ART. XIII.—*Rock Oil, its Geological Relations and Distribution*;
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MY investigations have been directed chiefly to the oil of the coal rocks, and I propose in this paper to give some of my results.

The surface indications of petroleum are oil and gas springs. These springs are found scattered over a very large area.

It is doubtless well known to scientific men that there are, in the West, two distinct geological formations from which petroleum or rock oil is obtained. These are the bituminous coal measures and the Portage and Chemung groups, (the Waverly sandstone of the Ohio Reports). The Portage and Chemung rocks sweep around in the form of a quadrant from north-western Pennsylvania into southern Ohio and south into Kentucky. Upon these rocks the famous oil regions of Pennsylvania and northeastern Ohio are located. The oil regions of western Virginia and southern Ohio, including a portion of western Pennsylvania, lie in the coal measures. Marietta, Ohio, may be regarded as near the centre of these extensive oil fields.

It is well known that in the manufacture of coal oil a large amount of vapor or gas remains uncondensed. The town of Newark, Ohio, has been lighted for several years by the surplus gas from the oil works there. While it is believed that the oil cannot be produced in the subterranean distillation without the production of gas, it is also reasonable to suppose that at the very low temperature at which this distillation must take place, the formation of gas necessarily implies the formation of more or less oil. Hence in our bituminous coal measures a gas spring doubtless indicates the existence of oil in the rocks below. The great majority of these gas springs are unknown, since they are seldom discovered, except when they appear in streams; and probably the same may be true of oil springs, since the soil would absorb the oil and in only a few cases would it be detected. I have assumed that the oil is the product of the distillation of bituminous strata, at low temperatures. This theory, which is a modification of the old one of distillation (at high temperatures), has recently been brought forward by Prof. J. S. Newberry and has received the sanction of many of our most eminent chemists. The chief objection to it is the fact that the coal, cannel and bituminous, in our oil regions gives no evidence of having lost any of its full and normal quantity of bitumen or hydrocarbons. For example, at Petroleum, Ritchie Co., Va., where strata have been brought up by an uplift from several hundred feet below, seams of cannel and bituminous coal appear, which, if judged by the standard of Nova Scotia or English coals, have lost none

of their bituminous properties. The cannel coal although somewhat earthy, yields from forty to sixty gallons of oil to the ton.

The other theory, that the oil was produced at the time of the original bituminization of the vegetable or animal matter, has many difficulties in its way. If the oil were formed with the bitumen of the coal, we should expect that wherever there is bituminous coal there would be corresponding quantities of oil. This is not so in fact, for, as will be seen presently, there is no oil except in fissures in the rocks overlying the bituminous strata, and these fissures can be shown to have been made since the coal strata became bituminized. Again, upon this theory it will be difficult to explain the large quantities of inflammable gas always accompanying the oil. If it is generated exclusively from the oil, then we should expect to find the quantity of oil least where the gas springs have for ages been the most active, but at such places the oil, instead of being wasted, is the most abundant.

That the oil is accumulated in fissures in the rocks and that these fissures are more or less vertical there is abundant proof. The oil in the same neighborhood is found at very different depths. It is very seldom that two adjoining wells strike the oil at the same distance below the surface. The accompanying diagram shows the relative depths of oil wells on Burning Spring Run in Wirt Co., Va. It is evident that in this case the oil is not

Fig. 1 shows the relative depths of the large wells in Burning Spring Run.

contained in anything like a horizontal reservoir. The famous Lewellyn well marked No. 2, struck an oil fissure at one hundred feet, while the Athens company's well marked 8, struck a large vein at two hundred feet. The oil in the first is said to stand at 41° , (Beaumé,) while that of the latter stands at 38° . On Duck Creek, Washington Co., Ohio, wells very near each other show a difference of ten degrees (Beaumé) in specific gravity.

At Smith's Ferry, in Western Pennsylvania, on the Ohio River, much of the oil is of a light straw color, while it is said other wells yield an oil of the more usual dark-greenish color. On the same lease of land and within six or eight rods of the well marked 8 in the previous figure, is a well two hundred and fifty feet deep. The oil from this well is not only different in its specific gravity from that in the other, but the deepest well contains fresh water, while the other contains salt water. From these and similar facts, it is evident that the oil is in distinct and separate fissures and that these are vertical rather than horizontal.

The contents of these fissures are generally water, at the bottom, oil floating upon the water, and gas filling the space above the oil. Where the gas finds an outlet through a crevice in the overlying rocks, there is produced a gas spring. When the water finds an outlet it carries the oil with it and an oil spring is the result. I have found oil springs high up on hill sides.

An oil fissure may be struck at any point. The following figure will illustrate this. The letter *a* (fig. 2) shows the position of a well which strikes near the top of a fissure and in that part which is filled with gas. The gas rushes up but no oil. If again the well is bored at *b*, it will strike oil, and the gas pent up in the upper part of the fissure will

force the oil up through the well *b*. There are several oil wells on Little Kanawha in which the gas has forced up very large quantities of oil. The action of the gas however soon becomes fitful and intermittent. If again the well is bored at *c*, it will strike that part of the fissure which contains water. In such case oil can be obtained only by pumping out the water. Doubtless many good oil wells are thought to be worthless, and abandoned because they contain at first only water. If bored at the point *c*, in the water part of the fissure, water alone is to be expected until the pump has been used. There may be floating upon the water, higher up in the fissure, a large quantity of oil.

If the oil is found in fissures in the rocks, it is natural to suppose that in those places where the fissures are the most numerous and largest, the oil would be formed in the largest quantity. This antecedent probability is fully verified by the facts. The rocks of Western Virginia and Southeastern Ohio may be divided into three classes, *those which are almost entirely horizontal, those which have a dip of from fifteen to forty feet in the mile, and*

those which are broken and dislocated by an uplift. The strata from the Ohio River at Parkersburg up the Little Kanawha to within a few miles of the great oil wells are very nearly horizontal and probably contain few fissures except such as may have been produced by the drying and shrinking of the rocks. There is not to my knowledge a single productive oil well in that region although a large number of wells have been bored. The compact and unbroken clay shales and other strata rest upon the deep bituminous strata and furnish no spaces through which the oil vapor could rise. Probably no such vapor is formed.

On the Great Kanawha River, at Pomeroy and vicinity on the Ohio River, in Athens, Morgan, Noble, Washington and other counties in Ohio, located on the coal measures, the rocks have more or less dip and contain, as a probable result of the uplifting force, many fissures. These counties all furnish oil—Noble and Washington in considerable quantities. The salt wells on Great Kanawha, at Pomeroy on the Ohio, on the Hocking and Muskingum Rivers and on Duck Creek, revealed more or less oil.

But it is in regions where the strata have been the most disturbed and where the fissures are the most numerous, that the most oil is found.

I have recently traced a most interesting line of uplift and dislocation from the eastern part of Washington county, Ohio, to beyond the great oil wells on the Little Kanawha River. The direction of it is nearly north and south. It makes an angle of about 40° with the general course of the Alleghany Mountains. As seen in Ohio it presents a well marked anticlinal axis but with the eastern slope more steep than the western. Near the

3.

Section on the Ohio in vicinity of Newell's Run.

anticlinal lines at A, fig. 3, are oil and gas springs. A few miles south, on Cow Creek, Va., it is seen as represented by fig 4. At

4.

Section on Cow Creek, Va.

the anticlinal line are gas and oil springs. Fifteen or twenty miles farther south, near Petroleum, Ritchie Co., Va., the uplifting force has been greater and the strata have been broken apart

and now stand on each side at an angle of about 50° . They are represented by the inclined strata B and C in fig. 5. At D, are

seen strata from below, which have been forced up and wedged in between B and C. They have been bent by the great force to which they have been subjected. These strata contain seams of cannel and bituminous coal and are altogether new to me. At A, just within the steep rocks on the east are gas and oil springs and some productive oil wells. At B, is seen the mouth of Oil Run and at C, the mouth of Laurel Fork of Goose Creek, where the rocks of the western dip are finely exposed in a railroad cutting. A few miles further south and on the line of this geological disturbance we find, near where Hughes River crosses the uplift, many new and interesting strata, which have been lifted up from considerable depths. Some of these are shown in fig. 6. At *a* we find a seam of light colored compact flint from

eight to eleven feet in thickness. At *b* is a seam of shale, brown at the top and blackened with bitumen at the bottom, which is remarkably rich in fossils such as *Productus*, *Chonetes*, *Bellerophon*, &c. The exact equivalent of this deposit of fossils I have nowhere seen in the outcrop of our coal measures.

At *c*, is shown the alluvial bank of Hughes River, out of which large quantities of petroleum have in former years been taken. The oil came up through a fissure in the underlying rock and saturated a stratum of sand and gravel. This stratum was laid bare by removing the superincumbent earth and the oil worked out by hoes from the water and sand. This locality, next to the old Pennsylvania Oil Springs, has probably furnished more oil than any other locality in the country. A few wells have been bored in this region, but with what success I did not learn, nor had I time to investigate the question whether they

were bored in that part of the geological disturbance, where the largest number of fissures would be found.

Between this point and the Little Kanawha River, the anticlinal line is easily traced, the rocks inclining to the east and to the west at angles varying from 28° to 8° . The rocks are well

7.

Section on Little Kanawha in vicinity of Burning Spring Run.

exposed on the heads of Standing Stone Creek, and at other points. On the Little Kanawha, a section would be represented

8.

Sec. on Lit. Kanawha R. above the mouth of Nettle Run. Dip West. *a* mouth of Nettle R., *b* ledge of rocks in the bed of river.

by fig. 7. The anticlinal line, or centre of the uplift is seen at A. Near A and extending towards B are the great oil wells.

9.

Sec. of Eastern dip $\frac{1}{4}$ mile E. of Burning Spring Run. Dip 11° .

They are exactly where the largest number of fissures would be made by the uplifting force. The accompanying figures 8 and 9

show the western and eastern slopes of the anticlinal. To the intelligent aid of E. H. Moore, Esq., of Athens, Ohio, I am indebted for the following map of the oil region of Little Kanawha. The directions and courses were taken accurately, the distances only approximately. It is so far as I know the only map of that district. The wells are on the north bank of the river and on a

Map of Little Kanawha Oil Region, Wirt Co., Va.

Scale about $1\frac{1}{2}$ inch to a mile.

little tributary called Burning Spring Run. The hills in this region are very high. The valleys are all valleys of erosion. The three angles marked *a* indicate the position of the western slope of the rocks. On Nettle Run, the dip is 21° , at the other points, somewhat less. At the points marked *c* are ledges of rock, seen in the bed of the river at low water, produced by the harder of the inclined strata.

At *b* the angle indicates the dip of the strata to the east. The rocks are there inclined at an angle of 11° . At *d* another ledge of rocks is seen in the bed of the river made by hard strata in their eastern dip. The central line or axis, between the two slopes, runs nearly north and south, and along this line the productive wells are found. Thus far, the oil is obtained only

in a narrow range extending north and south, and little more than one hundred and twenty rods wide. On the west of this range many wells have been bored without success. The exact limit of the oil on the East is not yet known,—but wells, now being bored, will soon determine it. The oil fissures are struck at different depths, as has been already shown, consequently there is no such thing as an “oil rock” as many suppose. The oil is found in any kind of stratum. Each oil fissure doubtless extends vertically or nearly so, through many different strata.

These wells have been unparalleled for the quantity of oil produced. Many of them, when first bored, poured out the oil in torrents, the oil being forced up by the pressure of gas. Hundreds of barrels were obtained from a well in a few hours. The Camden, Lewellyn, Weare and Harper wells and doubtless others, are fine illustrations of this. They yield a marvellous quantity of oil. In many wells the oil is entirely free from water and passes directly from the well into barrels for shipment. The oil varies in specific gravity from 32° to 42° (Beaumé.)

The oil is evidently the accumulation of long ages. The valleys of erosion which cross this line of uplift in almost every direction, and which have been produced by the drainage of the rains falling upon the surface, show that the uplift and consequently the fissures underneath, have existed for a vast period of time. It is therefore probable that during this long period the work of accumulation has been going on. If this is true, it will follow that when a fissure is once exhausted of oil, it may well be abandoned, as it will take a geological period to refill it. The original indications of oil in this region were, as I learn, only the gas springs, of which there were two on Burning Spring Run. Both of them are now destroyed by wells that have taken away the gas. A salt well bored at the mouth of Burning Spring Run, many years ago, yielded a large quantity of oil and it was this salt well which caused attention to be directed to this locality, now so famous.

I have thus shown some of the geological relations of the oil here in the upper part of the coal measures. The *horizontal* strata in Wood and Wirt counties, Va., are, I think, the highest in the series. Containing few fissures, the chances of finding oil in them is necessarily very small.

The *inclined* rocks with a dip of from fifteen to forty feet in a mile, contain more or less fissures and consequently yield more or less oil. It is in these inclined rocks that the productive wells on Duck Creek, O., at McConnelsville, Pomeroy, &c., are obtained.

In the *broken* rocks, as found along the central line of a great uplift, we meet with the largest quantity of oil. It would appear to be a law, that the quantity of oil is in a direct ratio to the

amount of fissures. By this law, the great wells on Little Kanawha are easily explained. With so much room for expansion, the hydro-carbons of the coal and bituminous strata underneath have risen in the form of vapor and during long geological ages have been filling the fissures with oil.

Since writing the above, I have examined the Report of the Geol. Survey of Kentucky, vol. iii, and find that the oil region which lies in Cumberland county and in several adjoining counties, is probably situated upon a line of peculiar disturbance. Mr. Owen states that "the principal axis of disturbance, already mentioned, which passes in a southwest course through Lincoln, Casey, Russell and Cumberland into Monroe county, probably crosses the Cumberland (river) at the Riffle, near the Turkey River Bend, where a dip of about 4° was observed at the head of the Riffle in a direction of 50° east, while a reversed dip, north 50° west, at about the same angle was noticed near the foot of the Riffle." A careful examination might show that the fissures containing oil in this region are to be found chiefly along the line of this disturbance.

Of a locality in Cumberland county, Mr. Owen thus writes: "On Crocus Creek, the blue limestone dips 2° to the northeast; a short distance up Puncheon Camp, the slate dips at an angle of about 1° in a course south 20° west, while not far off, on the Creek, it dips with about the same angle in a course north 10° to 20° east. Hence it is evident that the dip is very irregular." On Crocus Creek and on other streams in that region large quantities of oil were found many years ago in boring for salt water. From all I can learn, without visiting the region, the oil is found chiefly in the blue limestone and below the black shale. The oil is light in its specific gravity, while oil from similar locations in the geological series, in Ohio, is very thick and tar-like.

The oil from the coal measures varies in specific gravity from perhaps 20° to 52° (B.) Oil from Pomeroy, O., standing at 51° B. burns freely, and with brilliant flame, without distillation.

The heavier oils, such as are not profitable for distillation, afford a very superior lubricating oil. Hence the demand for heavy as well as light oils will doubtless be very great.

Marietta, Ohio, May 20, 1861.