Introduction

from

Kanawha County Report
West Virginia Geological Survey

By I. C. WHITE

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Kanawha county has had a most interesting history in the development of West Virginia's mineral industry. It was in this county at Charleston and vicinity that in boring for salt water, practically all of the tools, casing, and other implements used in drilling deep wells at the present time were invented. Here, too, natural gas was first utilized in America for manufacturing purposes, being burned in large quantities under the salt pans of the Kanawha valley, a few miles above Charleston as early as 1841, displacing 2,000 bushels of coal daily at one salt establishment.

The famous "splint" coals of the southwestern half of the State were first introduced to the commercial markets of the country from the mines of Kanawha county, so that the name "Kanawha Splint" has now become an established trade mark in all the great coal marts of the Middle West. In the development of the coal industry of the Kanawha valley, the late W. H. Edwards, the distinguished naturalist of Coalburg, Kanawha county, known all over the world through his beautiful and classic publications on "The Butterflies of North America," took a leading part, and it is very fitting that his son, the Hon. Wm. Seymour Edwards, should continue the work of keeping Kanawha county in the front rank along other lines of industry and science. To this son, more than to any other one man, Kanawha is indebted for its recent splendid oil and gas developments in the Blue creek and other regions of the county, and to his untiring energy, and love for pure science, the entire State is indebted for its deepest boring (5,595′), and which until recently remained the deepest drill hole in America, and the third deepest boring in the world. Hon. Wm. Seymour Edwards being always a pioneer, was the first man in the State to attempt to penetrate the earth to the deep lying Clinton or Medina oil and gas horizons of Ohio. The geologic formations, especially the Devonian shales, which overlie this deep petroliferous horizon, thicken rapidly south, and south-

eastward from the region of Bremen and other points in the State of Ohio, but nothing was known as to the rate of such thickening or whether or not it was possible to drill to the same horizon anywhere west of the Alleghanies in West Virginia until Mr. Edwards assumed the task of determining the matter, only a few miles distant from his home at Coalburg.

Through the courtesy of Mr. Edwards and the general manager of the Wm. Seymour Edwards Oil Company, Mr. Samuel R. Reynolds, the following record of this deep boring, on Slaughter creek, Cabin Creek district, Kanawha county, W. Va., is given to the public:

Record of the Slaughter Creek Coal & Land Company Well No. 1, drilled by the Wm. Seymour Edwards Oil Company, and located on Slaughter creek, one mile and a quarter south of the Kanawha river from Chelyan, about 15 miles above Charleston, W. Va.; Well mouth 640′ A. T. and 5 feet below the Peerless coal bed or top member of the Campbells Creek coal, and 490′ below the Kanawha Black Flint; Drilling began June 5, 1911; Completed late in 1912; Superintendent, J. V. Reishman; Drillers, J. M. Runnels and G. C. Clayton:

	Thickness Feet.	Depth Feet.	
Unrecorded (water at 50′)	55	55	
Coal, (Powellton)	5	60	
Sand	40	100	
Slate	10	110	
Sand	310	420	
Slate	15	435	
Sand, (gas at 450′)	105	540	
Slate	10	550	
Sand (Nuttall?)	90	640	
Slate	25	665	
"Salt Sand," (Raleigh?)	225	890	
Slate	2	892	
Sand, base of Pottsville Series	48	940	
Slate and lime	10	950	
Slate	25	975	
Lime shells	85	1060	
Slate	20	1080	
Lime	30	1110	
Slate	20	1130	
Sand, (Hole filled with water at 1175′)	135	1265	
Red rock	5	1270	Mauch Chunk
Slate and shells	50	1320	Series
Red rock	15	1335	513′
Slate	55	1390	
Lime	35	1425	
Slate	5	1430	
Lime shells	3	1433	
Slate	5	1438	
"Little Lime" (Broken)	10	1448	
Pencil cave	5	1453	

	Thickness Feet.	Depth Feet.
"Big Lime" (Greenbrier) (Yellow, at 1490′)	207	1660
Big Injun sand	36	1696
Slate	67	1763
Squaw sand (1st gas, 1830′; 2nd gas, 1843′)	108	1871
Slate	222	2093
Berea sand	12	2105
Slate and lime	140	2245
Slate, sandy, with smell of oil at 2400′ and 2690′; (Temperature, 113°F. at 4730′)	2695	4940
Very black slate (Marcellus)	5	4945
Lime (Corniferous), very hard, dark flint nodules	90	5035
Clean yellow sand (Oriskany)	10	5045
Fine-grained gray sand (Oriskany)	5	5050
Lime, light gray (Temperature, 129° F. at 5230′)	190	5240
Lime, dark	75	5315
Lime, light	40	5355
Lime, dark (water, 5592′)	240	5595

Conductor, 16 feet.
10″ casing, 37 feet.
8½″ casing, 954 feet.
6⅝″ casing, 1502 feet.

The well was cased at 1502 feet to shut off the "Pencil Cave" and the water from the Pottsville above, and it continued a dry hole to 5592 feet, where salt water was found in the "Big Lime" of the Ohio geologists at about the same geologic horizon where it occurs in Ohio, and this **salt water** evidently comes from near the base of the **Salina beds** which hold **rock salt** in Northern Ohio, Western New York, and which was struck in the Derrick City deep boring, 4 miles east of Bradford, Pa., at a depth of 4490 feet, 390 feet below the top of the Corniferous Limestone and extended to a depth of 4713 feet through an interval of 223 feet, of which 87 feet was pure salt, in beds of 30, 10 and 47 feet each at depths of 4490, 4596, and 4638 feet, respectively, with a mixture of salt and shale 20 feet thick at 4693 feet, ending at 618 feet below the top of the Corniferous Limestone, as against 647 feet below the top of the same horizon for the salt water in the Edwards or Slaughter creek well. The water rose in the well to about 4000 feet from the bottom, and the slates above the Corniferous Limestone caved so badly that further progress in drilling seemed

impossible without shutting off the water. This would have required more than a mile of 4¼" casing, and would have reduced the bore hole to such small dimensions that Mr. Edwards concluded the chances of reaching the Clinton oil and gas horizon of Ohio (the intended goal of the well) were so hopeless that he reluctantly abandoned further drilling. Then, too, the water in the well appeared to be very corrosive upon the tools, and everything of metal connected with the drilling operations, and hence it was feared that any casing inserted to shut off the water would be destroyed and its purpose defeated.

It is of interest to make some comparisons of this deepest well in West Virginia with the Geary deep well, now being drilled by the Peoples Natural Gas Company—a Standard Oil Company subsidiary of which Mr. J. G. Pew of Pittsburgh, Pa., is President—5 miles northwest of McDonald, Pa., which has already attained a depth of nearly 6950 feet and is the deepest well in America, being surpassed by only one other boring in the world, viz., the one near Czuchow in Selesia, which reached a depth of 7349 feet, and had a temperature of 182° F. at 7287 feet.

No temperature readings below 6270 feet, where the temperature of the water was 156° F., have been taken in the Geary well.

In the Slaughter creek well two determinations were made by Mr. John Johnston for the U. S. Geological Survey, the results of which have kindly been placed at the disposal of the W. Va. Geological Survey by Dr. Geo. Otis Smith, Director, as follows:

At 4730 feet, approximately.....113° F.
At 5230 feet, approximately.....129° F.

The determinations were made with the apparatus and thermometers of the late Dr. Hallock, loaned by him to the U. S. Geological Survey a short time before his death, and are the same with which he made the careful determinations of earth temperatures in the Wheeling, W. Va., and West Elizabeth, Pa., deep wells. The Wheeling well stopped at 4500 feet, where the temperature was 110.3° F., which would agree closely with 113° in the Slaughter creek well at 4730 feet,

In the Geary well the temperature at 5220 feet as reported by Capt. Barger was 120° F., but in the Slaughter creek well at 5230 feet or nearly the same depth, a temperature of 129° F., was measured, a difference of 9° F. at practically the same depth in the same geologic formations. The presence of a slight quantity of natural gas in the Geary well at very great depths and under enormous rock pressures, however, may have tended to reduce the temperatures found therein, since although a temperature of 140° F. is reported there at 5800 feet, the thermometer recorded only 100° F. at 6000 feet in the presence of a slight flow of gas at that depth. In the West Elizabeth deep well where some natural gas was also escaping from the walls of the unlined boring, a temperature of 120° F. was recorded by Dr. Hallock at a depth of 5010 feet and of 127° F. at 5380 feet, both of which are probably a few degrees lower than they would have been except for the escape of natural gas into the hole during the time the temperatures were in process of recording, so that the temperature of 129° F. in the Slaughter creek well at a depth of 5230 feet is probably more reliable than any of the others unless it be the temperature of 156° F. for the water in the Geary well at 6260 feet, which ought to have given fairly accurate results, since the gas would not have been escaping to any appreciable extent through the great column of salt water (5560′).

The character of the salt water in the McDonald and Slaughter creek wells, the former found in a sandstone (Oriskany and Lower Helderberg) at 6260 feet, 252 feet below the top of the Corniferous Limestone, and the latter probably in the Salina Limestones at a depth of 5592 feet, and 647 feet below the top of the Corniferous Limestone, is shown by the following analyses. The analysis of the water from the Slaughter creek well was made by Mr. Chase Palmer in the laboratory of the U. S. Geological Survey, through the courtesy of whose Director the results have been furnished to the W. Va. Geological Survey. The two analyses are expressed in different terms and quantities, but they can be readily translated into equivalent terms:

Slaughter Creek Well.

Water from 5592'
Approximate Analysis.
Contents of 100 grains of water.

Na_k	4.5600
Ca	2.2300
Mg	0.3800
Cl	12.0800
S	0.0224
CO_2	0.0015
	19.2739

"The solution showed no radio-activity. Sp. gr. equals 1.1595."

McDonald (Geary) Well.

Water from 6260 feet, by H. H. Graver, Chief Chemist, Pittsburgh Testing Laboratory;

Specific gravity at 60° F	1.1085
Oil	Trace

	Parts per 100,000
Alkalinity as calcium carbonate	5.50
Calcuim chloride	4,421.40
Magnesium chloride	251.60
Sodium chloride	5,018.20
Sulphuric anhydride	Trace
Iron oxide	Trace
Sediment (rock powder)	224.00
Total solids	9 921.30
Total solids exclusive of rock sediment	9,696.70

A comparison of the two results will show nearly double the amount of solids in the water derived from the limestone in the Slaughter creek well, over that from the sandstone in the McDonald well—a result not at all surprising, and both analyses may be regarded as throwing some light on the composition of the Paleozoic ocean waters.

The interval between the Berea Sand and the Corniferous Limestone in the Slaughter creek well is 2840 feet as against 1005 feet in the Central City boring on the Ohio river near Huntington, Cabell county, 55 miles W. N. W. which gives an E. S. E. thickening rate of about 33 1/3 feet to the mile. This thickening of 33 1/3 feet to the mile between the Central City well on the Ohio river and the Slaughter creek well on the Kanawha river, shows only a slight excess in the rate of thick-

ening over that in the 80 miles between Akron, Ohio, and the R. A. Geary deep well near McDonald, Pa., where these same Devonian beds between the Berea Sand and the Corniferous Limestone thicken from 1862 feet at Akron to 4386 feet, 80 miles southward in the Geary well near McDonald*.

The elevation of the top of the Corniferous Limestone in the Slaughter creek well is 4305 feet below tide, while the same geologic horizon in the Geary well is 4950 feet below tide, or 645 feet lower. In the Geary well the Pittsburgh coal crops at 130 feet above the mouth of the same, thus making the interval between it and the Corniferous Limestone (130′+6008′), 6138 feet. In the Slaughter creek well the Pittsburgh coal horizon would come about 1290 feet above the well, and thus make the Pittsburgh coal to Corniferous Limestone interval (1290′ +4945′), 6235 feet, or practically the same as in the Geary well, the difference being only 97 feet, a remarkable fact when we consider that the Devonian beds between the Berea Grit and the Corniferous Limestone in the Geary well have a thickness of 4386 feet, while in the Slaughter creek well the same beds are only 2840 feet, or 1546 feet less. This extra sedimentation in the Devonian beds of the McDonald region appears to have been finally compensated in the Slaughter creek region, although at a much later date, and largely during Pottsville time, since the latter series is only about 250 feet thick in the Geary bore hole, while on Slaughter creek the boring begins about 575 feet below the top of the Pottsville, and as its base was reached at 940 feet, the resulting Pottsville thickness is 1515 feet, an expansion of 1265 feet over the thickness (250′) of the Pottsville at McDonald. Then, too, the Mauch Chunk series, including the Greenbrier Limestone, which is only 42 feet thick in the Geary deep well, has expanded to (1660′— 940′) 720 feet in the Slaughter creek boring, so that if we compare the intervals between the Pittsburgh coal and the top of the Big Injun oil sand or base of the Greenbrier Limestone in each well, we find this interval at Slaughter creek (1290′+ 1660′) 2950 feet, while the same interval is only (130′+953′), 1083 feet in the Geary well near McDonald, 170 miles north-

*Bulletin of the Geological Society of America, Vol. 24 p. 278. Note on a Very Deep Well Near McDonald, Pennsylvania, by I. C. White.

eastward, a difference of (2950′—1083′) 1867 feet, which is only (1867′—1546′) 321 feet more than the excess of Devonian shales and sandy beds at McDonald over the thickness of the same formations at Slaughter creek (4386′—2840′=1546′), thus showing that the compensation for rapid sedimentation in Devonian times throughout the McDonald region took place in the Slaughter creek region during Mississippian and Pottsville time. From what is known of the reduced thickness of Devonian sedimentation southwestward from Pennsylvania along the Alleghany mountain region, and the great increase in Pottsville, Mauch Chunk and Greenbrier deposition, it is probable that the deficiency of the former was practically compensated by the excess of the latter over the southwestern portion of the Alleghany Mountain plateau, since in Summers, Monroe and Greenbrier counties of West Virginia, the Mauch Chunk series attains a thickness of nearly 3500 feet, the Greenbrier, 1300 feet, and the Pottsville, about 2500 feet, while in the same region the Catskill series, which exhibits such a great thickness in Maryland and Pennsylvania, along the central Appalachian plateau, has practically disappeared from the geologic column through the loss of all of its red beds under the counties mentioned, as exposed in the gorges of the New and Greenbrier rivers.

The general section of the Kanawha series given in this report had already been printed as well as most of the volume when the studies of Messrs. Hennen and Reger in Logan and Mingo counties, and the studies of Messrs. Krebs and Teets in Boone county during the year 1913 revealed the fact that the section of the Kanawha series would need some revision based upon the more detailed geologic work now possible with the aid of accurate field maps and elevations.

These Assistants of the Survey, led by Mr. Hennen, have traced the several coal beds from Mingo and Logan counties across Boone and Kanawha to the Kanawha river, and Mr. Hennen has prepared a revised section of the Kanawha series based upon the results thus obtained. In this tracing of the formations they were greatly aided by an impure limestone full of marine fossils which was first discovered at Dingess, Mingo county, by Assistant D. B. Reger and named from that

locality. It was later traced along Tug river by Ray V. Hennen from the region of Naugatuck to Matewan, 25 miles above, and thus its persistence in the section was established. It carries a well marked fauna which Dr. Price, the Paeleontologist of the Survey, is studying, and these fossils appear to be present in the sandy shales and shaly sandstones at the proper horizon even when the **limestone** as such is absent at many localities where the Dingess horizon is exposed between the Kanawha and Tug rivers. The Eagle Shales and Limestone horizon of the Kanawha river with its rich marine fauna, discovered and named by the writer in 1884, was also found to carry its fossils into Boone county and across to the Tug river in southern Mingo, and thus it, too, greatly aided in getting correct identifications and correlations through from Logan and Mingo to the Kanawha river.

A third **limestone** filled with marine fossils has been observed by the writer near the mining village of Winifrede at about 65 feet below the famous Winifrede coal bed. This as given in Vol. II(A), W. Va. Geological Survey, page 431, will probably prove a fossiliferous horizon at other localities when the exposures can be studied, and since the Campbells creek limestone overlying the coal of the same name contains marine fossils occasionally as observed by Assistant Krebs, there are at present five known horizons for **marine fossils** that have been definitely located in the Kanawha series of Kanawha, Boone, Logan and Mingo counties, thus indicating that this series of coals at least was accumulated along the margin of an ocean or gulf whose tidal flats and swamps were subject to incursions of marine waters throughout the deposition of more than 1,000 feet of sediments, since the "Kanawha Black Flint" near the top of the Kanawha series always contains marine fossils.

The revised section of the Kanawha series as prepared by Assistant Hennen for Kanawha county, and which with greater intervals (since they all increase southwestward from the Kanawha river) will also answer in a general way for Logan and Mingo counties, is as follows:

General Section, Kanawha Series—Kanawha County.

By Ray V. Hennen.

		Thickness Min.	Max.	Total	
		Ft.	Ft.	Ft.	
1.	**Sandstone, Homewood**	40 to	60	60	
2.	Shales, sometimes holding coal	0 to	20	80	
3.	**Kanawha Black Flint,** with marine fossils	0 to	10	90	90′
4.	Shale	5 to	15	105	
5.	**Coal, Stockton,** always multiple and 2 to 4 divisions separated by shales	5 to	10	115	25′
6.	Sandy shale or impure fire clay	10 to	20	135	
7.	**Sandstone, Upper Coalburg,** coarse, massive, gray, often weathering into "Chimney rock" columns on summits	50 to	60	195	80′
8.	**Coal, Coalburg,** multiple, splinty	5 to	10	205	
9.	Shale	5 to	15	220	
10.	**Coal, Little Coalburg**	1 to	2	222	
11.	**Sandstone, Upper Winifrede,** massive, yellowish gray	40 to	55	277	
12.	**Coal, Winifrede,** multiple-bedded	4 to	8	285	90′
13.	Shales and impure fire clay	1 to	3	288	
14.	**Sandstone, Lower Winifrede,** grayish white, hard, often massive and resting with local unconformity on the underlying beds	30 to	50	338	
15.	**Coal, Chilton "A,"** double-bedded, splinty	1 to	2	340	55′
16.	Fire clay, impure, and shale	5 to	19	359	
17.	**Limestone, Winifrede,** impure, fossil shells, many **Producti**	½ to	1	360	
18.	**Sandstone, Upper Chilton,** dull gray, medium grained, micaceous	20 to	40	400	
19.	**Coal, Chilton,** double-bedded, splinty, same as mined on Spruce fork, Dingess run, Rum and Buffalo creeks, Logan county, and once mined just east of Dingess and at Naugatuck, Mingo county	2 to	5	405	65′
20.	Fire clay, impure	0 to	8	413	
21.	**Sandstone, Lower Chilton,** dull gray, micaceous	10 to	25	438	
22.	**Coal, Little Chilton,** double-bedded splinty	1 to	2	440	35′
23.	Fire clay, impure	0 to	6	446	
24.	**Sandstone, Hernshaw**	15 to	25	471	
25.	**Coal, Hernshaw,** double-bedded, splinty and same as "Black Band" on Lens creek, Kanawha county	2 to	4	475	35′
26.	Shale, and horizon of Naugatuck sandstone of Mingo county	15 to	19	494	
27.	**Coal, Dingess,** gas type, same as once mined at Dingess	½ to	1	495	20′
28.	Shale	5 to	10	505	
29.	**Sandstone, Williamson**	10 to	25	530	
30.	Shale	0 to	6	536	

		Thickness Min. Ft.	Max. Ft.	Total Ft.	
31.	**Limestone, Dingess,** silicious, lenticular, ferriferous, many **Producti** and other marine forms	0 to	2	538	
32.	Shale, dark green, sandy, with iron ore nodules and plant fossils	10 to	20	558	
33.	**Coal, Williamson,** multiple-bedded, splinty, same as mined at Williamson, Mingo county, and upper seam mined by Auburn Coal Co., 1 mile above Matewan on Kentucky side of Tug	1 to	2	560	65'
34.	Fire clay, impure and shale	0 to	5	565	
35.	**Sandstone, Upper Cedar Grove,** dull gray, massive, medium grained, micaceous	10 to	20	585	
36.	Shale, dark gray with iron ore nodules and plant fossils	10 to	20	605	
37.	**Coal, Cedar Grove,** both gas and splinty, double-bedded; same as **Island Creek** bed of Logan county, and split into the **Upper** and **Lower Thacker** on Mate creek, Mingo county	3 to	5	610	50'
38.	Fire clay, impure	1 to	3	613	
39.	**Sandstone, Lower Cedar Grove**	10 to	20	633	
40.	Shale, dark gray, with iron ore nodules and plant fossils	5 to	15	648	
41.	**Coal, Alma,** some splint, mostly gas type, multiple-bedded, mined at Sprigg and Rawl, Mingo county; same as **Draper** vein at Logan and as mined at Big Creek, Logan county; and at Ramage, Boone county	1 to	2	650	40'
42.	Fire clay, impure, and shale	1 to	5	655	
43.	Sandstone Logan, bluish gray, massive, medium grained	10 to	20	675	
44.	Shale	0 to	4	679	
45.	**Coal, Little Alma,** double-bedded, crops near mouth of Armstrong creek	0 to	1	680	30'
46.	Fire clay, impure	0 to	4	684	
47.	Sandstone, Malden	15 to	25	709	
48.	Shale, gray, flaggy and sandy	0 to	5	714	
49.	**Limestone, Campbells Creek,** silicious, lenticular, dark gray, hard, the horizon carrying **marine fauna** at Bald Knob, Boone county	0 to	2	716	
50.	Shale, dark gray, with iron ore nodules and plant fossils	10 to	20	736	
51.	**Coal, Peerless,** gas type, split off top of Campbells Creek bed	2 to	4	740	
52.	Shale	0 to	20	760	
53.	**Coal, No. 2 Gas,** multiple-bedded, gas type, main bench of **Campbells Creek coal;** and including Peerless is same as mined in Logan county at Manbar, and lowest bed operated on Buffalo creek; and in Mingo county is known as the "Warfield," "Burnwell," "Freeburn," "Rawl," and "Upper War Eagle"	3 to	10	770	90

		Thickness Min. Ft.	Max. Ft.	Total Ft.	
54.	Fire clay, impure and shale	0 to	5	775	
55.	**Sandstone, Brownstown**	20 to	35	810	
56.	Shale	1 to	5	815	
57.	**Coal, Powellton**, double-bedded, same as "Hatfield Tunnel" of Mingo county	1 to	5	820	50′
58.	Fire clay, impure, and shale, sandy and flaggy	40 to	58	878	
59.	**Limestone, Stockton**, silicious, lenticular, hard, dark gray	0 to	2	880	60′
60.	Shale	30 to	40	920	
61.	**Coal, Eagle "A,"** double-bedded, gas type, exposed near mouth of Armstrong creek	0 to	2	922	
62.	Sandstone, Eagle	10 to	22	944	
63.	**Coal, Eagle**, soft gas type, same as "No. 1 Gas" of Kanawha valley, and "Middle Eagle" of southern Mingo county	2 to	6	950	70′
64.	Fire clay	0 to	3	953	
65.	Sandstone, Decota, massive	0 to	25	978	
66.	**Coal, Little Eagle**, double-bedded, gas type, and lower division once mined commercially at Cedar, Mingo county	1 to	2	980	
67.	Fire clay and shale	0 to	3	983	
68.	**Sandstone, Grapevine**, massive, type locality, mouth of Grapevine creek, Mingo county; observed at mouth of Armstrong creek	0 to	10	993	
69.	Shale, sandy	10 to	30	1023	
70.	Black slate	2 to	10	1033	
71.	Limestone, Eagle, dark gray, hard, marine fossils	1 to	2	1035	
72.	**Shale, Eagle**, dark, marine fossils	1 to	5	1040	
73.	Shale and sandstone, holding **Lower War Eagle** and **Glen Alum Tunnel coals** of Mingo county to top Nuttall sandstone and base of Upper Pottsville Series	150 to	200	1240	

This section should be used by the reader instead of the one given on pages 212-214 of the Detailed County Report on Kanawha County, West Virginia, of the West Virginia Geological Survey, in all questions of identity and correlation.