exposures in the Little Fork valley, at its proper level, as in section 1, plate I; the latter on the head of Newcomb creek, and also at a few points on Little Fork. This cannel seam does not promise well from an economic point of view; being too slaty or too thin where seen for profitable mining for the open market. As in Greenup and Carter, it appears to interrupt the Little Block ore, occupying very nearly the same horizon. The localities where coal 4 has been noted are as follows: In the Little Fork valley, near the head of Blaine Trace, Blevin's, Anderson's and Triplet's cannel coals; showing in two benches, the lower ten to twenty inches, somewhat slaty; the upper ten to fifteen inches, good cannel, separated from the lower bench by three to five inches of slate. In the Newcomb valley, near the head of the Left Fork, Riddle's cannel; opened at several points in the ridge between the Left Fork and the Middle Fork, and on the east side of Burnt Cabin Branch one-half mile above the steam mill. The thickness of the bed in this region is from three to four feet; of which less than one-half is cannel, after deducting six to eight inches of slate. On the Middle and Right Forks of Newcomb, so far as known, this seam shows only ordinary bituminous coal of reduced thickness, or with slight traces of cannel. The iron ore, which marks this level with much greater regularity, has not been noted in the region of these cannel coals as described. It is found very generally on the Little Fork, and may be supposed to average about as in the corresponding belt in Greenup and Carter. It has been observed by Mr. J. M. Hodge on Isom creek, associated with a so-called Black Band iron ore—a highly ferruginous carbonaceous slate, representing the cannel coal, as also it is represented in Lawrence county at one point by a similar black band.

The alternation of the Little Block with coal 4, and the occasional overlapping of these beds, with a tendency to

transform the coal into a black band, is an interesting indication of the varying conditions under which the carboniferous deposits were laid down. It illustrates, in some measure, the way in which beds of coal and of ore are formed in "basins" or "pockets," giving to them a distribution uneven as to thickness and quality, an irregularity which is more or less characteristic of beds in general, as is found in developing them. But it should be noticed that it is none the less an illustration of the widespread continuity of coal and ore horizons, however much the beds, as workable deposits, are limited by such irregularities.

Coal 3 is the most constant bed in the series so far as unbroken continuity is concerned; but while it is the most reliable coal in North-eastern Kentucky in this respect, it is at the same time apparently more variable in thickness and quality, and in the arrangement of parts, than any other bed. It is the most important coal in Elliott county. In the north-east corner of the county it is thin, as shown in section 1, plate II, twenty-five to thirty feet above the bed of Little Fork, and as known in the adjoining part of Carter. On Blaine Trace the bed shows three feet of good coal without parting, as opened at Blevin's towards the head of the creek. On the Robert Green Branch a thickness of five feet is exposed. (See section, plate II, enlarged scale.) On the head of Nicholas Branch three feet of excellent coal without parting is shown. Southward and westward this seam retains as great a thickness, but slaty and shaly partings become more or less prominent, detracting from the value of the bed by increasing the expense of mining. Coal 3 is found as far west as the Little Sandy river at Martinsburg, high up in the hill, as in section 4, plate II, and there is good reason for supposing that it is present in all the region east of the Open Fork. The place of this coal is often indicated by springy places or "licks" on the hill-sides, besides showing as a stain at the surface. Several openings made from these indications show as follows: On Wallowhole creek, thickness 47 inches, including partings, which have an aggregate thickness of 21 inches; on Prince's Branch west of Little Fork, 48 inches, with parting 11 inches; near the head of

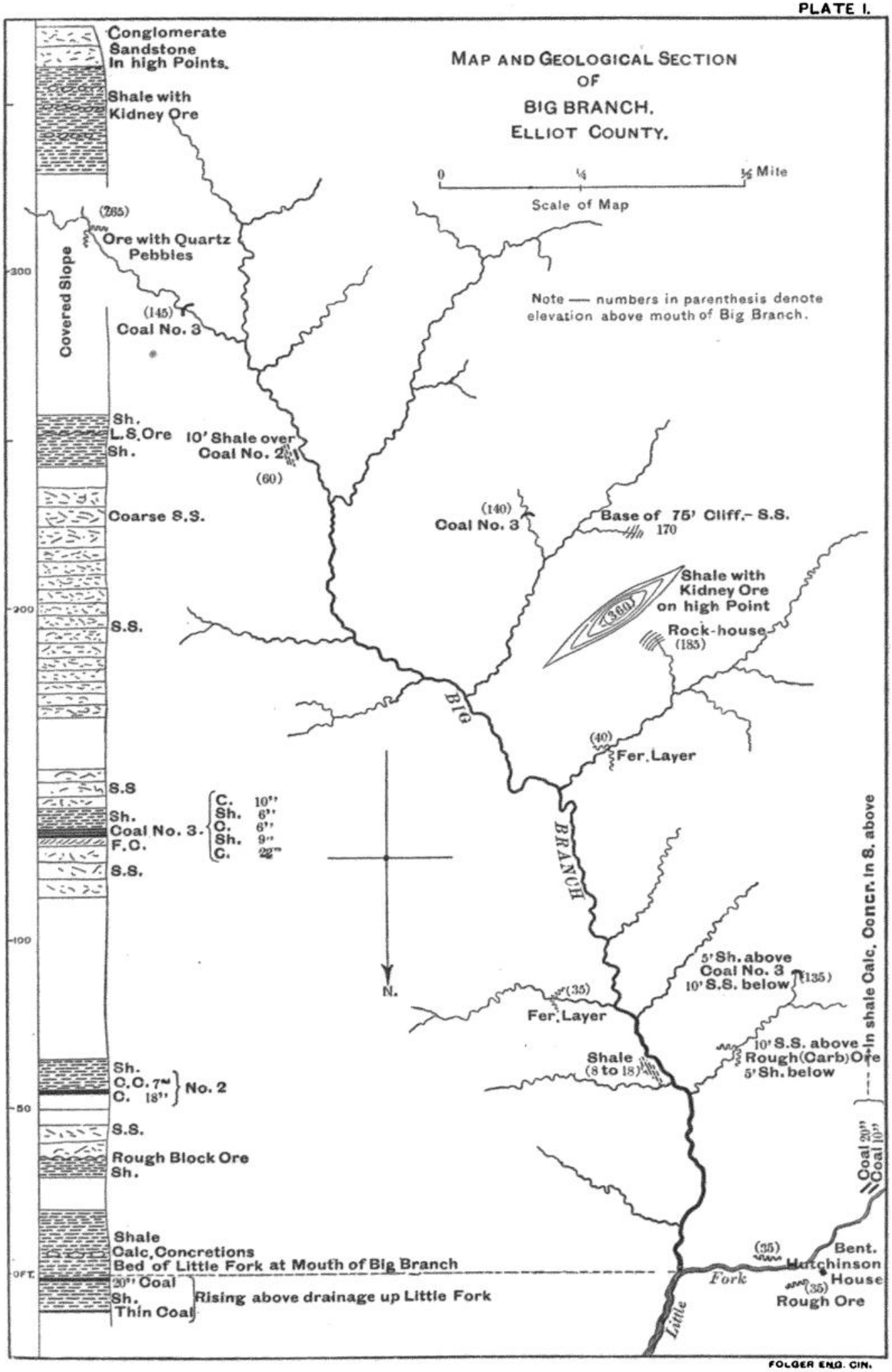
Meadow Branch 44 inches, with partings 10 inches; on Briar Branch, near Bent. Hutchinson's, 53 inches, with partings 17 inches; on the Bill Branch of Newcomb, 50 inches, partings 12 inches; at Mason's, on the Left Fork of Newcomb, 50 inches, with an 8-inch parting. On the Right Fork of Newcomb, and on the Middle and Open Forks of the Little Sandy river, test openings have not been made.

Coal 2 is the lower cannel coal of Elliott, Morgan and Johnson counties, and also of parts of Carter and Lawrence. It is in its southward extension, however, that it becomes a prominent cannel seam, as the Elk Fork, the West Liberty, the Pieratt and the Walnut Grove cannels in Morgan, and probably the Gilmore creek and the Frozen creek cannels in Wolfe and Breathitt counties, though it has been profitably mined in upper Carter for several years near Aden Station, on the Chesapeake and Ohio Railway,. where it has a thickness of about 30 inches; somewhat slaty in part, but free from objection in burning qualities, as I find from continued use in the grate. This bed is found in Elliott, as cannel coal wholly or in part, more constantly than is usual for a cannel seam. Its greatest thickness is near the Morgan line on the Buck Branch of the Middle Fork of Sandy, where about three feet of cannel is exposed, of inferior quality, however, from the large proportion of ash—about twenty per cent. At no other exposure in the county does this bed show a workable thickness of cannel coal alone. On the Right Fork of Newcomb, at Adkin's store, this bed shows 19 inches of cannel overlaid by 15 inches of ordinary bituminous coal, and on the Left Fork, at Segrave's, three feet of good coal is exposed, one foot at the bottom being cannel. Elsewhere coal 2, as exposed, is thinner as a whole and variable in its character. It is traceable on most of the creeks of Eastern Elliott, from seventy-five feet above the main drainage and downward to the creek bed. At the mouth of Hurricane Branch of Little Fork no cannel appears in this bed, and it falls below the drainage near the mouth of Isom creek. West of the Little Sandy river the coals have not been traced. It will probably be found that coals 1 and 2 will furnish a home supply for this farming region.

Coal 1 is mostly a thin coal as known. It falls below the drainage for the most part on the open creeks. At the Forks of Newcomb, as opened by Mr. Isom, coal 1 shows three feet of excellent coal. Westward over the cliffs it is shown as a stain, as indicated in the profile section with the map.

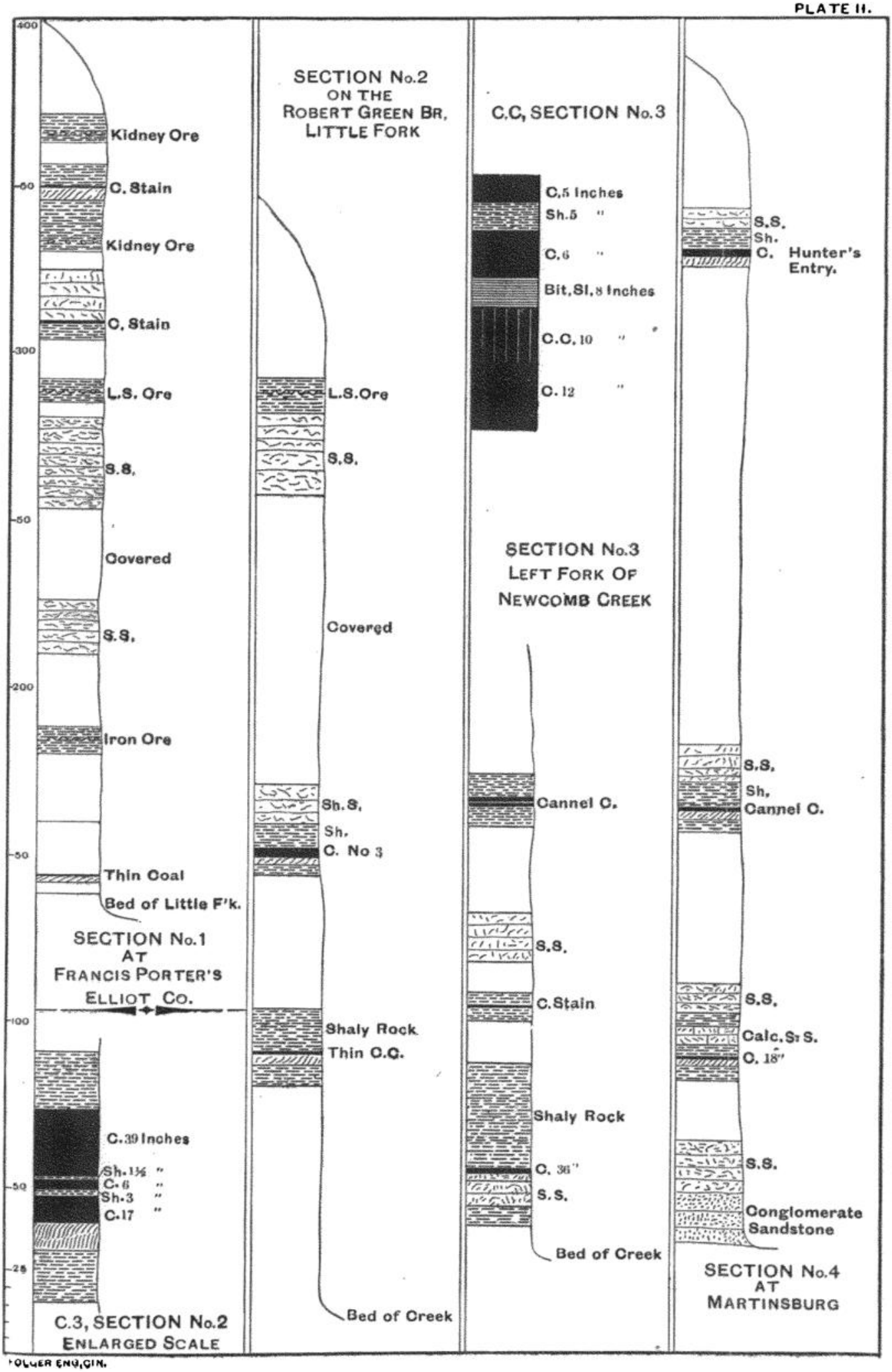
The rocks above the conglomerate sandstone differ little from the section as described for Carter county. The thickening of the sand rock above coal 5, as noticed on the head of Dry Fork and of Sycamore creek, on the Blaine side, in Carter, is also a noticeable feature along the ridge at the head of Blaine Trace in Elliott. The cliffs at the head of this creek are of coarse sandstone, resembling somewhat the conglomerate sandstone, and the horizon of coal 6 appears to be occupied by the massive rocks which are most prominent in this region. In general the most prominent bench along the hill-sides of the Little Fork valley is formed by the persistent sand rock immediately under the "limestone ore," though a number of low points extending into the main valley, extensions from the bench formed by the sandstone ledge above coal 2, gives greater prominence to the latter bench where these occur. The alternation of shale and sandstone is more or less noticeable throughout the whole series, in the benched hill-sides which figure in the topography of the country.

PLATE I.



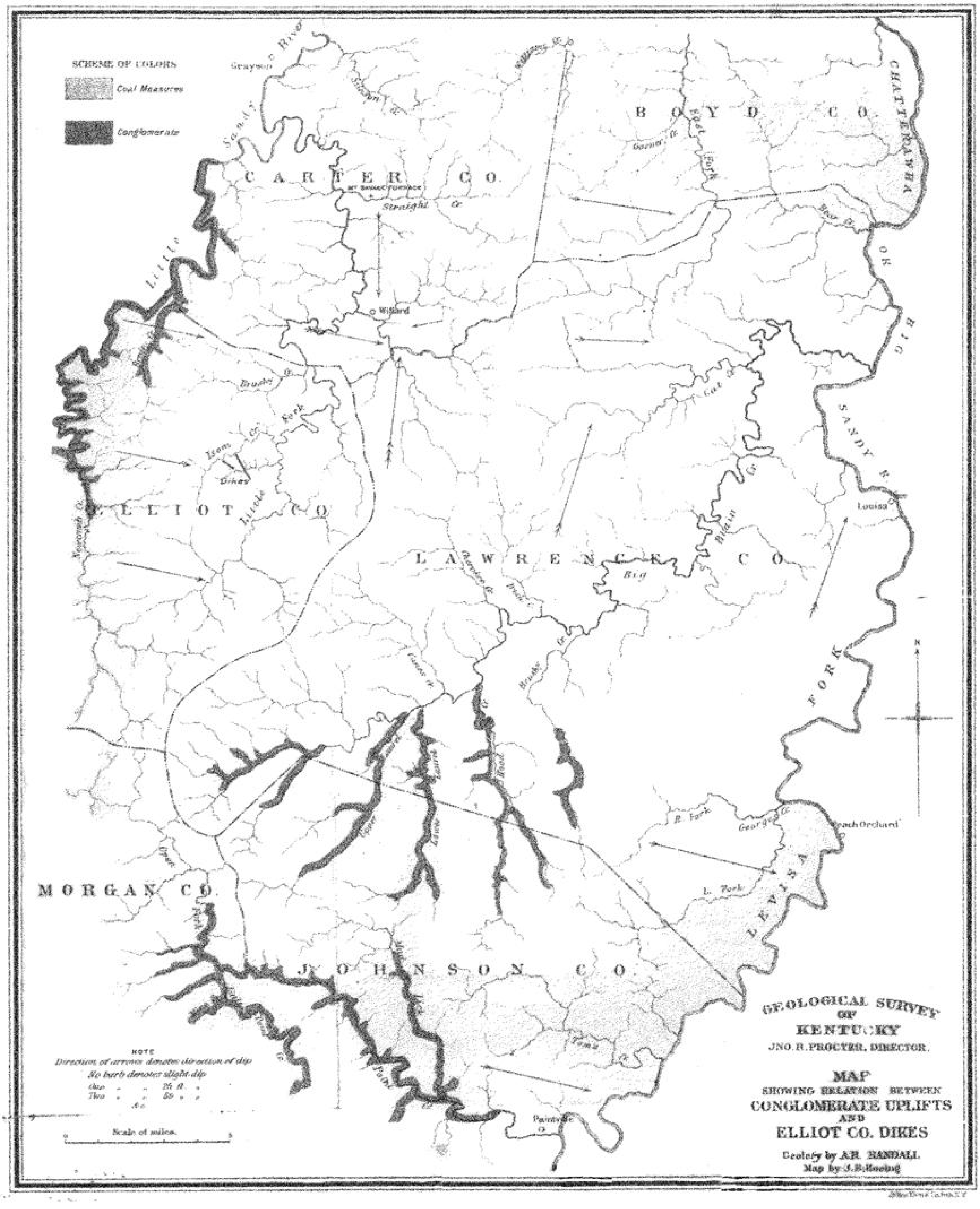
FOLGER ENG. CIN.

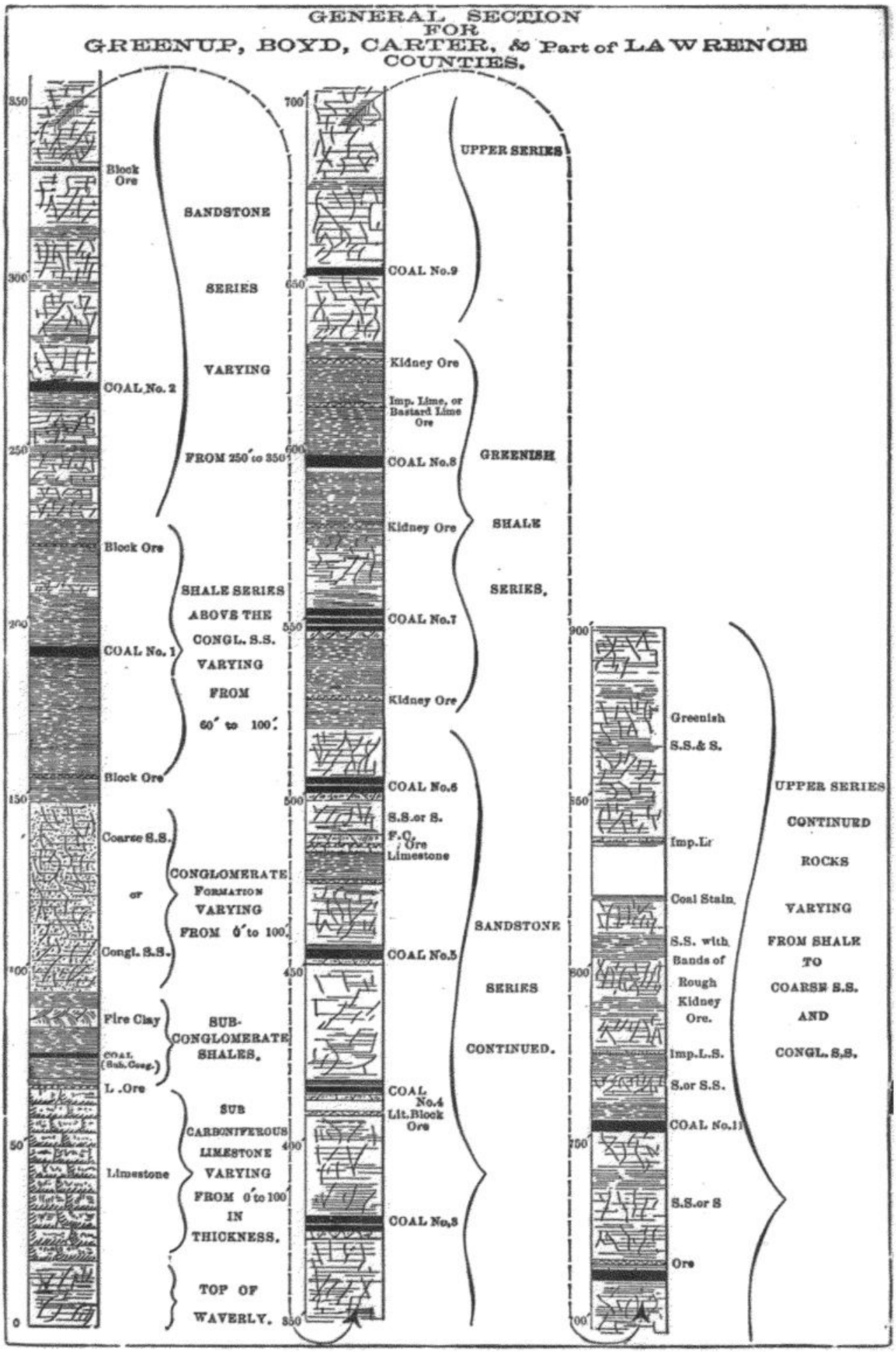
This page in the original text is blank.



FOLGER ENG.CIN.

This page in the original text is blank.


SCHEME OF COLORS
Coal Measures
Conglomerate
Grayson
Sandy River
Little
CARTER CO.
Straight Cr
Willard
BOYD CO.
East Fork
CHATTEROWHA
BIG SANDY RIVER
ELLIOT CO.
Dikes
Brushy Cr
Isom Cr
Little Fork
LAWRENCE CO.
Big
Louisa
FORK
MORGAN CO.
JOHNSON CO.
LEVISA
Peach Orchard
Georges Cr
R. Fork
L. Fork
Paintsville
Toms Cr
NOTE
Direction of arrows denotes direction of dip
No barb denotes slight dip
Scale of miles
GEOLOGICAL SURVEY OF KENTUCKY
JNO. R. PROCTER, DIRECTOR.
MAP SHOWING RELATION BETWEEN CONGLOMERATE UPLIFTS AND ELLIOT CO. DIKES
Geology by A.R. RANDALL
Map by J.R. Hoeing


GENERAL SECTION
FOR
GREENUP, BOYD, CARTER, & Part of LAWRENCE
COUNTIES.
350
300
250
200
150
100
50
0
Block Ore
COAL No. 2
Block Ore
COAL No. 1
Block Ore
Coarse S.S.
or
Congl. S.S.
Fire Clay
COAL (Sub. Coag.)
L. Ore
Limestone
SANDSTONE SERIES VARYING FROM 250' to 350'
SHALE SERIES ABOVE THE CONGL. S.S. VARYING FROM 60' to 100'.
CONGLOMERATE FORMATION VARYING FROM 0' to 100'.
SUB-CONGLOMERATE SHALES.
SUB CARBONIFEROUS LIMESTONE VARYING FROM 0' to 100' IN THICKNESS.
TOP OF WAVERLY.
700
650
600
550
500
450
400
350
COAL No. 9
Kidney Ore
Imp. Lime, or Bastard Lime Ore
COAL No. 8
Kidney Ore
COAL No. 7
Kidney Ore
COAL No. 6
S.S. or S.
F.C. Ore
Limestone
COAL No. 5
COAL No. 4
Lit. Block Ore
COAL No. 3
UPPER SERIES
GREENISH SHALE SERIES.
SANDSTONE SERIES CONTINUED.
900
850
800
750
700
Greenish
S.S. & S.
Imp. Lr
Coal Stain
S.S. with Bands of Rough Kidney Ore.
Imp. L.S.
S. or S.S.
COAL No. 11
S.S. or S
Ore
UPPER SERIES CONTINURD ROCKS VARYING FROM SHALE TO COARSE S.S. AND CONGL. S.S.

This page in the original text is blank.

NOTES

ON THE

ELLIOTT COUNTY DIKE, EASTERN KENTUCKY,

BY A. R. CRANDALL.

The trap dike recently brought to notice in Elliott county, Kentucky, is, so far as known, the only illustration of intrusive rock in Kentucky. It is also the only exposure of trappean rock in the region of the Cumberland Mountain uplift.

This dike represents an eruption of very limited extent, laterally, being found only in a small part of the valley of the Little Fork of the Little Sandy river.

From its limited range, and also from the readiness with which the rock of which it is composed disintegrates, it does not appear as a noticeable factor in the topography of the region; and it is with some difficulty that it can be traced beyond the exposures which mark a few points along its surface prolongations.

The dike appears to extend in two diverging lines from Critche's creek into the valley of Isom creek, with several minor offshoots of undetermined, but doubtless of limited extent, possibly no more than wedge-like projections from the main dike between the strata of the coal-measures which make up the whole height of the hills in this region.

The whole length of the dike, in its greatest surface extension, appears to be less than a mile, with a width of from a few feet to fifty or more, as indicated by one exposure near Isom's mill, though the slight local disturbance of the including rocks and the inconsiderable metamorphic action, as well as the limited area, indicates no great mass of the

intrusive rock. These considerations and some of the conditions noted at Isom's mill suggest the possibility that the exposure there is of a local lateral expansion rather than of the real width of the dike.

All the rocks of this region, including the beds up to coal No. 7 (the Coalton coal of Kentucky, the Sheridan and the Nelsonville of Ohio), are cut by both arms of the dike.

Little can be said, from present knowledge, descriptive of the dike itself, except of the petrology, which has been studied by J. S. Diller, of the U. S. Geological Survey, and will be treated of by him.

There are, however, some general geological features which may very properly be recalled in this connection.

The dike is found near the line which marks the eastward limit of the Silurian anticlinal ridge of Ohio and Kentucky, as modified by the final uplift of the Carboniferous series. That the Silurian axis was involved somewhat in this movement is indicated by all the conditions as now observed; but there remains a clearly defined anticlinal ridge, with the border of the coal-measures on its eastward slope, as has been pointed out in various reports on the geology of Eastern Kentucky.

The eastward dip from the Silurian anticlinal is interrupted along a line which is in general parallel with the border of the coal field. This interruption is more or less prominent as marked by a reduction of the dip, or by horizontal beds, or by a reverse dip of the exposed strata. The last condition is more noticeable in Elliott county than elsewhere. The line of change falls a few miles east of the dike.

The reverse and the varying dips eastward from this line are the result of the upheaval of the Cumberland coal field, a movement which hinged on the Silurian axis along this line. The Silurian axis still remains a prominent unmistakable feature as remarked, but reduced in width eastward, and somewhat obscured in the topography as modified by the resulting drainage.

That there may have been profound fractures along this line of hinge movement follows as a matter of course. The Elliott dike may be supposed to add something to the prob-

ability of such fractures as the result of this movement, and this part of the geological history of Eastern Kentucky may, in turn, throw some light on the occurrence of this outlying dike.

Transverse to the axis of uplift are some minor wave-like undulations, especially southward, but involving Elliott county in part, as noticed by Lesley in his report on the outcrop line of the Eastern Kentucky coal field. These undulations have a determinative relation to the drainage, as in the case of the Licking, the Red and the Kentucky rivers; and it is not improbable that they may stand in an important relation to the faults which traverse adjacent parts of the Silurian field and terminate in the border of the coal field.

The most striking modification of the general dip, by transverse flexure, is found along a belt which extends from the Big Sandy river south of Louisa, in Lawrence county, to a point opposite to and but a few miles east of the dike. The dip along this belt is to the northward, in places more than fifty feet to the mile, from a geological ridge of the Conglomerate formation, which elsewhere falls below the drainage along the border of the coal field.

It is along this belt that the oil and gas developments of Lawrence and Martin counties are being made.

The prominent geological basin centering at Willard is formed by a junction of this northward dip with the general south-east dip considerably increased by a local depression. Willard is about six miles in a direct line from the dike.

The dike is found near the junction of two lines of flexure, one parallel with the axis of uplift of the coal-measures, and the other a transverse or secondary undulation of considerable local prominence.

Whether or not these conditions throw light on the occurrence of igneous rock far from any region of great disturbance, they form an interesting, if not a necessary, background to any general view of the Elliott dike and its surroundings.

[From the American Journal of Science, August, 1886.]

NOTES

ON THE

PERIDOTITE OF ELLIOTT COUNTY, KENTUCKY,

BY J. S. DILLER.

Several years ago Professor A. R. Crandall discovered two dikes of an interesting eruptive rock in Eastern Kentucky, about seven miles south-west of Willard. The position of these dikes is well shown upon Professor Crandall's geological map of Elliott county.

A preliminary examination of the rock under the microscope revealed the fact that it belongs to the peridotites. These rocks are considered by most petrographers as eruptive, but there are others who regard them as of doubtful origin. One of the latest writers on petrography* divides rocks into two great classes: (1) those resulting from the accumulation of material transported from lower to higher levels (Anogene), and (2) those resulting from the accumulation of material transported from higher to lower levels (Katogene). The first group includes rocks of eruptive origin, while the second contains those derived from sedimentation. It is in the latter group that Kalkowsky places the peridotites. They nearly always occur intimately associated with highly altered rocks in regions of great disturbance, so that their relations can not be readily determined. In Eastern Kentucky, however, they are found with nearly horizontal unaltered sandstones and shales of the Carboniferous series, and present such a

* Elemente der Lithologie von Dr. Ernst Kalkowsky. 1886.

promising opportunity for completely demonstrating the origin of peridotite, that a more thorough examination has been undertaken.

The peridotite is a compact dark greenish rock with a specific gravity of 2.781. In it are embedded numerous grains of yellowish olivine, uniformly distributed throughout the mass. Rarely it is fine-granular and dense, like many dark colored basalts, but generally the grains of which it is composed are medium sized. Occasionally the olivine grains wholly disappear and the deep green serpentine pervades the whole mass. Besides olivine and serpentine, which together form nearly seventy-five per cent. of the rock, there are prominent grains of pyrope and ilmenite with a few scales of biotite.

The following table, showing the mineralogical composition of the peridotite, is based directly upon estimates made under the microscope of the areal distribution of the various minerals in the freshest portion of the sections taken from the locality where the peridotite is least altered:

Primary Minerals.		Secondary Minerals.	
Olivine	40 per cent.	Serpentine	30.7 per cent.
Pyrope	8 "	Dolomite	14 "
Biotite	1 "	Magnetite	2 "
Enstatite	1 "	Octahedrite	1.1 "
Ilmenite	2.2 "		
Apatite	*trace.*		

It is not claimed that this table represents, with a high degree of accuracy, the composition of the rock, but it closely approximates the real proportions in the sections studied. The table clearly indicates that originally at least eighty per cent. of the peridotite was olivine, and that ultimately it will be nearly all serpentine, or perhaps in some places dolomite, with a small proportion of magnetite, ilmenite, pyrope and octahedrite.

The olivine generally occurs in the form of irregular grains held in the net-work of serpentine and other secondary products, but rarely, however, it is bounded by well defined crystallographic planes, a feature which is somewhat unusual for the olivine in peridotites. The crystals are short

prisms terminated by brachydomes, like those so commonly seen in basaltic lavas.

Enstatite plays so small a part among the minerals of this rock that it can not be considered an essential constituent. It occurs in the form of irregular corroded grains with clouded borders, and is distributed throughout the mass with approximate uniformity.

Next to the olivine, pyrope is the most important constituent of the rock. It occurs in the form of spherical or elliptical grains varying from one to more than a dozen millimeters in diameter. They are found abundantly along the line of the dike in the soil resulting from its disintegration. The small, clear, deep red grains have a specific gravity of 3.673, and are locally regarded as rubies of problematical value. The most interesting feature of the pyrope is prominent under the microscope, where it is seen to be surrounded by a border of radial fibres exactly analogous to those described by Schrauf* as Kelyphite and later critically examined by A. von Lasaulx.† In this case the border is composed of several essentially different substances which are always present, although varying much in proportions. First of these may be mentioned a dark powder of magnetite, which is frequently so abundant upon the outer edge of the border as to render it opaque. The inner substance of the ring is of a grayish or reddish brown color and generally fibrous in structure, perpendicular to the periphery of the garnet. The fibres have occasionally very strong absorption in the direction of the longer axis, and have nearly or quite parallel extinction, indicating that the mineral is biotite. This conclusion is completely demonstrated by a border in part of which the uniaxial, negative, strongly dichroric folia of biotite may be clearly discerned. The biotite extends far into the fissures of the garnet and evidently results from its alteration. Associated with it are small triangular and quadratic sections of a yellowish brown isotropic mineral, which in all probability is picotite. Lasaulx clearly demonstrated the presence of py-

* "Ueber die Umrindungen von Granat." Sitzungsberichte der Niederrhein-Gessell. zu Bonn. 1882, July 3.

† "Beiträge zur Kenntniss des Associations Kreises der Magnesiansilicate," Zeitschrift fur Krystallographie, 1882, vi, 321–388.

roxene and amphibole, in the so-called Kelyphite. Becke* and Kalkowsky† pointed out the picotite, but, so far as I am aware, the presence of biotite in this connection is here noted for the first time.

The ilmenite is readily distinguished from the magnetite even under the microscope in reflected light by the brilliant coaly lustre of portions of its pitted surface. It occurs in large grains and not in the form of spongy particles like the magnetite. Under the microscope the ilmenite is frequently seen surrounded, penetrated, and even completely replaced by a mixed group of yellowish and black grains, resulting from its alteration. The black opaque grains are magnetite, but the yellowish ones are not as readily determined. They have a high index of refraction and are generally spherical, but occasionally their peripheries are straight and sharply defined, indicating crystallographic form. Such grains usually possess a higher degree of diaphaneity, and the sections are either triangular, square or diamond-shaped. The latter are most strongly doubly refracting, and extinction takes place parallel to the longest diagonal. No trace of cleavage could be discovered, but the facts enumerated render it highly probable that the mineral is octahedrite.

The relation of the peridotite to the Carboniferous sandstones and shales is of paramount importance in determining its age and origin. Only two reasonable hypotheses suggest themselves to my mind: (1) the peridotite may be older than the Carboniferous strata and formed on the floor of the sea a peak about which the horizontal strata were deposited; (2) the peridotite may have been erupted through the Carboniferous strata.

If the first hypothesis be correct, we should expect to find the adjacent sandstone composed largely of detritus derived from the peridotite, and to exhibit no evidence of contact metamorphism. On the other hand, if the second hypothesis be true, there would not necessarily be a correspondence in the composition of the neighboring rocks, and under favorable circumstances the sedimentary deposits would be metamor-

* Tschermak's Mineralog. und Petrographische Mittheilungen, iv, pp. 189, 285.

† Elemente der Lithologie, p. 238.

phosed near their contact with the eruptive. Chemical analyses 6 and 4 in the following table, are of the adjacent

	Olivine. 1.	Pyrope. 2.	Ilmenite. 3.	Peridotite. 4.	Syenite. 5.	Calcareous S. S. near dike. 6.	Fine grained fissile S. S. near dike. 7.	Indurated shale near dike. 8.	Fragment of slate included in peridotite. 9.
Water at 110° (H_2O)	0.14	0.17	0.20	8.92	0.51	0 85	1.94	. .	1.40
Water red h't (H_2O)	0.66	. . .	. . .	. . .	. . .	2.32	5.17	8.78	9.00
Carbonic acid (Co_2)	. . . .	. . .	. . .	6.66	. . .	6.29	. . .	0.55	0.88
Silica (SiO_2)	40.05	41.32	0.76	29.81	60.56	60.78	60.25	41.32	35.53
Titanic oxide (TiO_2)	0.07	0.16	49.32	2.20	1.19	0.03	0.23	0.48	0.95
Phosph. acid (P_2O_5)	0.04	none	trace	0.35	0.30	0.09	0.10	0.08	0 08
Chromic acid (Cr_2O_3)	0.24	0.91	0.74	0.43	. .	. .	. . .	trace	. . .
Alumina (Al_2O_3) . .	0.39	21.21	2.84	2 01	16.19	10.54	23.18	20.71	18.23
Ferric oxide (Fe_2O_3)	2.36	4.21	9.13	5.16	5.19	3.27	1.53	2.59	2.46
Ferrous oxide (FeO)	7.14	7.93	27.81	4.35	2.41	. .	3.42	5.46	4.81
Mangan's ox. (MnO)	0.20	0.34	0.20	0.23	0.36	0.10	0.10	0.17	0.13
Nickel oxide (NiO) .	CoO=tr.	. .	. . .	0.05	. .	. .	. . .	. . .	. . .
Lime (CaO)	1.16	4.94	0.23	7.69	2.09	10.15	0.51	9.91	21.17
Magnesia (MgO) . .	48.68	19.32	8.68	32.41	1.30	1.59	3.52	1.91	2.01
Potash (K_2O) . . .	0.21	}	}	0.20	4.82	2.36	3.17	0.88	1.08
Soda (Na_2O)	0.08	} 0.07	} 0.19	0.11	4.78	1.41	0.39	7.19	2.53
Sulphur (S)	. . . .	. . .	. . .	none	. .	. .	. . .	. . .	. . .
Sulph. acid (SO_2) . .	. . . .	. . .	. . .	0.28	. .	. .	. . .	. . .	. . .
Total	99.42	100.58	100.10	100.86	99.70	99.78	100.51	100.03	100.26
Specific gravity . .	3.377	3.673	4.453	2.781	2.633	. . .	. . .	. . .	2.489

sándstone and peridotite. The dissimilarity of the two rocks, both in chemical and in mineralogical composition, is so prominent as to at once dispel the thought that they are genetically connected. Although the exact contact of the two rocks was not exposed, hardened shale was found near the peridotite under such circumstances that its induration is certainly attributable to the influence of the eruptive mass. But this is not the strongest evidence, for the peridotite itself includes many fragments of shale which were picked up on its way to the surface. The contact metamorphism has resulted generally in the development of a micaceous mineral, and the production from the shale of a rock such as has been designated spilosite. On the other hand, the peridotite itself has experienced endomorphic influences which

resulted in the development to a very limited degree of a sphærolitic structure, similar to that of the varioles in variolite.

The chemical analyses given in the foregoing table were made with great care by T. M. Chatard, in the U. S. Geological Survey laboratory at Washington. The specific gravities were determined by the writer with a pycnometer in the case of the olivine, pyrope and ilmenite; for the others Westphal's specific gravity balance was used. Analysis 5 is of a fragment of syenite found upon the border of the peridotite and supposed either to have been brought up from a great depth by the peridotite or else to have reached the surface by an independent eruption of syenite. A fragment of granulitic rock was also included in the peridotite, and that the latter is a truly eruptive rock which traverses many thousand feet of Paleozoic strata to reach the surface, is a matter which does not admit of reasonable doubt.

U. S. GEOL. SURVEY OFFICE,
WASHINGTON, D. C., March 29, 1886.

[From "Science," October 29, 1886.]

THE GENESIS OF THE DIAMOND.

Professor Carvill Lewis, in his remarks on "The Genesis of the Diamond" (*Science*, viii, p. 345), briefly alludes to the peridotite of Elliott county, Kentucky, as "suggesting interesting possibilities." My notes (*American Journal of Science*, August, 1886, p. 121) on this remarkable eruptive rock are but a brief digest of a report (Bulletin No. 38, U. S. Geological Survey, not yet published) in which its peculiar features are more completely described. If the hypothesis advanced by Professor Lewis really accords with nature's method of manufacturing this precious gem, it gives to prospectors a most valuable guide; and it is well worth while to carefully examine all localities the geological composition and history of which are analogous to that of the South African diamond fields.

In Elliott county, Kentucky, near Isom's mill, six miles south-west of Willard, there are two short dikes of peridotite breaking through the horizontal sandstones and shales of Carboniferous age in such a manner as to locally envelop many of their fragments. The slopes in the vicinity are well covered with soil, so that there are but few exposures of either the intrusive mass or the adjacent strata near the line of contact between them; and no considerable excavations have been made. Nevertheless it is evident that the shales have been distinctly metamorphosed by the peridotite. This is most plainly visible in the enveloped fragments of shale, which are quite numerous in the dike at one exposure near Isom's mill, but elsewhere they are almost or entirely absent. Thus both varieties of peridotite described by Professor Lewis occur in Kentucky, but the brecciated form has not yet been found to contain diamonds

The dark shale, fragments of which are included in the peridotite, may be regarded as composed of sand and clay in varying proportions. The amount of metamorphism experienced by the small fragments of shale is very unequal, and by no means proportional to the sizes of the inclusions. One of the earliest and predominant metamorphic effects is the development of a micaceous mineral in the agillaceous cement. This development may extend so far as to render the inclusion chiefly micaceous. Each enveloped fragment is surrounded by a narrow zone of colorless mica, the scales of which are frequently arranged perpendicular to its surface. An advanced stage of metamorphism is marked by the appearance of very interesting spheroidal bodies with remarkably suggestive properties. They have a high index of refraction, and are pale yellowish to colorless, translucent to almost transparent, and completely isotropic. The diameter of these little globules is generally about .02 of a millimetre, and they are remarkably uniform in size. Rarely this substance appears in irregular grains; but generally it occurs in a form very suggestive of the diamond, for it resembles a hexoctahedron with curved faces. In general appearance it simulates the small translucent crystals of octahedrite in the adjacent peridotite, but their optical properties and action in

acids readily distinguish it from that species. They are soluble in concentrated hydrochloric acid, and, when heated to bright redness, they become less translucent and somewhat earthy in appearance; but the change is not prominent. In the small fragments the globules are usually numerous, and scattered throughout the scales of clouded mica, but most abundant and least regular in form near the periphery of the inclusion, where they sometimes form quite a distinct border just inside the one of colorless mica. In the fragments where this peculiar isotropic substance is most abundant, there is but little well-developed mica. Notwithstanding the fact that some of their properties suggest that they are diamonds more or less perfectly crystallized, their solubility in acid renders such a view untenable. Were they diamonds, they would be of comparatively little value, because of their exceedingly small size.

The dark shale which is frequently enveloped by the peridotite is somewhat carbonaceous, but contains a small proportion of carbon as compared with that of the South African diamond field: for this reason, it appears to me rather improbable that diamonds will be discovered at the locality in question.

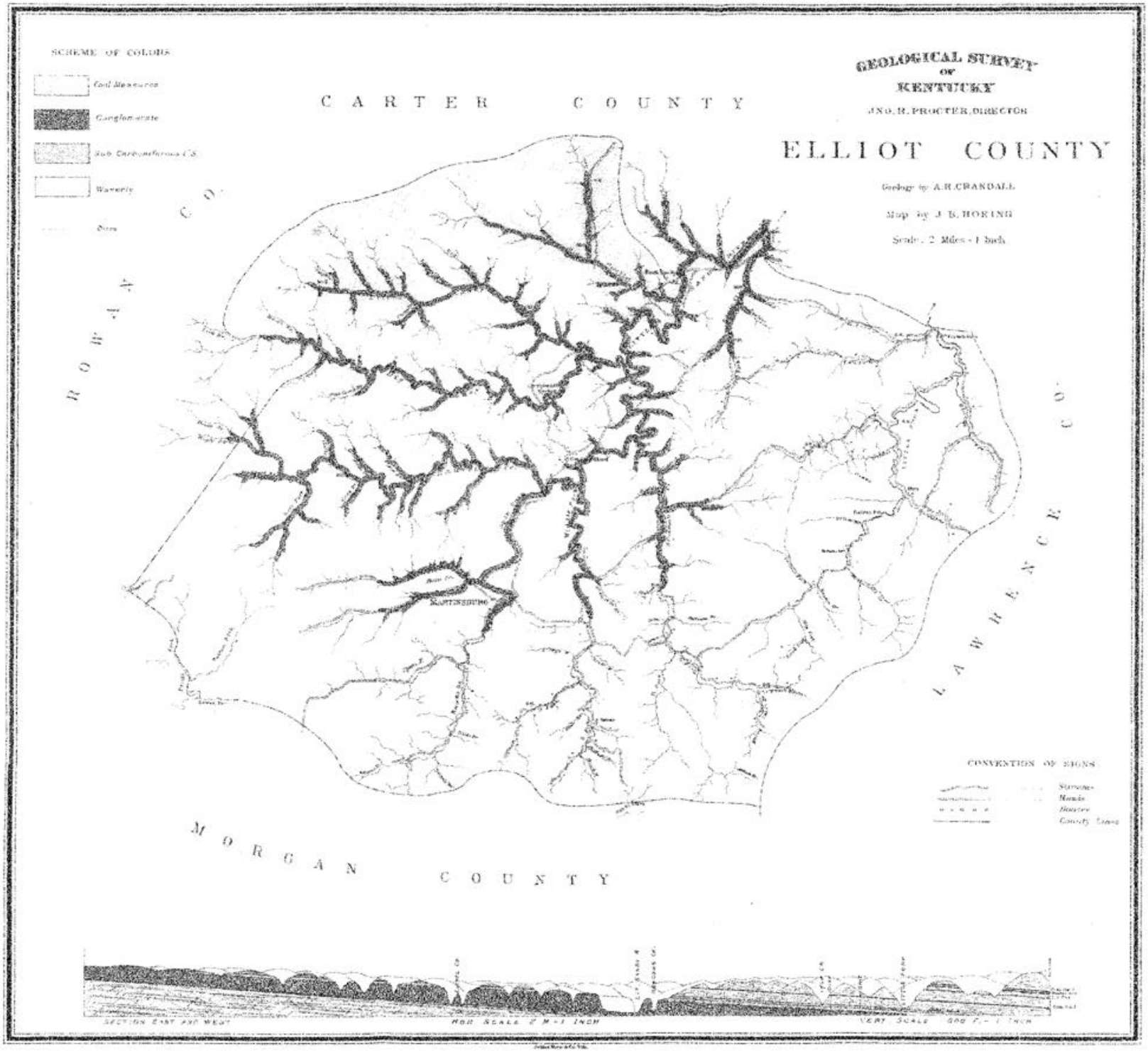
Some very pretty pyropes, locally supposed to be rubies, have been picked up in the soil resulting from the decomposition and disintegration of the peridotite, but nothing of greater value has yet been discovered at that place. That the dikes have been prospected, and supposed to contain valuable metals, is evidenced not only by slight excavations, but also by the ruins of what appears to have been a structure for reducing ore. Nothing is known in that country of the history of these ruins, and they may be of considerable antiquity.

It appears to be a significant fact in favor of Professor Lewis's hypothesis, that the diamonds found in the United States have been discovered where peridotites abound. The chief localities are either in North Carolina and Georgia or in California. Of all the mountain ranges of this country, the northern portion of the Sierras in California is perhaps the richest in serpentine. In cases I have examined, the serpentine is derived by alteration from peridotites. In the same

region, among older stratified rocks of the auriferous series, is a black shale or slate which occasionally contains a considerable amount of carbonaceous matter; and it is quite possible that the diamonds which have been discovered in the Sierras had their origin along a contact between peridotite and carbonaceous shale. At any rate, the suggestion opens another field for prospectors, and it should be remembered the corundum, with its gems, is also found under similar geologic conditions.

J. S. DILLER.

PETROGRAPHIC LABORATORY, U. S. GEOL. SURV.,
WASHINGTON, D. C., October 21.


SCHEME OF COLORS
Coal Measures
Conglomerate
Sub Carboniferous C.S.
Waverly
Drift
GEOLOGICAL SURVEY
OF
KENTUCKY
JNO. R. PROCTER, DIRECTOR
ELLIOT COUNTY
Geology by A.R. CRANDALL
Map by J. B. HORING
Scale - 2 Miles = 1 Inch
CARTER COUNTY
ROWAN CO.
LAWRENCE CO.
MORGAN COUNTY
MARTINSBURG
CONVENTION OF SIGNS
Streams
Roads
Houses
County Lines
SECTION EAST AND WEST
HOR. SCALE 2 M = 1 INCH
VERT. SCALE 500 F. = 1 INCH