



MAP OF
FLOYD CO.
Kentucky
 SHOWING
 OIL & GAS WELLS
 AND
 GEOLOGIC STRUCTURE
 BY
 Willard Rouse Jillson
 Lexington Ky
 1918

Legend
 ● OIL WELL
 ⚙ GAS WELL
 ● DRY HOLE
 —+—+—+ PIPE LINE

**AN OUTLINE
OF THE
GEOLOGY
OF
FLOYD COUNTY, KENTUCKY**

BY

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Sandy Valley was begun shortly after July 6, 1917, when the writer, having removed from Tulsa, Oklahoma, where he had been engaged for some time as a consultant in the geology of oil and gas in the Mid-Continent field, arrived in Prestonsburg to establish permanent residence. A general reconnaissance of all of Floyd and parts of the adjoining counties, was first undertaken, after which detailed studies of the stratigraphy and structure of the main river valley and each of its principal tributary water sheds—Abbott, Middle, Beaver, Mud and a portion of Johns creek were undertaken.

The progress of this work in the field has been much facilitated by the use of the excellent topographical maps recently prepared and issued for this district by the United States and the Kentucky Geological Surveys at the scale of 1:62,500. From these maps accurate elevations above sea level have been available from numerous bench marks, and elsewhere approximate elevations have been determined by the interpretative reading of surface-feature contouring. While the use of these maps has advanced the work in this field, the lack of good roads throughout Floyd County has greatly retarded and added to the physical difficulties encountered in completing this study.

All of the work in the field has been done horseback or afoot as no modern buggy or automobile road exists in Floyd County today. Investigations in the Big Sandy Valley proper and up Beaver Creek and its Right Fork to Wayland have been somewhat speeded by the use of the trains of the Chesapeake & Ohio Railroad, but rail schedules at best, are poorly timed for the advancement of work in the field, in the prosecution of which, not infrequently under very trying conditions, the writer has been very courteously treated throughout Floyd County.

DRAINAGE

All of Floyd County is drained by the Levisa Fork of the Big Sandy. This master-stream heads somewhat to the southeast of the Pine Mountain—the great barrier ridge between Kentucky and Virginia. It flows in a meandering northwesterly course from the Pike County line to Prestonsburg at which point it turns to the north, a direction it maintains to and beyond the Johnson County line. The “valley of the Big

Sandy"—as the west and main fork of the river is usually called—is confined to the eastern-central part of the north half of the county. Besides numerous smaller ones, three large tributaries, Mud, Beaver and Middle creeks enter the river from the south and west, while only one of comparable size—Johns creek—joins it from the southeast.

The width of the bottoms of the Big Sandy in this area rarely exceed 1500 or 1600 feet and occasionally it is narrowed down to not more than 750 or 800 feet, nearly half of which is occupied by the stream channel alone. The width of the inner valley—from ridge to ridge—is usually not more than a mile and sometimes much less. The fall of the bed of the river from Pikeville to Prestonsburg is forty-two feet and from Prestonsburg to the vicinity of Paintsville it is twenty-three feet thus giving an average slope of about 1.4 feet per mile.

The bed of the stream is characterized by extensive deposits of loose sand interspersed with occasional outcroppings of sandstone. These hard rock ledges provide, during the dry period of the year, a flow pattern of successive shallow slack-water pools and shoals which now effectually bar navigation, though up to about 1910 small steamboats carrying both passengers and freight ascended this fork of Big Sandy during six or eight months of the year a distance of about 100 miles above the Ohio.

A notable instance of the alteration of the pattern of drainage by piracy may be seen on the upperwaters of Right Middle creek. This stream rises at Ivyton in Magoffin County and flows to the southeast through the northwestern part of Floyd County to join Left Middle creek about three miles nearly west of Prestonsburg. From Prater branch, about two miles above Dotson P. O., all up-stream branches of Right Middle creek including the State Road Fork join the main creek valley at an acute angle against the direction of stream flow. The original headwaters of Right Middle creek is seen as about a mile above the mouth of Richardson branch. All of the area drained by this creek above this point—some 10 or 12 square miles mostly in Floyd, but partly in Magoffin County—has been diverted from the drainage basin of the Burning Fork of Licking river by Right Middle creek of the Big Sandy. This piracy has been brought about by a gradual headwaters migration to the north-

west—still in process—caused by the shorter course and more rapid down cutting of the very much lower waters of Right Middle creek.

TOPOGRAPHY

Although Floyd County is commonly referred to as one of the "mountain" counties of eastern Kentucky, the description is somewhat misleading for there are in fact, no real mountains within its boundaries. The nearest and the only upland of truly mountainous proportions in this part of the State is the Pine Mountain which attains a crestal altitude of about 3000 feet near Jenkins, Kentucky. It lies some thirty-five miles in an airline "up the valley" from Prestonsburg and is at least ten miles removed to the southeast from the southern-most tip of the county.

A great and intricately dissected tableland sloping to the north and northwest, Floyd though not actually mountainous is nevertheless, an extremely rough area topographically. In its entirety the county is an internal part of the broad Cumberland plateau, a notoriously rugged upland which flanks the Alleghany mountains on the west from New York to Alabama. Characterized throughout by meandering V-shaped valleys and steep-sloped, sharp-crested ridges, Floyd County exhibits its maximum elevation—2300 feet—on the drainage divide at the head of Left Beaver creek two miles nearly due south of Weeksbury where it corners with Knott and Pike counties.

The lowest elevation in Floyd County—600 feet—is found at low water at East Point where the Big Sandy river flowing to the north enters Johnson County. The maximum relief exhibited in Floyd County is therefore 1700 feet. The immediate relief in any given locality is usually not more than 600 or 800 feet, though 1000 to 1200 feet is commonly found on the head-waters of Left Beaver creek. On the other hand, below Prestonsburg to East Point the hilltops of the inner valley rarely extend more than 400 or 500 feet above the bottoms of the Big Sandy.

The upper bottom or old flood plain of the river on which the town of Prestonsburg is seated has an elevation of 641 feet above sea level and from this by very gradual graduations the bottoms of the main valley rise to 653 feet at Boldman on the

Pike County line. The nice topographic adjustment of drainage levels in this district is further evidenced by the fact that the bottoms of Johns creek at Thomas on the Pike County line are 654 feet above tide while similar elevations are found in the county road as far up the waters of Right Beaver creek as the hamlet of Dinwood.

As might be anticipated in an unglaciated upland area of homogeneous sedimentary rocks where stream dissection has reached maturity, there are in fact in Floyd County, Kentucky, no broad upland flat lands, nor are there anywhere more extensive bottoms than those found in the great southwestern bend of the river at Prestonsburg. Because of these topographical peculiarities, from the days of the earliest exploration and settlement—1755 to 1790—down to this year of 1918, the activities of man in Floyd County have been largely confined to the valley bottoms of the Big Sandy river and its principal tributaries.

While these originally rich and easily accessible lowlands have been cleared and farmed for upwards of 150 years, the upper slopes of the ridges, steep, thin of soil and cropped with only the very greatest efforts—still stand, quite generally in timber from which during the past quarter century the best grades of hardwood—oak, ash, hickory, poplar and walnut have been logged out to feed the great mills that stood during the early part of this century in Ohio, West Virginia and Kentucky near the mouth of the Big Sandy river.

LITERATURE

The first printed reference to the geology and mineral resources of Floyd County, Kentucky, is found in the *Report of Survey of Mountain Roads* made by Napoleon Bonaparte Buford to the House of Representatives of the Commonwealth of Kentucky in 1836. In this brochure published as an appendix to the House Journal, the territory involving Floyd County along the upper part of the road leading to Prestonsburg and points farther up the Big Sandy river Mr. Buford described as an "almost inaccessible portion of the State." With more than passing interest he cites the "celebrated Burning Spring on the road between Licking Station—now Salyersville

—and upper Middle creek” in Floyd County. This natural gas spring, which the writer has visited and flamed on numerous occasions, was again referred to as one “which constantly emits a thick sulphurous vapor * * * and ignites on the application of fire” by Judge Lewis Collins in his *Historical Sketches of Kentucky* printed in Maysville in 1847.

Twenty years after Mr. Buford’s reconnaissance report to the Legislature was put into circulation, Dr. David Dale Owen in his *Report of the Geological Survey in Kentucky for 1854 and 1856*, included a preliminary note of the Coal Measures at Prestonsburg. In this early report there also appeared an analysis of Aaron and Bogg’s coal taken from domestic mines or “banks,” as they were then called, located in the main Big Sandy valley near the Johnson County line. This is the first printed analysis of Floyd County coal. In 1861 there appeared from the hands of Leo Lesquereux the first stratigraphic section for Floyd County. It was printed with remarks concerning the coals outcropping near Prestonsburg in his *Report of the Fossil Flora and of the Stratigraphical Distribution of the Coal in the Kentucky Coal Field*.

In 1877 Dr. Nathaniel Southgate Shaler, Director of the Kentucky Geological Survey, issued his *Preliminary [Geological] Map of Kentucky*. It made use of seven distinct colored patterns to exhibit the areal geology of the State, and is the first map to indicate Floyd County as completely embraced within the Coal Measures. A year later—in 1878—there was issued by the State Geological Survey the first of a series of chemical reports, which continuing to 1913, presented analyses of the coals, ores, mineral waters and soils of Floyd County as executed by Dr. Robert Peter and his son, Dr. Alfred M. Peter, chemists to the Survey in Lexington.

Professor A. R. Crandall’s *Preliminary Report on the Geology of Morgan, Johnson, Magoffin and Floyd Counties*, a 24-page pamphlet, was issued by the Kentucky Geological Survey in 1890, but unfortunately only a few citations touch on Floyd County. Nevertheless it prepared the ground for Professor Newton C. Brown’s report on the *Mineral Wealth of the Big Sandy Valley From Louisa to the Head of Navigation* which was issued by the Government at Washington in 1900 as Document No. 326 of the United States House of Representa-

tives. In this very readable report, the most comprehensive that had yet appeared, the design and the descriptions are those of Professor Brown but the coals and the stratigraphy as applied to that part of the valley embraced within Floyd County is the labor of Professor Crandall.

It may be stated without fear of contradiction that the most extended work up to the present time discussing oil, gas and coal in Floyd County has been done by Mr. Joseph B. Hoeing and Professor Crandall. In 1905 the Kentucky Geological Survey issued Mr. Hoeing's *Oil and Gas Sands of Kentucky*. In it there appear numerous logs of wells drilled for oil and gas in Floyd County and, as interpreted from these records, a description of the oil and gas producing formations in this part of the upper Big Sandy Valley is given. During the same year, Professor Charles J. Norwood, then the head of the State Geological Survey also issued Professor Crandall's *Coals of the Big Sandy Valley*. This report describes in some detail the commercial coals on Mud, Beaver, Middle creek and the Big Sandy in Floyd County, and gives occasional measured sections, but it is very weak in its regional correlation and general stratigraphy.

Five years ago—in 1913—the State Geological Survey of which he was then the head, issued Mr. Hoeing's *Coals of the Upper Big Sandy Valley and the Headwaters of the North Fork of the Kentucky River*. Although this report represents a great advance over anything that had preceded it, no effort was made apparently to present the entire stratigraphic section or correlate other than a few of the lower coals of Floyd County adjacent to the Big Sandy river, and its local tributaries, Abbott, Middle, Beaver, Mud and Johns creeks. It should be noted with credit to this report by Mr. Hoeing, however, that it is the first and only piece of writing up to this time to attempt an interpretation and description of the geological structure of the surface rocks of Floyd County.

In summation of all previous work in this area it is proper to state that a careful review of the literature, while it reveals some twenty-five or thirty separate maps and reports of specific, if not detailed bearing, as indicated in the checklist of references attached to these pages, no comprehensive report on the geology and mineral resources of Floyd County, Kentucky, has

yet appeared. Such a report would be of very great value at the present time due to the expanding interest in oil and gas and coal development.

INDEX FOSSILS

A careful search of the literature reveals nothing in print on the paleontology or the paleo-botany of Floyd County, Kentucky. This is not remarkable when it is considered that no unit work on the geology of this part of the State has ever been written. Nevertheless it is believed, in accord with casual discoveries made in the northeastern part of the county during the past mid-summer, that Floyd County affords an attractive opportunity for the invertebrate paleontologist. Late in the month of August, 1918, while pursuing structural investigations, the writer came upon a remarkably prolific invertebrate fossil horizon in a blue-gray limey shale on the Dr. G. T. Kendrick farm on the headwaters of Cow creek. This stream is a westerly flowing tributary of the Big Sandy, debouching into the river just east of Emma postoffice.

The type fossil locality occurs about 400 feet up the branch from the Kendrick dwelling which is seated just above Bear Branch. Here a fossiliferous shale, which may be styled "the Kendrick," rises from the bed of the stream. It is a thin sedimentary unit exhibiting a thickness of about eight or ten feet in the lower part of the hills on either side. Stratigraphically this shale is about 150 feet above the Prestonsburg or Van Lear coal and about thirty feet below a bench which is probably the Whitesburg coal. Broad distribution of invertebrate shells is found in the Kendrick shale, both in and outside of nodular "cone-in-cone" masses. In a rather considerable collection of fossils taken from the type locality on the Kendrick farm by this writer there is at least one coral, fragmental parts of a crinoid calyx, and a number of brachiopods, pelecypods, gastropods and cephalopods.

While specific determinations of this interesting group of fossils have not been made, the coral is identified as *Lophophyllum proliferum* a definite index of the Pennsylvanian. Among the brachiopods there are apparently about six different species of *Products*, two *Spirifers* and several specimens of the trim elongate *Leda*. Among the pelecypods there is the large

Deltopecten Texanus and among the gastropods a species of *Bellerophon*. The cephalopods are represented by at least one very interesting *Orthoceras*, one or more *Goniatites* and a *Nautilus*. On loose blocks of shale on the lower waters of Cow creek the writer has seen the typical *Lingula umbonata*. Several of these forms taken individually, and this group of fossils considered as a unit are definitely characteristic of the lower Pennsylvanian or Pottsville. The writer is of the opinion that within a reasonable distance from this locality on the head of Cow creek other interesting exposures of the Kendrick shale may be found in Floyd County and that diligent search may reveal additional limey-fossiliferous-shale beds both above and below this horizon.

In the field of paleo-botany, both the shales and the sandstones of widely separated localities give ample evidence of the luxuriant plant life that was here existant during the growth of the stratigraphic section. Brown sandstone casts of the roots of *Lepidodendron*, *Stigmaria*, *Calamites* and *Sigillaria* are commonly found in both the beds of the streams and on the hill-sides where they have been carried by stream action or weathered out of the formations in situ, while the coals of the area frequently reveal the carbonized figure of the bark, and shales the outline of the leaves or branches of these old Coal Measure tree-like plants.

STRATIGRAPHY

Exposed Rocks

Unconsolidated beds of gravel, sand, clay and mud of fluvialite origin ranging in thickness from five to about fifty feet as a maximum are to be found bordering the Big Sandy river and all of its tributaries throughout Floyd County. These loose sediments make up the bottom lands of the river and its tributary creeks and branches and are of Pleistocene and Recent age. Soft and easily eroded, these stream deposits are of much importance to agriculture, provide town and homestead sites and afford the easiest levels of communication, but they contain no important mineral resources except an occasional lenticular bed of sand suitable for building purposes.

The hard rocks exposed at the surface in Floyd County are all sediments, dominantly sandstones, shales and coals of Potts-

ville (Lower Pennsylvanian) age. Igneous and metamorphic rocks are unknown. Two calcareous horizons, the Kendrick limey-shale at about 150 feet above the Van Lear or Prestonsburg coal, and the Fossil limestone at about 400 feet above the same coal bench are known, but as both are thin, rarely exceeding eight to ten feet, and occur in the stratigraphic section well above ordinary farming and transportation levels, they are usually covered with talus or timber and are inconspicuous in the landscape. Nevertheless these calcareous horizons because of their fossiliferous character are important markers in the stratigraphy of the county though they appear to have been entirely overlooked by both Professor Crandall in 1905, and Mr. Hoeing in 1913 in their separate studies of the coals and Coal Measure sections of Floyd County.

The entire stratigraphic section of Pennsylvanian rocks as exposed in Floyd County slightly exceeds 1100 feet, the maximum measurement for any single locality occurring on the head of Left Beaver creek, some two miles above Weeksbury at the Pike County line. Here a massive sandstone caps the ridge underneath which occurs a coal of good thickness but very small areal extent. It will here be called the Ridge coal. The upper 350 or 400 feet of the section as found in the southernmost tip of the county, and high in the hills, is dominantly sandstone.

In this area below the Ridge coal four rather thick coals can be found spaced from 80 to 120 feet apart, if one is fortunate enough to locate the few openings that identify them. What the separate names of these upper coals may be, the writer is unable to indicate specifically but since they occur well above the Fossil Limestone, and the lowest of them about 400 feet above the Van Lear or Prestonsburg coal, it is probable that they are correlatives in ascending order of the Haddix, the Hazard, the Flag, and the Hindman coals which have been described by James M. Hodge in his *Report on the Coals of the Three Forks of the Kentucky River* and its tributaries which was published by the Kentucky Geological Survey in 1910.

From the Haddix coal which occurs about thirty or forty feet above the Fossil limestone, down to the varying levels of creek and river drainage, shales predominate in the succession of exposed rocks of Floyd County. This lower 550 or 600 feet

of the stratigraphic section contains the two significant calcareous units—the Fossil limestone at about 450 to 500 feet and the Kendrick shale at about 200 to 250 feet above the lowest water level in the river.

* Seven or eight coals occur in this lower part of the surface section of the Pottsville rocks and it is to be noted that such sandstone members as are a part of this division are found associated both above and below (1) the three Elkhorn coals (the middle or No. 2 bench of which is the Van Lear or Prestonsburg coal) and (2) the three higher associated coals which in descending order are: the Fire Clay, Little Fire Clay and Whitesburg seams. The somewhat higher Limestone coal, as it is known elsewhere in Eastern Kentucky, occurs about thirty or forty feet below the Fossil Limestone and is notably bedded both top and bottom in heavy shale.

The lowest exposed stratigraphic unit in Floyd County is the heavy gray-black, fine, carbonaceous shale found underlying a heavy massive, cross bedded sandstone at the juncture of Beaver creek and the Big Sandy river. At this locality this shale, a distinct Pottsville unit, can be seen just north of Allen Postoffice in the cliffs below the county road leading over Bull Mountain to Prestonsburg. It is also exposed opposite Dwale near the mouth of Cow creek and may be seen at various points up the Big Sandy river to the Pike County line.

In summation the exposed 1100 or more feet of upper Pottsville rocks in Floyd County, exhibit principally sandstones in the upper half of the section and shales with two calcareous beds in the lower portion with an overall inclusion of twelve or thirteen separate coals eight or nine of which are locally, if not widely, of commercial importance. Of the workable coals the three lowest in the section which in descending order are the Elkhorn No. 3 (possibly the equivalent of the Amburgy in the valley of the North Fork of the Kentucky river as described by Mr. Hodge), the Elkhorn No. 2 (which is the Van Lear or Prestonsburg bench) and the Elkhorn No. 1 (noted as the Wayland seam) are the coals supporting the extensive and growing mining industry in the vicinity of Prestonsburg, up the Big Sandy river and on Beaver creek and its branches. In order of superposition these upper Pottsville sediments may be tabulated as follows:

Ridge top at the head of Left Beaver creek.

1. Massive sandstone	}	450 to 500 feet
2. Coal—"Ridge"		
3. Interval, principally sandstone		
4. Coal—"Hindman"		
5. Interval, principally sandstone		
6. Coal—"Flag"		
7. Interval, sandstone		
8. Coal—"Hazard"		
9. Interval, sandstone		
10. Coal—"Haddix"		
11. Interval, shale	}	550-600 feet
12. Fossil Limestone		
13. Interval, shale		
14. Coal—"Limestone"		
15. Interval, shale and sandstone		
16. Coal—"Fire Clay"		
17. Interval, sandstone		
18. Coal, thin—"Little Fire Clay"		
19. Interval, sandstone		
20. Coal—"Whitesburg"		
21. Interval, sandstone and shale		
22. Kendrick, limey shale		
23. Interval, shale and sandstone		
24. Coal—"Elkhorn No. 3"		
25. Interval, shale and sandstone		
26. Coal—"Van Lear, Elkhorn No. 2"		
27. Interval, shale		
28. Coal—"Wayland or Elkhorn No. 1"		
29. Interval, sandstone		
30. Lowest exposed bed, shale at Allen		

Unexposed Rocks

The records of numerous wells drilled for oil and gas in widely separated localities in Floyd County reveal an uninterrupted downward continuation of the surface sediments of upper Pottsville (Pennsylvania) age to a depth of about 850 or 900 feet below drainage. This upper portion of the subsurface stratigraphic section is dominantly siliceous, though shales,

sandy shales and one, two or three coals are known to occur. Somewhat removed to the southeast in the upper valley of the Big Sandy river where this group of rocks is exposed in increased thickness along the top and upperwestern slope of the Pine Mountain, Ralph W. Stone in his report on the *Coal Resources of the Russell Fork Basin in Kentucky and Virginia*, issued in 1908 has grouped them as a unit formation and styled them the Lee sandstone. Farther to the north and elsewhere generally the lower portions of this massive coal measure unit, frequently, if not usually, exhibiting many white quartz pebbles has been described as the Pottsville conglomerate.

Separated by an erosional unconformity varying from a few to perhaps as much as 100 or 150 feet from the heavy bedded conglomeratic sandstones of the upper Pottsville (Pennsylvanian) above, indurated sediments of Mississippian age, limestones, sandstones and shales, exhibiting a thickness of about 900 or 1000 feet continue the subsurface stratigraphic section to a depth of about 2000 or 2100 feet. Due principally to the thickening of the unexposed Coal Measure section, to the southeast, the base of the Mississippian series will of course, be found at greater depths in the southern part of the county than at points farther north. The upper part of this subsurface section of the Mississippian rocks has been described by Mr. Stone as the Pennington shale. As a formation unit in Virginia it usually contains a considerable thicknesses of sandstone, but in Floyd County this sandstone known as the "Maxon" by drillers is lenticular in character, varying in thickness and may be entirely absent. In such instances only a few feet of shale, sometimes reddish or pinkish gray is present as a dependable correlative of the Pennington of the South and the Mauch Chunk of the north.

Beneath the argillaceous and siliceous beds of the uppermost Mississippian, there is found in Floyd County about 200 or 250 feet of shelly and massive limestone, the upper third of which is probably a time equivalent in deposition to the Chester and the lower two-thirds to the St. Louis (Meramec) of the Mississippi Valley. Below this prominent calcareous unit, the Waverly vari-colored shales with two included, relatively thin sandstones, the "Big Injun" and the Berea, extend downwardly some 650 or 700 feet to complete the Mississippian section.

At the base of the lowest Carboniferous beds, as described above, a rather uniform, though not consistently black, but usually dark, fine grained shale sets in and extends about 700 or 800 feet deeper. This is the correlative, in part at least, of the Chattanooga and the Ohio shales, seen on outcrop at the periphery of the Bluegrass region of central northern Kentucky and elsewhere in Ohio. A sedimentary unit of great prominence in the sub-surface stratigraphic section of Floyd County, like its correlatives to the northeast and north it is generally regarded as of upper Devonian age.

Beneath the Devonian black shale occurs a gray to brown porous limestone that has generally been referred to, particularly by oil and gas drillers, as the Carboniferous, the exact identification of which stratigraphically has not been made with assurance. If it is the Carboniferous—as is the first limestone beneath the Chattanooga shale at the outcrop somewhat to the northwest on the flank of the Cincinnati arch, as for example in Estill County, Kentucky, it is probably of Hamilton or Onondaga age and so would be middle Devonian, but such determinations at the present time, due to the fact that only one or two wells have so far penetrated this formation, must remain inconclusive.

Beneath the lowest Devonian sediments, whatever they may be, hard sedimentary rocks, dominantly calcareous, with many shale intercalations and possibly a few thin sandstones, referable to the Silurian, Ordovician and Cambrian systems are thought to occur in a very considerable but unmeasured, because undrilled, thickness in the lower subsurface stratigraphic section of Floyd County.

STRUCTURE

In its simplest conception the upper Pottsville or surface sediments of Floyd County lie in a broad synclinal or down fold between what Mr. Hoising has called the "Paint Creek Uplift"—a high, faulted domal and anticlinal structure extending generally in an east and west direction through central Johnson and Martin counties on the north, and the Pine Mountain Overthrust and Uplift which coincides with the Kentucky-Virginia line on the south. This broad syncline, exhibiting no faults or sedimentary displacements of consequence, has its

lowest surface expression, as may be noted by the disappearance of the Van Lear coal below river level, at a point about three miles south of East Point. A major syncline, its axis extends southwestwardly across lower Abbott creek, where it is not very plain, and is again seen well defined near the forks of Middle creek. From this locality it appears to follow a winding course through the hills between Spurlock and left Middle creek to the south and southwest into Magoffin County. From the lowest point on the Big Sandy river, as indicated above, this syncline is to be noted as plunging to the east onto the waters of Johns creek past the hamlet of Edgar toward the Martin County line where in the high timbered hills of this area its axis becomes less apparent.

South of the trough of this broad syncline the surface beds of the upper Pottsville formation steadily rise. The Van Lear coal again comes to the surface at the mouth of Abbott creek and continues on up to a point some forty or fifty feet above the level of the flood plain of the river at Prestonsburg. In this rapid upfold, evidenced at many points by the Van Lear or Prestonsburg coal, one limb of the prominent Prestonsburg anticline located on the lower waters of Middle creek and the Big Sandy river is seen. Proceeding further up the river the pronounced eastern extension of this large anticlinal or doming structure, the apex of which is found on the mid-waters of the Bull creek, is seen about one mile by the river below the mouth of Cow creek.

Another well defined extension of the Bull creek anticline or upfolding may be seen at the mouth of Beaver creek where the Van Lear coal is some seventy-five or eighty feet above the river plain. Farther up the river valley proper, at the mouth of Ivy creek another doming, the Ivy anticline of northeast-southwest strike crosses the Big Sandy followed on the southeast by a paralleling syncline. From this point up the river the Coal Measures continue their steady rise as indicated by the Van Lear coal which is about 750 feet above sea level at the Pike County line.

Elsewhere in Floyd County the character of local surface structure is not as apparent as in the main river valley, which with its numerous cliffs and coal mines affords ready access to the lower coals and their changing elevations. Ascending

Beaver creek no appreciable change of structure is noted until the vicinity of Dinwood where a very perceptible rise sets in toward the southwest. This rise culminates in a pronounced fold, the nearly north and south axis of which passes through the juncture of Wilson and Right Beaver creeks and may extend to the south to the vicinity of Wayland. This is the Beaver creek anticline. The reversal of this upfold has produced a rather broad but probably localized synclinal basin centering about the mouth of Salt Lick creek. This Salt Lick syncline delimits the Beaver Creek oil pool. Somewhat north of this downfold there is a localized up warping of domal character on the ridge—divide between Pitts Fork and Caney Fork of Left Middle creek and the southeast drainage of Wilson creek, Stevens branch and Buck branch into Beaver creek.

It is presumed that other similar anticlinal and synclinal folds are to be found elsewhere within Floyd County, but precise data indicating their exact location or character is not at hand. Generally it may be pointed out, however, that as computed on the Van Lear or Prestonsburg coal, and other coals higher in the exposed section when the Van Lear is below drainage, the lowest point of surface structure is probably about 490 feet above sea level and about three miles nearly due east of Edgar on the Floyd-Martin County line, while the highest surface structural point presently known—about 1265 feet on the Van Lear coal—is in the ridge separating Floyd County from Pike County about $1\frac{3}{4}$ miles due south of Weeksbury. Also it should be noted that all observable coals in the valleys of Abbott and Right Middle creek—the alternate road routes from Prestonsburg to Salyersville—rise as one progresses from the major Sandy river syncline to the west and northwest suggesting here an anticlinal fold or perhaps a southern limb of the domal structure at Ivyton. More remotely, an axial high of Mr. Hoeing's Paint Creek Uplift may extend into this northwestern part of Floyd County. A strong and rather steady rise of the Coal Measures is also to be noted as one ascends Mud creek toward Beaver postoffice near the Pike County line.

The character of the structure of the sedimentary beds at depths of 1000 or 1500 feet or more below the drainage of Floyd County is entirely unknown at this time. Since the records of a number of wells drilled for oil and gas in the area show the

unexposed Pottsville beds to be rapidly thickening toward the southeast, however, it may be assumed that surface structural features will be greatly modified, and that some synclines, such as the great trough north and west of Prestonsburg, and the elongate basin centering on Bosco on Right Beaver creek, may disappear altogether. The axes of anticlines and domes will also tend to be shifted horizontally at depth.

While the literature is barren of references to the influence of surface structure on the drainage pattern of Floyd County, the region is not without a number of interesting examples of stream deflection brought about in this manner. Three outstanding instances may be outlined as follows: 1. The great eastward bend of the Big Sandy river between Prestonsburg and Allen is very evidently caused by the well defined Bull creek anticlinal upfolding which stands as a barrier in its normal course. 2. Right and Left Beaver creeks, from their headwaters northwesterly flowing streams, are shunted to the northeast beginning at Brush creek by the long anticlinal upfold on the southern headwaters of Left Middle creek which merges with the upfold on Bull creek. As a result Right and Left Beaver creeks joined, debouch into the Big Sandy at Allen some four to nine miles to the east of their directional course which would normally have caused them to meet the Big Sandy opposite Prestonsburg. 3. Johns creek from a point about three miles below the Pike County line at Thomas P. O. follows the major Sandy river syncline in a westerly direction to Stratton branch. Here rapidly rising structure on the west turns Johns creek due north causing it to enter the river several miles further downstream, not far above East Point.

THE COALS

The earliest settlers of Floyd County were acquainted with and no doubt made occasional use of the coals widely outcropping throughout the middle upper Big Sandy river country. Lifted from beds of the creeks and branches, or chipped from natural exposures in low sandstone cliffs, bituminous coal from accessible benches of varying thickness probably found its way in small volume to domestic forges and fireplaces as early as 1800. With the steady growth of population throughout the

first quarter of the 19th Century, during which time most of the original stands of timber in the creek and river bottoms were cut and burned to provide agricultural lands, the economic value of the excellent coal so abundantly distributed became generally recognized.

By 1830, as not a few legal documents of record in Prestonsburg indicate, domestic coal openings were quite commonly found on the larger and more substantial farms up and down the main valley, and ten years later—in 1840—the first real mine producing coal for export was opened by the Kentucky Coal Mining Company on the Town Branch opposite Prestonsburg on property now owned by the Colonial Coal and Coke Company. The bench operated then as now was the Van Lear or Prestonsburg coal.

This early Floyd County mining operation was abandoned in 1856 not because of the failure of this coal in either quantity or quality, but due to the very real difficulties experienced in getting the coal to market. All shipments were then made by barge on the Big Sandy river, the navigation of which was marked by such uncertainties as must everywhere necessarily attend unregulated river flow levels ranging from two or three to twenty-five or thirty feet. At that time the miners built their barges near the mine, loaded them with coal and then floated them to the Ohio and on down to Cincinnati and Covington where after being unloaded they were sold to go into Pittsburgh and Louisville river traffic as it was impossible to tow them back up the Big Sandy river to the mines.

Though the coal mine on Town Branch was forced to close down a few years prior to the Civil War due to the vagrancies of the river, its sixteen years of operation did much to popularize the use of coal and bring about its continuing discovery at many widely separated points in Floyd County. When Dr. David Dale Owen, the first State Geologist of Kentucky, arrived in the middle upper Big Sandy Valley in 1854 he visited the Big Sandy Coal & Mining Company's property at "the edge of Floyd and Johnson counties," sampled the coal—evidently the Van Lear seam—and later published in his *Report of the Geological Survey of Kentucky Made During the Years 1854 and 1855*, an analysis of this coal in which the volatile and combustible matter is stated to have been 35.2 and the coke 64.8

per cent. The fixed carbon he indicated as 63.8 per cent. This is the first coal analysis to appear in the State's geological record as it pertains to Floyd County.

In 1854 Dr. Owen's examination of the exposed section along the river from "the northern Kentucky mines" southwardly to the vicinity of Prestonsburg resulted in his finding "five or six beds of coal, the main bed [now known as the Van Lear] lying in the vicinity of Prestonsburg about seventy-five or eighty feet above the rock bed of Big Sandy." Fifty years later Professor Albert R. Crandall in his rather broad studies of *The Coals of The Big Sandy Valley*, increased the number of coal benches observed in Floyd County to seven or eight.

Today as the result of a great deal of prospecting which has followed the building and operation of: (1) the Chesapeake and Ohio Railway in the main valley of Sandy to Pikeville and above, and up Beaver creek and its Right Fork to Wayland, and (2) the Baltimore and Ohio Railroad up left Beaver creek to Weeksburg, the number of coals, known to occur in the exposed stratigraphic section of Floyd County has been increased to twelve. It is suggested that one or more of the highest coals in the ridge separating Floyd from Martin County may rise above the Pottsville section and actually be correlated with the Cat creek or No. 5 coal of the basal Allegheny Series as described by Dr. William C. Phalen in his report on the *Economic Geology of the Kenova Quadrangle* which was issued by the United States Geological Survey in 1908. One and possibly two coals are known to exist, at considerable depth, in the central subsurface section near Prestonsburg, and one or two others, in all probability, farther south giving a total of three or four down to 918 feet in the drilling section of the Beaver valley. The total number of coals in the exposed and unexposed Pottsville section of Floyd County is therefore about fourteen or fifteen separate benches of which four or five are either too thin or too deep to ever be of commercial importance.

At the present time the three Elkhorn seams of which the Van Lear or Prestonsburg bench is the middle one are the only coals of commerce. They rise with the drainage as one progresses to the south on the Big Sandy river, Mud and Beaver creeks and range in thickness, depending upon locality, from two to four feet or occasionally a little more. Mr. Joseph B.

Hoeing's many excellent descriptions of the coals of Floyd County issued by the State Geological Survey in 1913 under the title: *The Coals of the Upper Big Sandy Valley and the Headwaters of the North Fork of the Kentucky River*, make it unnecessary to describe them in detail here. In the future, some twenty-five or thirty years hence when the lower coals now being operated are to a considerable degree worked out and abandoned, it may be that some of the higher coals such as the 80-inch coal (Hazard or Flag) observed and described by Professor Crandall in 1904 and 1905 on the headwaters of Left Middle creek may be reached by rail extensions and thus become a competing coal of commerce in Floyd County.

There are now in Floyd County twenty-five or thirty coal mining groups, a number of which operate more than one mine. The names of the principal mining organizations are: Alonzo Coal Company, Auxier Coal and Mining Company, Beaver Pond Coal Company, Blue Beaver Coal Company, Big Sandy Coal Company, Black Diamond Coal Company, Bucks Branch Coal Company, Cliff Coal Company, Colonial Coal Company, Drift Coal Company, Duncan Elkhorn Coal Company, Dwale Coal Company, Elkhorn Coal Corporation, Elkhorn Gas Coal Company, Floyd Mining Company, Goodwin and Barney Coal Company, Layne Coal Mining Company, Martha Leslie Coal Company, Middle Creek Coal Company, North-East Coal Company, Prestonsburg Coal Company, Purity Cannel Coal Company, Salt Lick Coal Company, Standard Elkhorn Coal Company, Stover Elkhorn Coal Company, Wells Elkhorn Coal Company, and the Winchester Coal Company. During the year 1917 Floyd County, Kentucky, produced 819,206 tons of high grade bituminous, block and cannel coal.

OIL AND GAS

It is entirely probable that the natural gas seepage on the headwaters of the Right Fork of Middle creek because of its conspicuous location was "a place of notoriety" to the early residents of Floyd County. Napoleon Bonaparte Buford in the report to Governor Owsley of his survey of the "old State road" from Mount Sterling to Licking Station, Prestonsburg and the Virginia line in 1836 speaks of it, and Judge Lewis Collins in his *Historical Sketches of Kentucky*, issued in 1847, called it

the "Burning Spring" and stated that it "instantly ignites on the application of fire." Thus it was when the writer found it without direction or guide in mid-August last year and thus it remains today. It is not likely that time will greatly alter it as a natural phenomenon—so slight is its effusion.

While natural gas in such manner, like coal, became known to the residents of this portion of the Big Sandy Valley during the early part of the last century, it was not until Lewis Henry Gormley, an experienced operator of New Castle, Pennsylvania, drilled in the "Howard Purchase" No. 1 well at the mouth of Salt Lick on the Right Fork of Beaver creek in 1891 that oil and gas in commercial quantity became a certainty in Floyd County. This "discovery well," it is reported, produced with a moderate gas head an initial flow of about twenty or twenty-five barrels. It finally settled to about ten barrels per day as other wells were drilled in the field on nearby locations, and now after the lapse of twenty-seven years, it is still producing oil with a few other old wells into collecting tanks that are usually run twice a month through its two-inch line to the main oil line near Royalton in Magoffin County by the Cumberland Pipe Line Company.

The "Howard Purchase" No. 1 well together with some twenty-five or thirty other small oil producers in this old Floyd County field, a number of which have now been abandoned, are today the property of the New Domain Oil and Gas Company. This corporation was organized in the early nineties by Mr. Gormley and his associates for the development of the Beaver creek oil pool. A few years later, after the oil producing area surrounding the juncture of Salt Lick and Rock Fork with Right Beaver creek had been proven, the New Domain Oil and Gas Company was sold to the South Penn Oil Company, of which Standard Oil unit it is still a subsidiary.

The discovery oil well on the Howard lease on Right Beaver was drilled to a depth of 1116 feet. Its record revealed for the first time the occurrence in Floyd County of four thick and important oil and gas sands in the lower part of the Pottsville formation as known in Eastern Kentucky. These sands in descending order, with the names that were later applied to them were: The Beaver, 124 feet thick, from 580 to 704 feet; the Horton, 129 feet thick, from 714 to 843 feet; the Pike, 67

feet thick, from 848 to 915 feet and the Salt Sand, 49 feet thick, from 1064 to 1113 feet.

A well subsequently drilled on the Webb farm on Henry branch of Right Beaver creek was completed 204 feet in the black Devonian shale at a depth of 1930 feet. This well showed the base of the Pottsville at 872 feet; and below it 76 feet of Mauch Chunk (Pennington) red shale, but no Maxton sand down to 948 feet. Somewhat to the northeast, the east and southeast a number of wells spread over Cow creek, Johns creek and Left Beaver creek show the Mauch Chunk in a much fuller development, with total thicknesses ranging from 164 to 205 feet of red shale including a central sandstone member—the Maxton—generally about seventy or eighty feet thick. A well drilled to a depth of 2141 feet and completed in the black Devonian shale on Pitts Fork of left Middle creek showed no Mauch Chunk at all suggesting marked formational unconformity setting in at the horizon of the Mauch Chunk and extending broadly over northwestern Floyd County.

The Webb well, previously referred to, showed 195 feet of the Greenbrier (Big Lime) from 1125 to 1320 feet. This is fairly thick for the Meramec member, numerous drillings, particularly in the northern part of the county in the vicinity of Prestonsburg exhibiting not more than 120 or 160 feet. A well on Johns creek, however, shows the Greenbrier (Big Lime) to be 240 feet thick and 232 feet has been found on the upper waters of Left Beaver.

Numerous wells drilled at various locations in Floyd County have shown the Big Injun sand about eighty feet thick occurring some fifty feet below the Big Lime. At about 300 feet lower, the Berea sandstone occurs, as in the Trimble branch well in a thickness of about forty feet. The Gray well on the headwaters of Bull creek, drilled to a depth of 2440 feet, one of the deepest in Floyd County to date, showed the entire (sub-surface) Pottsville to be 920 feet thick; the Mississippian to be only 573 feet thick and the Devonian black shale 726 feet thick. This well penetrated the Corniferous (Devonian) limestone underlying the black shale, but in this location produced from it neither oil nor gas. As revealed by the records of the Gray and other wells in this part of Eastern Kentucky, the following sequence of oil and gas producing formations is established:

Pennsylvanian

Beaver	}	Pottsville
Horton		
Pike		
Salt		

Mississippian

Maxton	Mauch Chunk
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Big Lime	Meramec
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Big Injun	}	Waverly
Berea Sand		

Devonian

Black Shale	Ohio-Chattanooga
Corniferous Lime	Hamilton-Onondaga

In the sedimentary sequence as indicated above, all of the Pottsville "sands" are oil and gas producing, frequently with salt water and individually and in combinations are the source formations of the Beaver Creek Oil pool at Bosco. The surface structure of this oil pool is synclinal possibly of the "sink" or "basin" type. Oil of good quality but not large daily quantity, has been produced from these Pottsville wells for upwards of twenty-seven years and the indications are that their productive life may ultimately be shown to be about thirty or thirty-five years—a goodly span for oil wells anywhere. Unfortunately the total number of barrels of oil produced and run from the Beaver Creek oil pool is not known.

Natural gas is frequently produced from these Pottsville "sands" on anticlinal locations in large open flow volume—300,000 to 2,000,000 cubic feet—but the life of such wells, if they are continuously produced to capacity, is not long due to the open character of the sand. With conservative use, reduced and regulated flow, and frequent rest periods, these Pottsville gas wells will last, as many productive drillings indicate, about five to ten years, and in exceptional instances fifteen or twenty years. Good examples of Pottsville gassers are the Keystone Gas Company's J. N. Allen No. 1 on Right Beaver creek, drilled to a depth of 885 feet in August, 1896, with initial production of 1,986,720 cubic feet open flow; and the Penna-grade Oil and Gas Company's T. A. Martin No. 2 on Steele's branch of Right

Beaver which was drilled to a depth of 951 feet two years ago—in June, 1916—and produced a reported initial open flow of 2,000,000 cubic feet. These Pottsville gas wells usually have a rock pressure ranging from 225 to 350 pounds which is slightly sub-normal.

The Maxton (Mauch Chunk) sand, though frequently removed or reduced in thickness by pre-Pottsville erosion, when present on anticlinal structure, will produce from 500,000 to 750,000 cubic feet of natural gas open flow when flush as evidenced in the Isaac Bradley No. 1 well drilled to a depth of 1666 feet at a high elevation about $1\frac{3}{4}$ miles up Right Beaver creek. The Maxton frequently shows oil but so far as the writer is aware has never produced oil in commercial quantity in Floyd County. It may properly, however, be considered as potentially an important oil sand in the southern or southeastern part of the county if the carbon ratio of the area is not too high.

The Big Lime on high structural locations will produce gas wells ranging from about 250,000 to 4,680,000 cubic feet initial open flow with rock pressure varying from 250 to 540 pounds, depending upon depth. A typical Big Lime gas well is the E. S. Frazier No. 1 which was drilled, by the Columbia Gas Company to a depth of 1566 feet (into the Sunbury shale) on January 26, 1907, and produced, according to report, 500,000 cubic feet of gas from 1288 to 1437 feet with a show of oil at 1431 feet. This well was re-drilled, without increasing production, in the fall of 1915 to a depth of 2754 feet at which point the bit stood about thirty feet in the Corniferous (Devonian) limestone. Another Big Lime gasser of outstanding significance is the W. R. Bolen No. 1 drilled by the Pennagrade Oil and Gas Company in July, 1916, to a depth of 1635 feet on Rock Fork of Right Beaver, a short distance south of Floyd County line. It produced 4,680,000 cubic feet of gas with a rock pressure, as gauged by the writer early in November this year, of 450 pounds.

The Big Injun (Mississippian) an important natural gas horizon in the adjoining State of West Virginia, has produced relatively few important wells in Floyd County. Open flow volumes derived entirely from the Big Injun sand in this part of Eastern Kentucky rarely exceed 500,000 cubic feet and more often are half this amount. A typical Floyd County well producing gas from the Big Injun is the Nathaniel Estep No. 1

drilled by the Pennagrade Oil and Gas Company on Right Beaver creek during the past summer—August 14, 1918—to a depth of 1560 feet. This well showed considerable oil in the Beaver, Big Lime and Big Injun, and from the Big Injun alone produced 431,000 cubic feet of natural gas with a rock pressure of 550 pounds when first closed in at the tubing head. The Joseph Gray No. 1 well, previously referred to, drilled by the Eastern Gulf Oil Company during the early part of this year on Bull creek, above the mouth of Long's branch to a depth of 2440 feet produced an initial open flow of 1,250,000 cubic feet with rock pressure of 250 pounds from 1285 feet—the Big Injun sand. A third well, the A. P. Webb No. 1 drilled by the new Domain Oil and Gas Company on a branch of Beaver creek produced an initial open flow of natural gas from the Big Injun sand of 450,000 cubic feet with a rock pressure of 450 pounds.

Three oil and gas horizons remain to be discussed, no one of which is now known to be of commercial importance in Floyd County. The uppermost of these is the Berea (Lower Mississippian) a small oil producer today and for many years in some parts of Johnson and Lawrence counties in the lower part of the Big Sandy Valley. The Berea has been recognized in the W. S. Harkins No. 1 well drilled on Trimble branch just east of Prestonsburg, but it is either absent or reduced to a mere three or four feet further south in the Beaver creek country. In the Harkins well, the most northerly deep well (1750 feet, T. D.) now drilled in Floyd County, the Berea sand, as indicated by the record, was about thirteen feet thick and showed oil from 1467-1480 feet. Probably on proper anticlinal location in the northern part of the county the Berea will produce some gas, but it is greatly doubted if it will ever make enough oil or gas in any well drilled in Floyd County, to be of commercial importance. In the southern part of Floyd County—south of the mouth of Beaver creek—the Berea sand probably does not exist.

Some thirty to fifty feet below the Berea, when it is present the bit of the driller tips into the Devonian black shale. This extraordinary formation, a correlative of the Ohio-Chattanooga group, is always recognized by its softness, its dark "coffee brown" to black color and its great lithological uniformity. In Floyd County it has a variable thickness as deduced from the

only two or three wells that have fully penetrated it to find completion in the underlying limestone. In the record of the E. S. Frazier No. 1 well the Devonian black shale was 564 feet thick; in the John Gray No. 1 well on Bull creek, the log shows that the black shale was 730 feet. The difference—162 feet—seems large, possibly abnormal for the area. Since this unique formation, based upon the study of many logs of wells drilled in Kentucky counties to the north and northwest, is undoubtedly thickening toward the southeast it is probable that wells drilled near the Pike County line in the southern part of Floyd County might find the black shale as much as 825 or 850 feet in thickness.

A highly bituminous formation, showing where drilled, a good deal of small-volume disseminated gas, there is just one well in Floyd County so far as the writer is aware that has produced up to this time—December, 1918—commercial amounts of natural gas from the black shale. This exceptional well is the J. P. Akers No. 1, drilled on Akers branch of Left Beaver creek about three years ago—September 8 to October 19, 1915—by the Keystone Gas Company. In this well below 150 feet of black shale at a depth of 1979 feet a 21-foot porous horizon was encountered which terminated in dense black shale at 2,002 feet. From this porous horizon in the black shale a reported initial open flow volume of 2,600,000 cubic feet of gas was developed with a rock pressure of 578 pounds. The occurrence of so considerable an amount of gas in this formation as is evidenced by the Akers well, points to the Devonian black shale, now but lightly considered by oil and gas operators generally, as an horizon from which in the future when some method of increasing the open flow of gas from this formation, perhaps by shooting, shall have been found, as a large commercial producer of natural gas in Floyd County.

Immediately beneath the black shale in the two wells referenced above, a gray limestone loosely correlated with the Corniferous as known in Estill, Powell, Wolf and Morgan counties to the northwest, has been found. Although regarded as a possible oil and gas producer in the southeastern part of Kentucky, the results up to this writing have been negative. Little as a matter of fact, is known concerning this rather deep Devonian limestone in the upper Big Sandy Valley and for this

reason further details concerning it, of necessity, must be left to the future.

Exact records are non-existent, but it is thought that about 100 wells have been drilled in Floyd County, up to this time, in search of oil and gas. The writer has personally located about eighty-five or ninety wells but there are a number of locations which have been lost by plowing and other farming operations. It is estimated on a calculated basis that there is now about twelve or fifteen million cubic feet of natural gas in use or available for use per day in Floyd County. Systematic drilling, it is thought, might increase this daily open flow, from shallow and medium depth sands, to about fifty or seventy-five million cubic feet or more per day.

There are at this time eighteen or twenty oil and gas operating concerns in Floyd County, Kentucky, and about 75 per cent of the area of the district is under lease. The principal operating corporations or partnerships are: Keystone Gas Co., A. B. Brode and Son, Columbia Gas and Electric Co., Midas Oil and Gas Co., Yolanda Oil Co., Pennagrade Oil Co., Pat J. White and Co., Harkins and Harkins, New Domain Oil and Gas Co., Texas Co., Eastern Gulf Oil Co., Carter Oil Co., Stanton Oil Co., Cumberland Pipe Line Co., Omar Oil and Gas Co., Great Central Oil Co., United Fuel Gas Co., Big Sandy Oil Co., Empire Oil and Gas Co., and others.

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