

Analysis of Air-Dried Sample.

	Per cent.
Moisture at 100° C.	0.70
Combined water	3.46
Silica	76.90
Alumina	13.03
Ferric oxide	1.36
Ferrous oxide	0.42
Calcium oxide	none
Magnesium oxide	0.72
Sulphur trioxide	none
Phosphates	none
Potassium oxide	2.30
Sodium oxide	0.47
Titanium dioxide	0.87
Carbonates	none
Total	100.23
Ratio of Iron and Alumina to Silica.....	4.80

A sample of this clay gave the following characteristics: Color, greenish-white; burned to a pink, changing to a green at cone 9 (2390° F.). Taste, fat, sour, and some grit. When ground to 20-mesh and mixed with 24.0 per cent of water, it made a fairly plastic paste, that shrank 5.0 per cent in drying, and an equal amount in burning, giving a total shrinkage of 10.0 per cent. The air-dried mud showed a tensile strength of 29.5 pounds to the square inch. Incipient vitrification occurred at cone 4 (2210° F.), complete at cone 8 (2354° F.).

This clay will make a satisfactory pressed brick.

REPORT ON THE COALS OF THE HEADWATERS OF LICKING RIVER, MAGOFFIN COUNTY.

BY

JAMES M. HODGE.

This report gives the results of a recent investigation of the coal field drained by Licking river from the mouth of Oakley creek, about five miles south of Salyersville, the county seat of Magoffin County, to the head of the river. This area is about twelve miles long and nine in width at its northern end narrowing to four miles at its southern end.

The accompanying map shows the position of the principal coal openings, and the longitudinal section shows the vertical order of the coal beds with relation to the main drainage. This section shows the coal beds very nearly in their actual position where they are above drainage on the Licking river, and their probable position below drainage. Their extension of all beds shown on to Beaver creek waters will doubtless require much modification as data, now lacking, is supplied.

Like most of Eastern Kentucky, the valleys are all narrow, generally proportioned to the size of the streams, the hills steep and terminating in narrow ridges. These serrated ridges are some three hundred feet high along the river, but increase towards the heads of streams, more especially southward, where they reach a height of about 1,700 feet above tide, and six hundred feet above the river near its main head.

The height of the Upper Licking valley varies little from that of the corresponding part of the Kentucky river, but, farther down stream, owing to greater volume of water to effect erosion, and possibly also to less resistance of the conglomerate measures forming the north-east edge of the geologic basin, the Kentucky river is several hundred feet lower than the Licking.

For the same reasons the same is true as regards the height of Big Sandy river (and principal branches) relative to the Licking, but the difference is more marked

there, as the head of the latter abuts directly against the former. These differences in altitude make railroad passage from the Licking river to the Kentucky river troublesome, and to the Big Sandy river almost impracticable, even though remarkably low gaps assist, as on Brushy creek, and at the head of Grassy creek where they are only 175 feet higher than their mouths.

The fall of the Licking from a mile below its extreme head to Oakley creek is very light, being, in a distance along the river of over twenty miles, but about 200 feet, an average of less than ten feet per mile. Branches of the river also have but little fall.

The difference in altitude of the highest point of the region under review, say 1,700 feet above sea, and of the lowest, the mouth of Oakley creek, 860 feet above sea, is about 840 feet, but owing to rise of strata toward surrounding ridges the vertical range of the strata is limited to a thickness of some 500 feet.

In the following description of these strata the nomenclature of the several principal coal beds followed is that adopted in Bulletin No. 11 of the Kentucky Geological Survey. The Hyden, or Fire clay coal bed, with its unique parting gives means for positive correlation of that bed here and in adjoining fields, and also serves as a reliable guide in correlating other beds.

The three most prominent coal beds of the region and intervals between them are as follows:

Flag coal	
Interval	80 to 90 feet
Hazard coal	
Interval	60 to 90 feet
Haddix coal	
Interval	30 to 60 feet
Fire clay coal	
Interval	50 to 80 feet
No. 3 coal.	

The correlation of all but the No. 3 coal, the lowest of these beds, with the same on Kentucky river is given with confidence, though the intervals are much reduced below those obtained on that river.

The lowest coal is supposed to be No. 3, because of its similarity to the bed in the counties to the northeast.

The adjacent strata tend also to confirm this view; but, if such is the case, there is an unexpectedly large decrease of interval from the Fire clay coal of the Kentucky river to the Licking, and but little thence northeast. The assumption that it is No. 3 in the following pages must therefore be regarded as tentative. A still lower coal showing at the mouth of Oakley creek near the bed of the river and about 120 feet below the Fire clay coal may possibly be the No. 3, but as it goes under drainage up the river its bed section cannot be given.

The 500 feet of strata above drainage range from 125 feet below the Fire clay coal at the mouth of Oakley creek to about 175 feet above the Hazard coal at the head of the river.

Their general dip along the river is up stream from the mouth of Oakley to the vicinity of Bullmire creek at a rate of some fifteen feet per mile, while going up the river from the mouth of Gun creek to the mouth of Bullmire (more nearly in the direction of the dip), the fall is about 30 feet per mile. The dip reverses there, and rises at a slightly faster rate to Bull creek; from the mouth of Bull creek up to the mouth of Grassy creek they rise about with the river, but rise somewhat faster from there to the head of the river. Up Grassy creek the strata rise rapidly.

Along the main river above the mouth of Grassy creek the rate of rise is considerably less than up Grassy, but it is known to continue to within a half mile of the head of the river, and from this it is inferred that the rise continues beyond the gap at the head of Grassy creek. Data are lacking for any attempt at accurate connection with the coals of Beaver creek, but the section is continued to show, in a general way, what this connection may be.

Up branch streams on the east side of the Licking river there is a rise of strata nearly conforming to the ascent of the valleys, until their heads are closely approached, and this presumably continues to and beyond the dividing ridge.

On tributaries from the west up to Bullmire creek the strata lie so nearly level that their dip has not been determined. Above Bullmire there is a slight rise up the streams.

Nothing is known in this field of any coals higher than the Flag, except that their areas must be too small for working. Nor does the Flag bed give promise of value, its two known openings giving only about three feet of coal, in one case, at least, ruined by partings. Its bench, however, is a conspicuous feature of the hillsides in numerous places.

The chief bench throughout all except the extreme lower end of the region is that of the Hazard coal. By it the location of the bed, within narrow limits, can often be defined with a tolerable degree of certainty when other means are lacking. This coal, too, is by far the most important of the region, though it has been developed as a thick coal mainly near the head of the river, with an area of some 25 square miles only, and within this area probably from one-half to two-thirds of the area underlaid by the coal has been eroded. On the other hand loss by erosion may be largely offset by available coal beyond the limit of the Licking watershed, thick coal having been reported across the divide on Quicksand creek, and (more definitely) eastward on Middle creek.

Within this limited area the Hazard seam has a thickness of coal, as now developed, of from five to eight and one-half feet, an inch or two short of five feet being most common; where of this or less thickness partings are absent or nearly so. Usually a rider of coal a foot thick, more or less, lies in clay shale about five feet above the main bed. This shale makes a bad roof for the coal, but occasionally a hard stratum near the coal affords better mining conditions.

Elsewhere in this field, except on Oakley and Bullmire creeks, this coal has been found rather thin and hurt by partings, though some partial exposures are rather promising.

The coal of this bed consists of common block and splint in varying proportions, the latter generally occupying most of the lower half of the bed. Both, as a rule, appear to be good, though the splint is of a somewhat dull appearance. Thin seams of an inch or two look much like bone coal, but several tests in fires proved them not quite such, though evidently high in ash. Wherever

seen in stock or burning in grates no fault could be found with the coal of the whole bed.

Analyses of samples recently obtained are not at hand, but one of a sample by Prof. Crandall, high in ash as compared with coals farther south, is given on a succeeding page.

The Haddix coal is opened near the mouth of Salt Lick creek, 28 inches thick without parting, containing cannel coal, and at the head of that creek (with doubtful correlation) 34 inches coal with cannel slate roof. Elsewhere it has only been found as a thin bed, but its known openings are very few.

The Fire clay coal bed has been mined for local use to a considerable extent in the hill opposite the mouth of Oakley creek, and on that stream and the river above it up to the mouth of Gun creek, frequent openings into the bed have been made. With few exceptions they give less than three feet of coal, and with the flint fire clay parting everywhere present. Mr. Patrick's opening on Gun creek with over four feet of coal and 18 inches of parting appears to be of this bed.

Up the river from Gun creek the bed becomes thinner. At Swampton it shows 10 inches of coal, with parting 1 inch. Beyond there it lies near river level to the mouth of Grassy creek, rising thence well above drainage, but without yet developing workable coal. An opening showing 40 inches of coal with 4 inches parting across the Beaver divide, near the head of Salt Lick creek, should lead to its development on the extreme head of the river.

The No. 3 coal, which on the Kentucky river is some 200 feet below the Fire clay coal, and in the northeastern counties is given at about 40 feet, appears to be on Gun creek 80 feet and possibly on Grassy creek 60 to 80 feet below that bed.

Its outcrop is limited in the lower part of this region to Oakley creek below Open Fork, the river valley up to Puncheon Camp creek, and the streams east of the river up to that creek, and in the upper part of the region, perhaps to the heads of Salt Lick and Grassy creeks and of the main river. The numerous openings made into the bed on Gun and Puncheon Camp creeks nowhere

show so much as 3 feet of coal, and all have a parting, but it is not unlikely that a 4-foot bed found on Grassy creek is of this bed, and that it continues at about creek level a mile or more up that valley, as well as along the river above Grassy creek. This deserves thorough investigation, for if present of minable thickness it will add immensely to the importance of the whole region thereabout. Its location on the longitudinal section, 50 feet below drainage, is only tentative.

No. 2 coal is nowhere very attractive, but No. 1 coal, 200 feet below the No. 3 on Kentucky river and little less below it to the northeast, should be found to lie 150 to 200 feet under the river between Oakley and Gun creeks. The excellent showing 3 to 5 feet of coal in a seam at approximately the same horizon on Beaver creek, and elsewhere, should lead to its investigation by the drill on those creeks.

All of the above coals, so far as known, give satisfactory service for domestic use, are doubtless good steam coals, dry burning and non-coking. Evidence of sulphur is extremely rare, and ash, except in a few cases, seems to be not high.

Carbonate iron ore such as was formerly worked quite extensively in the northeastern counties, was found at several places, noted in the detailed description following. It appeared to be too thin for working, but further investigation of it is desirable.

In the following detailed description of openings visited elevations are given as above tide water, based on those obtained from a railroad survey giving heights at the forks of Oakley and mouth of Gun creek, another survey, assumed to agree with the above, giving height of the river a half mile below Grassy creek and a U. S. Geological Survey elevation on the river near its head. Other river elevations were obtained by interpolation, and from all these data heights of openings were deduced by barometric readings, and are given as above tide, generally sufficiently accurate for present purposes.

Distances are given as estimated, being intended merely to serve for guidance.

Beginning with the lowest tributary each stream on which coal was seen is followed up in ascending order,

left the right being used in description according as the object is on the left or right when facing up stream.

OAKLEY CREEK.

ELEVATION AT MOUTH, 860.

William Harris has a 10-yard entry on the left, and left of the road, $\frac{3}{4}$ mile up the creek in which the fire-clay coal has a somewhat variable section taken as:

Fire Clay Coal.

S. S.	8 ft.
Coal	11"
Flint fire clay	5" Elevation 955.
Coal	22"

OPEN FORK OF OAKLEY.

ELEVATION AT MOUTH, 865.

Calloway Montgomery's opening on the left, $\frac{1}{4}$ mile up, gives the same bed:

Fire Clay Coal.

S. S.	10 ft.
Coal	11"
Flint fire clay	3"
Coal	11" Elevation 935.
Soft shale	3"
Coal	10"

At the creek level, a mile up, under 15 feet of sandstone, at a natural exposure the three seams of the preceding vein contain but 26 inches of coal and the lower parting is 12 inches thick. The flint fire-clay is black, and looks almost like shelly cannel coal when freshly broken.

Directly under the bed is 5 feet of shale, containing calcareous concretions, and 8 inches of coal is under that: Elevation, 890.

Two and one-half miles up the main creek, $\frac{1}{4}$ mile up a left branch, Asbury Salyers has a good showing of the fire-clay coal, but the lower part is in the branch. It has a sandstone roof, 14 inches of coal to the flint fire-clay and 2 to 2 $\frac{1}{2}$ feet of coal below. Elevation, 930.

On the left, 3 miles up a natural exposure shows by the road only 14 inches of coal with 3 inches of black flint fire clay parting: Elevation, 890.

BEE TREE FORK OF OAKLEY.—On the right, 3 miles up. Elevation of mouth, 915.

On the left at the mouth, Isaac Montgomery has an entry, now abandoned, of which Prof. Crandall gives, in Bulletin No. 10, the following section:

Hazard Coal.	
Shale.	
Cannel slate	4"
Coal	35" Elevation 1040.
Shale ..	7"
Coal ..	20"

This is the Hazard bed, on a good bench, plainly visible on the neighboring hillside. A minor bench and spring at 975 mark the location of another coal opened at the head of Oakley. Almost under the entry the fire-clay bed is exposed beside the road up Bee Tree with elevation 920. This gives an excellent opportunity for getting the interval (120 feet) between that bed and the Hazard.

On the left of the fork, a mile up and 100 feet above it, Wesley Rewe has an entry into the Hazard bed, which is about four feet thick. Elevation, 1,085.

On the right, $1\frac{1}{4}$ miles up, $\frac{1}{8}$ mile up a right branch an entry gives at its mouth the following section:

Hazard Coal.	
S. S.	18"
Coal ..	30"
Shale ..	8" Elevation 1070.
Coal ..	9"

The bottom 3" of this coal was in water and not seen.

On the left at the forks of Bee Tree fork, $1\frac{1}{2}$ miles up and two feet above it an entry, now fallen in, on the same bed, the Hazard gives:

Hazard Coal.	
S. S.	
Shale ..	5 ft.
Coal ..	24" + Elevation 1055.
Shale ..	12"
Coal (reported)	12" +

Probably this is the same as Prof. Crandall gives with 28 and 10 inches coal and $7\frac{1}{2}$ inches parting, though he gives a different roof.

The heights given of the four Hazard openings on this fork indicate an irregularity of the barometer rather than of dip of strata. It appears likely that those given for the mouth and head are nearest correct, making a slight rise in going up the fork.

RIGHT FORK.—Four miles up; elevation of mouth, 926. (By R. R. Survey.)

Ed. Marshall has an entry on a left branch $\frac{1}{4}$ mile up and $\frac{1}{8}$ mile up it, 120 feet above the fork, with the following section:

Hazard Coal.	
Shale	
Coal ..	40"
Shale ..	9" Elevation 1050.
Coal ..	9"

At the forks a mile up, behind Joseph Watson's house, on the left, $\frac{1}{8}$ mile up the branch, this section has been uncovered:

Hazard Coal.	
Shaly S. S.	2 ft.
Coal ..	4"
Shale ..	9"
Coal ..	18"
Shale and S. S.	15 ft.
Coal ..	33"
Black clay	10" Elevation 1090.
Coal ..	6"

On the right of the same branch $1\frac{1}{2}$ feet of coal 50 feet lower has a parting of shale (with coal) one foot thick and 5 feet of shale covering.

In view of the fact that the Hazard bed improves to good thickness near the forks of the creek it is especially regrettable that no openings could be learned of on the Left Fork. If the bed is found there up to the thickness of the Marshall coal, an important addition to the workable coal of the creek will be developed.

On the river opposite the mouth of Oakley creek, 130 feet above it, Joseph Arnett has an entry into the fire-clay bed from which (and connected entries) considerable coal for local use has been mined.

Following is a section taken at the mouth of the entry, a 6-inch "draw slate" found in the mine not appearing at the surface:

Fire Clay Coal.	
S. S.	10 ft.
Coal ..	10"
Flint fire clay	4"
Coal ..	21" Elevation 980.
Clay or shale	18"
Coal (reported)	14"

Judge R. Salyers has an entry on the left $\frac{1}{2}$ mile above the Arnett mine in which the thickness above the flint clay is 8 inches and below the flint clay 25 inches.

In both of the two preceding the foot of coal next under the flint clay is splinty. In all cases the coal of the whole bed appears to be excellent.

On the left, a mile above Oakley creek, Francis Gardiner has an abandoned entry with an exposure showing the beginning of a splitting of the fire-clay bed, which becomes more pronounced farther up the river. This section is:

S. S.	20 ft.
Coal ..	4"
Shale ..	3 ft.
Coal ..	5"
Shale	7 to 10" Elevation 955.
Flint fire clay	3"
Visible coal	12"

The bottom coal may be two feet or more thick.

GUN CREEK.

ELEVATION OF MOUTH (BY R. R. SURVEY), 868.

In the river at the mouth of Gun creek a coal is mined for local use. 40 feet above it is another coal (probably No. 3), and 80 feet above that the fire-clay coal at an elevation of 980.

On the left, $\frac{1}{2}$ mile up, at the big bend in the road, are two abandoned entries into what is regarded as the No. 3 coal. In conjunction with openings farther up the creek the dip toward the river is ascertained, and the consequent interval up to the fire-clay coal. The elevation of the entries is 905.

At $\frac{3}{4}$ mile up the creek, $\frac{1}{8}$ mile up a left branch, the same bed has, in a 3-yard entry with sandstone roof, 26 inches of coal with 4 inches of parting.

At Fred Patrick's, one mile up and $\frac{1}{8}$ mile up a hollow on the right, 125 feet above the creek, a 7-yard entry gives the following section, the bottom 8 inches, being in water, and somewhat uncertain:

S. S.	5 ft.
Shale	6"
Coal	22" Elevation 1020.
Shale	18"
Coal	29"+

This appears to be a little too high for the fire-clay bed, and may be the Haddix.

BILL MAY BRANCH OF GUN CREEK.—On the left, $1\frac{1}{2}$ miles up.

Three openings into the No. 3 bed on the first half mile of this branch give about $2\frac{1}{2}$ feet of coal each. The bed rises from elevation 940 at the mouth of the branch to 960 a half mile up it.

At Marshall's, at the forks, 2 miles up, a 10-yard entry on the right, 40 feet above the creek, gives the following section:

No. 3 Coal.	
Shale ..	7 ft.
Coal ..	6"
Shale ..	2" Elevation 985.
Coal ..	24"

Other openings reported on the forks above Mrs. Marshall's, with coal about the same thickness, were not visited.

ANDREW HOWARD BRANCH.

On the right, $\frac{1}{2}$ mile above Gun creek. Elevation of mouth, 870.

At Andrew Howard's, on the right, $\frac{1}{4}$ mile up the branch, an entry with mouth filled up gave:

Fire Clay Coal.	
Shaly S. S.	24"
Black and cannel slate	12"
Impure flint clay.....	4" Elevation 940.
Coal ..	24 to 36"

The upper seam (and elsewhere the lower seam) of this coal is sometimes wanting, but this is the only known instance of its replacement by black slate. A case on Beaver creek has been reported of the absence of all coal from the bed, the flint fire-clay alone remaining to represent it.

HIGGINS BRANCH.

On the left, one mile above Gun creek. Elevation of mouth, 875.

On the left, $\frac{1}{2}$ mile up the branch, Branch Higgins' 10-yard entry has the following section:

No. 3 Coal.	
Shale ..	8 ft.
Black slate	6"
Coal ..	13"
Clay ..	6"
Coal ..	16"
Elevation, 900.	

From the mouth of Higgins' branch to Henry Patton's house, $\frac{1}{4}$ mile up the river, the following section was obtained:

Soft S. S.	15 ft.
Covered ..	60 ft.
Coal ..	24"
Covered	5 ft.
Thin iron ore	
S. S.	20 ft.
Shale ..	6"
Coal ..	6"
Flint fire clay	1" Fire clay coal.
Coal ..	4" Elevation 945.

Shale and clay.....	5 ft.
Coal ..	24"
Shale and thin S. S.	8 ft.
Coal ..	9"
Fire clay	24"
Shale ..	8 ft.
Coal ..	6"
Fire clay.	
Shale to river	40 ft.

The thick shale at the base is abundantly supplied with thin seams of limestone, small calcareous concretions in layers and some large lime boulders; by the road just above the Patton house it appears to be in part replaced by massive sandstone.

The two sandstones over the fire-clay coal are peculiar in having there nearly vertical seams an inch or two wide running in various directions, and filled with a darker and harder sandstone. In weathering the filling is left jutting somewhat above the softer sandstone enclosing it.

HALF-MOUNTAIN CREEK.

ELEVATION OF MOUTH, 890.

Asbury Stacy, $\frac{1}{2}$ mile up the creek, has a 20-yard entry, $\frac{1}{4}$ mile up a right branch and 5 feet above it, with the following section:

Fire Clay Coal.	
S. S.	2 ft.
Shale ..	8 ft.
Coal ..	15"
Flint fire clay	3" Elevation 930.
Coal ..	16"

The only other openings heard of on this creek are near the head of Equal Fork (a fork on the right 4 miles from the river). A mile up Equal Fork, it divides into three forks. At their junction a thin splint coal lies in the stream, and follows the bed of the left one of the three forks for $\frac{1}{4}$ mile. At this point, some 30 feet above the splint coal, Thomas Conley has an opening into what is probably the Hazard bed. Milburn Conley has openings up the other two forks the same distance.

The three sections are given below:

Left Fork.

Shale ..	4 ft.
Soft Coal ..	18"
Mud ..	2" Elevation 1015.
Soft coal ..	20"

Middle Fork.

Shaly S. S.	4 ft.
Coal ..	17"
Shale ..	1"
Coal ..	14" Elevation 1015.
Shale ..	2"
Coal ..	4"

Right Fork.

Shaly S. S.	3 ft.
Splint coal ..	27"
Shale ..	1" Elevation 1000.
Splint coal ..	5"

The proximity of the left fork of the main creek to the thick coal of Bullmire creek should be an incentive for search for the Hazard bed on this fork, and especially as thick coal is reported on the Quicksand side of the divide.

PUNCHEON CAMP CREEK.

ELEVATION OF MOUTH, 900.

By Milburn Conley's house at the mouth of the creek, on the left, he has opened the following:

Fire Clay Coal.

Coal stain.	
Shale ..	11"
Coal.	
Shale and flint fire clay ..	6" Elevation 935.
Coal ..	8"

On the left fork of this creek, a mile up from the river, are a number of openings into the No. 3 bed, some of which were not visited, as they were reported to be

about like those that were seen, all of which gave thin coal. The bed rises up-stream nearly as the Left Fork valley does. The two bed-sections given below are (1) from Green Howard's pit on the right, $\frac{1}{2}$ mile up Left Fork and (2) from a 6-yard entry on the right, $\frac{1}{4}$ mile up Jake Fork, which is on the left a mile up Left Fork:

(1)

S. S.	10 ft.
Coal ..	12"
Shale ..	12" Elevation 950.
Coal ..	18"

(2)

Shale ..	5 ft.
Coal ..	11"
Shale ..	7" Elevation 980.
Coal ..	18"

On the left of Left Fork, $1\frac{1}{2}$ miles up it, an opening by the road shows the parting $2\frac{1}{2}$ feet thick, and the coal somewhat less than in the preceding.

No openings appear to have been made on Right Fork.

Opposite the mouth of Puncheon Camp creek the Arnett heirs have a 3-yard entry into what is probably the Haddix bed. Its bed section here is:

Shale ..	24"
Coal ..	6"
Clay ..	8"
Coal ..	12"
Shale ..	3" Elevation 990.
Coal ..	25"

On the left of the river, $\frac{1}{8}$ mile above Puncheon Camp creek, cannel coal was found in an old prospect hole at elevation 1,155, evidently very thin. This is probably the Flag coal. About 50 feet higher are sandstone cliffs.

BULLMIRE CREEK.

ELEVATION OF MOUTH, 915.

A mile up the creek and $\frac{1}{4}$ mile up the Right fork, an usually well made 15-yard entry on Bird Howard's land gives what at first sight is a most excellent showing of the Hazard bed, but closer examination is somewhat disappointing, the bed-section giving:

Hazard Coal.

Shale ..	10 ft.
Coal ..	18"
Shale ..	6"
Coal ..	2"
Shale ..	1"
Coal ..	1"
Shale ..	1" Elevation 1020.
Coal ..	11"
Shale ..	1"
Coal ..	32"
Black slate ..	1"

The lower seams are largely splint coal, which looks fine in the stock pits as one passes, but the shale partings in sampling were found to adhere, more or less, to the adjacent coal; the splint is dull in appearance, and coal marketed will probably prove very high in ash. The impression acquired is that the increased thickness over surrounding openings is gained largely at the expense of quality.

Excepting incomplete openings in the close vicinity no others are known on this stream.

On the left of the river, $\frac{1}{2}$ mile above Bullmire creek, A. J. Brown has a 10-yard entry at elevation 1,020, into a bed which is probably the Haddix coal. It is of about the same thickness and quality as the coal next described, a small hill only intervening between the two openings.

SALT LICK CREEK.

ELEVATION OF MOUTH, 925.

On the left of a left branch, $\frac{1}{4}$ mile up Salt Lick, Joseph Allen has a 4-yard entry with the following bed-section:

Haddix Coal.

S. S.	10 ft.
Shale ..	5 ft.
Soft coal ..	11"
Cannel coal ..	7" Elevation 1030.
Splint coal ..	10"

The splint and cannel coal are mined in one block the change from one to the other being gradual and al-

most imperceptible. The cannel looks good and the splint is an exceptionally fine bright rich coal, with lamination hardly visible.

On the left, 5 miles up the main (right) head of the creek, in front of Ellett Stowe's house, are two entries under massive sandstone, the bed-section being:

S. S.	10 ft.
Cannel slate ..	7"
Splinty coal ..	34" Elevation 1100.

An inseparable half inch of bone coal 29 inches from the bottom detracts little from the value of the whole seam, which is very bright and good, much like the splint of the Allen opening, next preceding, and is probably the same bed, though in going up the creek the strata seemed to rise too fast to make it possible.

LONG CREEK.

ELEVATION OF MOUTH, 945.

The only coal seen on this creek is on the right, 3 miles up at elevation 1,085, 20 feet above the creek. But 2 feet thick with 4 feet of shale and then soft sandstone, it lies probably between Mr. Stowe's coal and the fire-clay coal.

The creek is peculiar in having no branches of consequence up to its forks, $3\frac{1}{4}$ miles from its mouth.

BUCK CREEK.

ELEVATION OF MOUTH, 955.

While working on this creek the barometer changed considerably and the heights of coal openings given are unreliable. It is believed, however, that no material error is involved.

RIGHT FORK OF BUCK CREEK.

A half-mile up the fork, on the left, $\frac{1}{8}$ mile up a left branch by Proctor Wireman's house, he has a 4-yard entry into a 30" coal-bed having 10 feet of sandstone roof. Apparently there is no parting. The bottom 7 inches, being in water, was not seen. The bed is 130 feet above the fork at the house and its elevation about 1,120,

too high for the Haddix coal (as appeared to be the case in going up to it), but it is probably of the Hazard bed—the sandstone roof rather indicative of the Flag bed.

A mile up the Right fork and $\frac{1}{8}$ mile up a Right fork at J. M. Owens house, a bank on the right shows:

Coal stain	1	ft.
Shale ..	5	ft.
Coal stain	1½	ft. Elevation 1055.
Coal ..	1	ft.

One of these coals has been dug from the stream 100 yards farther up, and on the right 100 yards still farther up the Hazard bed has been entered, but the entry is partly filled. The following remains visible:

S. S.	5	ft.
Shale (with two small coals)	10	ft.
Cannel slate	5"	Elevation 1085.
Coal ..	30 to 36"	

The coal is reported 3 feet thick (probably including the cannel slate). The coals in the shale bank below seem to be offshoots from the main bed, a separation but just beginning in the Bullmire opening, a mile northwest from this one.

LEFT FORK OF BUCK CREEK.

Three openings, as given below, have been made into one bed on this fork. The sandstone roof, as in the Procter Wireman entry on Right fork, places the bed as the Flag rather than the Hazard, but this involves such a dip from the river up Buck creek and down the Right fork from Owens' entry as seems somewhat improbable. The three openings are:

$\frac{7}{8}$ Miles Up Left Fork and $\frac{1}{8}$ Mile Up a Left Branch.

Shaly S. S.	36"	
Splinty coal	22"	Elevation 1080.
Knife edge parting		(above stream 25)
Coal ..	4"	

Ellett Wireman's on Right, 1 Mile Up.

S. S.	5	ft.
Coal ..	19"	Elevation 1085.
Shale and coal	4"	(above stream 110.)
Coal ..	4"	

Irwin Bailey's (on left, 2 miles up.)

S. S.	10	ft.
Coal ..	23"	Elevation 1055.
Knife edge parting.		(above stream 20.)
Coal ..	7"	

WHITLEY CREEK.

ELEVATION OF MOUTH, 970.

Three exposures of one bed on this creek give a down stream dip of 40 to 50 feet per mile, which would bring it about to the level of the Haddix coal, and one of the adjacent small seams it probably represents. The exposures are:

Smith Whittaker's on Left, 1 Mile Up.

Shaly S. S.	5	ft.
Shale ..	1	ft.
Coal ..	26"	Elevation 1065.
Shale ..	6"	(above creek 20.)
Coal ..	2"	
(Probably coal below.)		

On Left, $1\frac{3}{4}$ Miles Up.

S. S.	10	ft.
Coal ..	12"	
Shale ..	1"	Elevation 1090.
Coal ..	15"	(above creek 10.)
Shale and coal	4"	
Fire clay.		

At Creek, $1\frac{7}{8}$ Miles Up.

Coal ..	14"	
Shale ..	1"	Elevation 1110.
Coal ..	3"	
Shale ..	2"	
Coal ..	10"	

TRACE FORK.

ELEVATION OF MOUTH, 975.

Sam Wireman's house and store are $\frac{3}{4}$ mile up this fork: A mile up a right branch and $\frac{1}{8}$ mile up a hollow on the right the following section of the Hazard coal shows in and over his entry, now hardly accessible:

Shale ..	20 ft.
Shaly S. S.	10 ft.
Shale and black slate	5 ft.
Shale ..	2 ft.
Coal ..	12"
Shale ..	36" Elevation 1120.
Coal ..	44"

The upper 6 inches of this coal is a good soft block, the remainder a particularly rich-looking block and splint.

RIGHT FORK OF TRACE FORK.

TWO MILES UP: ELEVATION OF MOUTH, 1,025.

Three entries on this fork show the Hazard coal somewhat reduced from the preceding. They are as follows:

Adam Allen on Right, $\frac{1}{4}$ Mile Up, 30 Yard Entry.

Coal stain.	
Shale ..	5 ft.
Coal ..	3 ft. Elevation 1120.

D. E. Stacy on Left, $\frac{1}{2}$ Mile Up, 6 Yard Entry.

Coal stain.	
Shale ..	15 ft.
Coal ..	3"
Clay ..	4" Elevation 1190.
Coal ..	31"

Stephen Wireman, $\frac{3}{4}$ Mile Up. $\frac{1}{2}$ Mile Up Right Branch and $\frac{1}{8}$ Mile Up Right Fork.

Shale ..	10 ft.
Coal ..	9"
Shale ..	5" Elevation 1160.
Coal ..	33"

A seam of carbonate iron ore shows in the point of the hill 30 feet under the Allen entry.

At a pit in the branch 60 yards above the Wireman entry the coal is almost four feet thick and the parting reduced to three inches.

LEFT FORK OF TRACE FORK.

 $2\frac{1}{2}$ MILES UP: ELEVATION OF MOUTH, 1,035.

Bake Lick branch is on the left, $\frac{1}{2}$ mile up this fork. On the right, $\frac{1}{2}$ mile up the branch and 100 yards up the middle one of three inlets, a coal without a parting shows 29 inches thick under shale roof at elevation 1,105.

In the point of the hill on the right of the above Wiley Wireman has a pit sunk into the Hazard bed, at elevation 1,230, showing when visited 1 foot or more of splint or semi-cannel coal. The bed was reported $3\frac{1}{2}$ feet thick, but whatever it may be there it would doubtless be more if down under proper cover. The bench here is very broad.

On the right, a mile up Left fork, the fire-clay, or the coal above it, gives, in a 2-yard entry of Wiley Wireman, 39 inches of coal with two thin partings included: Elevation 1,070, 15 feet above stream. The bed is reduced to 33 inches and one parting $\frac{1}{8}$ mile farther up. The roof there is of sandstone.

Barb fork is on the left $1\frac{1}{2}$ miles up the Left fork. From the stream, $\frac{1}{2}$ mile up, coal has been taken, leaving a face of over 2 feet and no bottom reached. Its elevation, 1,160, leaves correlation too uncertain.

At Cal. Hale's, $5\frac{1}{2}$ miles up Trace, a pit in the point of the hill on the right, 140 feet above the creek, gives 28 inches of coal to a shale or clay bottom. This pit is also on a broad bench marking the coal of the Hazard bed; its elevation is 1,230. The 28 inches thickness of coal can only be regarded as a minimum: How much may have weathered away from the top or be underneath should be determined by drifting.

JOHN HOWARD BRANCH.

ELEVATION OF MOUTH, 985.

William Conley, $\frac{1}{4}$ mile up, has an 8-yard entry on the left of and $\frac{1}{4}$ mile up a right branch, on the first broad bench of the hill. Its bed-section is:

Hazard Coal.

Shale ..	10 ft.
Coal ..	30" Elevation 1090.

The lower part of this coal is hard and splinty. Possibly more coal lies below, as at the next following Hazard opening.

The fire-clay coal soon rises above drainage on John Howard branch. Two of its associate seams are probably represented by thin coals in the branch and ten feet above it, two miles from the river on the Road fork: Their elevations are 1,050 and 1,060.

A half mile above John Howard branch, A. Wireman's coal, taken from the river bed level, is probably of the fire-clay coal. It was not in condition for measurement when visited, but its thickness is estimated at $2\frac{1}{2}$ feet.

In the point of the hill on the right of the river a mile above John Howard branch, James Neeley has entries, 120 feet above the river, one of which gives the following:

Hazard Coal, 10-yard Entry.

Shale ..	8 ft.
Shelly coal ..	7"
Clay ..	2"
Coal ..	39" Elevation 1105.
Shale ..	4"
Coal ..	6"

At the mouth of the entry the partings are but half as thick and the top coal two inches thicker than at the face as given.

The first foot of coal above the lower parting is very hard. The whole bed would have been better developed away from the point of the hill. The bench here is very broad.

MOLLY BRANCH.

ELEVATION OF MOUTH, 995.

Mrs. Howard, one mile up, has four exposures of the Hazard coal, $\frac{1}{4}$ mile up the left branch, just below her house:

No. 1 (on Left.)

S. S.	10 ft.
Coal ..	6 "
Shale ..	2 to 3 "
Coal ..	6 " Elevation 1125.
Shale ..	$\frac{1}{2}$ "
Coal ..	28 "

No. 2, 50 Yards Below No. 3.

Massive S. S.	20 ft.
Coal ..	15"
Shale ..	1" Elevation 1125.
Coal ..	32"

No. 3 (on Right.)

Thin bedded S. S.	20 ft.
Coal ..	49" Elevation 1120.

No. 4, on Right Branch and 150 Yards Above No. 3.

Shale ..	5 ft.
Coal ..	6"
Shale ..	3"
Coal ..	15"
Clay ..	1" Elevation 1120.
Coal ..	26"
Covered ..	10 ft.
Coal ..	3"

In No. 3 the upper 3 inches of the 28-inch seam is shelly, the 4 inches under that and 2 inches in the middle of the 16-inch seam higher up have a decidedly bony look, but, tried in a fire the ash, though evidently in large proportion, went completely to powder, while bone coal is regarded as such as retains its original form.

These four contiguous exposures illustrate markedly not only a locally conspicuous roll and changes of bed-section, but, chiefly important, the change in character of roof which, farther up the river, usually consists of a thick bed of shale containing a rider of coal.

Here the massive sandstone over No. 2 forms an unusually deep rockhouse, proving the strength and uniformity of the rock. At No. 3 the roof is in thin-bedded layers of sandstone wholly different from the preceding, while at No. 4 a complete change to shale is affected. This indicates a change in rock-making material rather than the decrease or increase of thickness of strata.

Mrs. Howard has another opening, just started, on the left, $1\frac{1}{2}$ miles up Molly Branch, 15 feet above it, where the following section is uncovered:

Hazard Coal.

Coal stain	4"
Shale ..	18" Elevation 1140.
Coal ..	59"

At river level on the left of it and on the right of the road, just below the mouth of Big Branch, coal for local use is taken and this section was obtained:

S. S.	15 ft.
Shale ..	3 to 6 ft.
Coal ..	6 to 8"
Shale ..	$1\frac{1}{2}$ to $4\frac{1}{2}$ ft. Elevation 1005.
Coal with two thin partings ..	30"
S. S. at river bed.	

This is probably of the fire-clay coal without its characteristic parting, the elevation being too low for the Haddix coal.

The change in thickness of shales here is gradual and not due to replacement as on Molly Branch.

BIG BRANCH.

ELEVATION OF MOUTH, 1,005.

Three openings on this branch give the Hazard bed and covering as shown below:

Widow Sheppard on Right, 3 Miles Up.

S. S.	5 ft.
Shale ..	4 ft.
Coal ..	1 ft.
Shale ..	8 ft. Elevation 1125.
Coal ..	$1\frac{1}{2}$ ft.
Shale ..	8 ft.
Coal ..	$4\frac{1}{2}$ ft.

Hiram Johnson on Right, $\frac{7}{8}$ Miles Up.

Shale ..	6 ft.
Coal ..	6"
Shale ..	4 ft. Elevation 1135.
Visible coal	36"

On Left, 1 Mile Up.

Shale ..	5 ft.
Coal ..	23"
Clay ..	1" Elevation 1140.
Coal ..	33"

None of this coal was found shelly, bony or otherwise impaired. That of the middle opening was hardly accessible and partly covered by fallen earth. The coal is probably about as thick as at the other openings.

BULL CREEK.

ELEVATION OF MOUTH, 1,015.

LICK FORK.—On the right, $\frac{3}{4}$ mile up.

A half mile up this stream and $\frac{1}{4}$ mile up a right branch Mr. Bradley has a 10-yard entry giving:

Shale ..	10 ft.
Hazard coal	69"+

The bottom 6 inches being in water was not seen.

At the mouth of this branch, 100 feet below the coal, is an impure limestone, nearly a foot thick, which has a tendency to weather into blocks about a foot square. If this is continuous it may serve as an aid elsewhere in finding the Haddix and Hazard coals above it or the fire-clay coal about 20 feet beneath it. A similar stone was found on Whiteley and other streams near by, but that deposit is below the fire-clay coal.

In the point of the hill on the right at the forks of Lick Fork, a mile from its mouth, carbonate iron ore is exposed twenty feet below the stain of the Hazard coal and perhaps 40 feet below the actual level of the bed. An abandoned entry into the coal shows on the hillside across the creek.

On the left, a mile up Bull creek, 100 feet above it, Dan Wireman has a 60-yard entry from which the following section was taken:

Hazard Coal.

S. S.	10 ft.
Coal ..	12"
Shale ..	5 ft.
Coal ..	43"
Shale ..	1" Elevation 1130.
Coal ..	16"
Fire clay ..	3"
Coal ..	12"

The bottom seam, not seen by the writer, is as reported by Mr. Crider of the State Geological Survey.

The upper 8 inches of the bed is shelly and would count for little in mining, more than its giving good head room. A "draw slate" 8 inches thick lies on the coal, above which is a moderately good holding shale, although it has fallen in several places in the length of the entry.

On the left, $1\frac{1}{4}$ miles up Bull creek 5 feet above the creek is 27 inches of coal between sanstones (one foot shale roof) at elevation 1,050, probably above the fire-clay coal.

Dan Wireman has an unfinished opening into the Hazard bed, $1\frac{1}{2}$ miles up the creek, on the left, $\frac{1}{8}$ mile up a right branch, which appeared to have slightly under 5 feet of coal—entirely covered on a second visit.

BRUSHY CREEK.

ELEVATION OF MOUTH, 1,020.

MUDDY BRANCH.—On the left, $\frac{3}{8}$ mile up Pine branch; on the left, $\frac{1}{2}$ mile up.

On the right, $\frac{1}{4}$ mile up each of these branches, William Shepard has openings as follows in the Hazard coal:

Muddy Branch, 7-Yard Entry.

S. S.	3 ft.
Shale ..	1 ft.
Coal ..	3" Elevation 1120.
Knife edge parting.	
Coal ..	48"

Pine Branch.

Earth.	
Coal ..	59" or more. Elevation 1105.

In the entry the top 3 inches of coal is shelly, and 2 inches of block coal under the parting is poor.

ROAD FORK.—On the left, 1 mile up.

A half mile up this fork, on the right, $\frac{1}{4}$ mile up a left branch, Win Shepard has another opening, in which the bed is badly split up, as shown below:

Hazard Coal.

Shale ..	10 ft.
Coal ..	23"
Shale ..	12"
Coal ..	12" Elevation 1080.
Covered ..	36"
Shale ..	5 ft.
Coal ..	12"

It is to be noted that, as obtained by barometer, this opening is 25 or 30 feet lower than those on either side of it. Also this opening is at the bottom of the broad bench, whereas the next following is 15 to 20 feet up on it. This leads to a possibility that this opening is below the main seam of the Hazard bed.

A fourth opening of Mr. Shepard's, an 8-yard entry on the right of road, $\frac{3}{4}$ mile up Road fork, gives the following:

Hazard Coal.

Earth.	
Coal ..	12"
Shale ..	5 ft.
Coal ..	21" Elevation 1110.
Shale ..	1"
Coal ..	28"

This opening is but 75 feet below the low gap to Middle creek.

At (or near) R. B. Hale's, a mile above Brushy creek, Mr. Crider found the fire-clay coal 12 feet above the river; elevation, 1,040.

Back of and below Mr. Hale's house, on the left of the river, the Hazard coal is opened in a 3-yard entry, where the following section was obtained:

Shale ..	5 ft.
Coal ..	12"
Shale ..	9 ft.
Coal ..	59"
Elevation, 1160.	

The coal is largely splint and makes an excellent showing burned in a grate.

T. B. Whittaker has a 6-yard entry at the head of a drain on the right, $1\frac{3}{4}$ miles above Brushy creek, showing nearly the same thickness as Mr. Hale's, but with 10 inches of shelly coal at the top. Possibly Mr. Hale's has this also, but water in the entry prevented access to the face. The covering differs, as shown in the following section:

Hazard Coal.	
S. S.	10 ft.
Coal ..	12"
Shale ..	5 ft. Elevation 1215.
Coal ..	58"

WILL BRANCH.

ELEVATION OF MOUTH, 1,035.

Coal 16 inches thick has been taken from this branch, $\frac{1}{4}$ mile up it, which is probably underneath the fireclay coal. The strata rise nearly as the valley does.

On the right, $\frac{3}{8}$ mile up, John Shepard has an 8-yard entry, the face now inaccessible, but measured at the mouth gave:

Hazard Coal.	
Shale ..	6 ft.
Coal ..	24"
Mother coal ..	1" Elevation 1215.
Coal ..	41"+

At the face there appeared to be another one inch parting about 2 feet from the bottom. This appears to be the same opening visited by Prof. Crandall, as reported by him in Bulletin No. 10, although the covering differs considerably. His section and the analysis of his sample as given in that bulletin are repeated here:

Hazard Coal.

S. S.	
Shale ..	24"
Coal ..	21"
Bit. slate ..	1"
Coal ..	25"
Bit. slate ..	1"
Coal ..	11"
Bit. slate ..	1"
Coal ..	8"

Analysis.

Moisture ..	3.40
Volatile matter ..	32.80
Fixed carbon ..	56.30
Ash ..	7.50
	100.00
Sulphur ..	0.826

Mr. Crider gives the following bed-section found on J. B. Shepard's land on the right of Will's branch:

Hazard Coal.

Slate.	
Coal ..	6"
Clay ..	4"
Coal ..	18" Elevation 1350.
Shale ..	14"
Coal ..	18"

GRASSY CREEK.

ELEVATION OF MOUTH, 1,040.

Mr. Crider also found on the river "by the road just below the mouth of Grassy creek:"

Fire Clay Coal.

Shale ..	20 ft.
Coal ..	30"
Fire-clay and shale ..	5 ft.
Coal ..	12"
Flint fire clay ..	3"
Coal ..	12" Elevation 1040.
Fire-clay ..	18"
S. S.	24"

At T. B. Whittaker's, $\frac{1}{4}$ mile up the creek, in it and in the road a 4-foot bed of coal was reported to the writer, but the pit was filled with wash and no sign of coal remained. Mr. Crider reports the following section for this bed (its elevation reduced to the present basis), below the mouth of Grassy creek:"

Top of hill—Elevation 1520.
Heavy S. S., forming cliffs.

Flag Coal.

Slate.	
Coal ..	6"
Clay ..	4"
Coal ..	18" Elevation 1350.
Carb. shale ..	14"
Coal ..	18"
Interval ..	120 ft.

Hazard Coal.

Shale ..	7 ft.
Coal ..	26"
Shale ..	5"
Coal ..	4"
Shale ..	1"
Coal ..	3"
Shale ..	1"
Bl. slate ..	1" Elevation 1230.
Coal ..	24"
Shale ..	2"
Bl. slate ..	1"
Coal ..	16"
Clay ..	1 to 2"
Coal ..	30"+
Interval ..	130 ft.
Slate ..	4½ ft.
Coal ..	3"
Gray shale ..	24"
Coal ..	8" Elevation 1100.
Clay ..	4"
Coal ..	10"
Slate ..	2½"
Coal ..	9"
Interval ..	50 ft.
S. S.	
Shale ..	24"
Coal ..	3"
Slate ..	4½" Elevation 1050.
Coal ..	42"

The second bed is probably a part of the fire-clay seam, the lower bed may possibly be the No. 3, but it seems too close to the fire-clay coal for that bed. The highest bed is given as the Flag, but the interval seems too great and it may be a higher coal. The rapid rise of strata up the creek makes it probable that the No. 3 bed may be opened above drainage there. If of the No. 3 bed a large area about the head of the river may be reasonably expected workable, readily accessible by shafts or slopes, if not in outcrop, and practically undiminished in area by erosion, the possibility urgently invites full investigation.

On the left, $\frac{1}{4}$ mile up Grassy creek, in the drain behind Mr. Whittaker's house, several small seams of coal appear, which, at elevation 1,080 to 1,100, must be in the close vicinity of the fire-clay coal. Some of this group also appear on the river above Grassy creek near its mouth.

At the head of the right fork of this drain an unfinished opening at the bottom of a broad bench gives the following:

Hazard Coal.

Shale ..	7 ft.
Coal ..	26"
Shale ..	5"
Coal ..	4"
Shale ..	1"
Coal ..	3"
Shale ..	1"
Black slate ..	1"
Coal ..	24" Elevation 1230.
Shale ..	2"
Black slate ..	1"
Coal ..	16"
Clay ..	1 to 2"
Coal ..	30"+

Half of the bottom seam was in water, and the measurement therefore inexact, but there is no doubt of its being all coal.

At Albert Shepard's, $\frac{3}{4}$ mile up Grassy, at the head of a small drain on the left, also at the bottom of a broad bench and 205 feet above the creek, the same bed is found

in an incomplete opening still more injured by partings and with the coal much reduced. Its bed-section follows:

Hazard Coal.	
Rock and clay.....	5 ft.
Coal	16"
Shale	16"
Coal	8"
Covered	30"
Shale	16" Elevation 1280.
Coal	11"
Black slate	2"
Coal	12"

The height of this bed above the creek gives ample room for the appearance of the No. 3 bed above drainage, if its interval below the Hazard is no greater than was found down the river.

At Elkanah Gearhart's, a mile above Grassy creek and 190 feet above it, an unfinished opening gave to Mr. Crider the following section:

Hazard Coal.	
Slate	10 ft.
Coal	15"
Slate	3½ ft. Elevation 1240.
Coal	48"

Full development may give thicker coal. This was in process on the writer's visit, but at that time a fall of earth had nearly hidden the whole.

QUICKSAND FORK.

Sam Bailey has an opening on the point of a hill on the right, ½ mile up the fork, in which the following bed-section shows. With scant covering the coal has doubtless weathered away considerably and the parting, perhaps, crept in:

Hazard Coal.	
Shale	2 ft.
Coal	12"
Clay shale	7 to 12"
Coal	34"

This and the next preceding opening are on the first broad bench above the river.

At Gardner Bailey's, 2½ miles above Grassy creek, in the point of a hill, ¼ mile up a right branch, on a good bench, but with another equally good 80 to 90 feet lower, an abandoned entry shows 2½ to 3 feet of coal under 10 feet of shale. This is of the Flag bed, its elevation 1,370; the river about 1,090.

At the mouth of the branch, or, at Mr. Bailey's house, the Flag bed is probably about 300 feet above the river, the fire-clay coal 100 feet above, and the No. 3 should be found within 40 feet of the river, probably above water level but possibly below. Both give justification for search, the fire-clay coal, across the divide to the south, in an opening on the head of Salt Lick creek, having 40 inches of coal and but 4 inches of parting.

THE ELKHORN COAL.

The Elkhorn seam is found of good thickness across the divide on Big Sandy waters, but is everywhere beneath drainage in this section. Its place would be probably 250' below the surface at the mouth of Grassy and less than that with the rising dip down the river. The well known character of this coal would seem to justify some drilling with a core drill to test its presence and thickness here.