A Paper read at the Cleveland Meeting, June 25th, 1884.

THE GAS WELLS OF OHIO.

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Ever since the valley of the Ohio has been occupied by man, it has been known that inflammable oils and gases transude in places through its rocky strata. Before the advent of the white race, the Indian was acquainted with and often set high value on the oil springs, gathering in a rude way their product and turning it to great account in his restricted pharmacy. Around these springs, also, the war-dance was often celebrated. Some of the early chroniclers describe the strange spectacle, the surface of pool and stream bursting into a blaze and lighting up the midnight

darkness of the primeval forest, while the red men danced and shrieked around the ghastly fires.

The earliest distinct and conspicuous notice of inflammable gas in this region seems to come from the Kanawha Valley. Burning springs were known there from the first occupation of the country. In one situated a few miles above Charleston, the gas rose from a cavity about a foot deep and 5 or 6 feet in diameter, partly filled with water, through which it made its way with considerable commotion. When lighted the gas burned to a height of two or three feet and played with a lambent flame over the water until extinguished purposely or by some accidental current of the air. There is an element of historic interest in connection with this Burning Spring. The tract on which it was found was one of several large tracts in the Kanawha Valley that belonged to General Washington. Viewing the Spring as an interesting natural phenomena, which an individual ought not to monopolize, Washington generously presented to the public the acre of land that held the Spring in its center.

Petroleum and gas have always been associated with salt production in the State. When the Ohio valley was first occupied by white settlers, to secure an adequate supply of salt was one of their most troublesome problems. For this indispensable element they were dependent on the Atlantic seaboard, and during a period of many years, the precious commodity was carried across the mountains on pack horses, the price of it to the settlers ranging between $4 and $8 per bushel of 50 lbs. It was considered at that time that the high price of salt might always prove a drawback to the prosperity of this portion of the country. It is not therefore to be wondered at that the first promises of the home supply were considered to be matters of the most vital interest to the new communities. Congress and infant territories joined their efforts to prevent any monopoly from getting control of the salt springs, but two or three of which were then known and none of which ever had any real value.

The first salt works of Ohio were established in 1798 or thereabouts, at what is now Jackson Court House. Wells were dug on Salt Creek through surface deposits to a depth of 20 or 30 feet and the salt water rose into them from the underlying rocks. The brine was weak and impure. It required 600 to 800 gallons of water to make a bushel of salt and the product was very inferior,

all the bittern being counted in. Over this infant enterprize the government kept strict and jealous watch.

In the year 1808, a new departure was taken in salt manufacture. Up to this time the wells from which the brine was obtained had been sunk only to the underlying rock, but now a successful attempt was made to pierce the rocky floor and reach more directly the fountains of brine below. This was first accomplished in the Kanawha Valley and by a descent of even 70 to 80 feet a great increase in the strength of the brine was secured. Following the clue thus obtained, the wells were carried down 300 to 400 feet and brine was obtained of such strength that 75 gallons, or even less, would make a bushel of salt, a great change from the 6 to 8 hundred, already chronicled. The new process was soon introduced into Ohio and with it came the development of the first gas wells of the State.

Wherever the drill descended to the sources of the salt water, as was very soon established, inflammable gas was invariably released at the same time, and often, in astounding and most troublesome volume. It was soon learned that the free rise of the water was intimately connected with the volume of the gas. In some wells both salt water and gas rose in a steady and uniform flow. In others, the gas would rise at intervals of 10 to 12 hours, or as many days, in vast quantity and overwhelming force, throwing the water from the well to the height of 50 or 100 feet. This "blowing" of the salt wells was a very troublesome and vexatious phenomenon to the salt manufacturer. Sometimes it caused the copper tube or casing that was used to shut off the fresh water to collapse, and sometimes it would displace and derange all the fixtures of the well.

Some wells grew tame and manageable by constant use, through the exhaustion of the supply, but others were abandoned as incorrigible and uncontrollable. A well on the Muskingum, 10 miles above McConnelsville, 600 feet in depth, afforded an immense quantity of gas in a constant stream. In the process of drilling, the friction of the tools against the sides of the well set fire to the ascending column several times, driving away the workmen and destroying the shed which covered the works, and even spreading along the ground to objects several rods removed from the well, being extinguished with great difficulty. It became so trouble-

some, in fact, that this cause alone led to the abandonment of the well.

The first use of these gas supplies as well as the first records of the springs seems to have been made in the Kanawha Valley. As in the similar case already described, the gas rose to some places through the sands of the river banks so freely that a flame could be lighted wherever a shallow cavity was made. The sand beneath the burning gas would soon become red-hot and the boatmen would sometimes turn this source of heat to practical account in cooking their food, or the housewives of the neighborhood would boil the water for the family washing in this way. These were homely but real uses and quite in the line of some of the modern applications. The Kanawha gas was afterwards turned to account in salt boiling, a use which is still maintained.

For these and many other facts bearing on the subject I am indebted to the articles of that excellent Ohio geologist, now long deceased, Dr. S. P. Hildreth, of Marietta. These articles were written in 1833 and 1836, but their interest is as fresh as ever. In Dr. Hildreth's clear statements of his carefully gathered observations, we have the first application of sound geological reasoning to the structure of the state. Many of the elements on which he seized in building his geological column have proved to be the leading elements, and have as important a place in our most recent statements of geological order as they had in these earliest attempts to find an order.

We know a great many things about the geology of Ohio which Dr. Hildreth did not know. Many things which were indistinct and obscure 50 years ago, are among the very elements of our present knowledge, but some of the questions which the early geologists asked but could not answer are among our unsolved problems to-day. The source and mode of origin and storage of petroleum, the origin of gas, the relation that the two bear to each other, and also to salt water, our answers are as far from going to the root of questions like these as the earlier answers were. Some progress we have made, however, and in view of the recent astonishing developments of gas-wells in our State, and of the greatly extended applications of gas in manufactures, and of the wide spread interest in the subject as evidenced by the willingness to use money freely in exploration in all parts of the State, I have thought it might

be serving the public to spend a little time in setting forth the grounds of our present knowledge and belief on these very interesting questions of scientific and practical geology.

1. We have learned that gas and petroleum and salt water have their *store-houses*, their *receptacles*. They are not contained in one rock or another indifferently. You may not look for them intelligently in shale or limestone or granite or sandstone alike, but their storehouses are all of one sort. *Sandrock* makes the universal receptacle. It may be coarse enough to take the name of conglomerate or pebble rock, or it may be quite fine grained and close, but at all events it must be *sandstone*, distinct and pronounced. The coarser the better receptacle it proves. We have come to know a good deal about these storehouses, about the shape in which they exist, the extent they hold, their thickness, their quality. They are often lenticular or lense-shaped, thinning out to nothing on every side. Sometimes they do not rise to-day. There is nothing on the outcrop that corresponds to them. They are old gravel ridges, transported by the currents of a distant age, dropped on a former sea floor and having no distinct connections with the shore. On the other hand, some of them are the pebbly and sandy beaches of these ancient seas, covered by a depression of the coast line with hundreds of feet of deposits and still capable of being followed with unmistakable distinctness along their various meanderings.

2. We have learned that these sandstone receptacles must be *sealed* in order to fulfil their purpose. They must be enclosed by impervious shales. If the stratum should extend to-day, no matter what its composition, or grain, it could not be an oil or gas rock. Its original contents we have had a chance to escape by outcrop. The sealing may not be hermetical. There may be some slight connections with the surface by which a hint of its contents is given, in gas spring or smell of oil, but practically the isolation must be complete. The gas rocks are bedded in shales as well as covered by them. Some slow circulation must be provided for from below, as is evident from many facts, but the proper picture of a gas rock in Ohio, is a sandstone shut in—enclosed on all sides by fine-grained shales.

3. We have learned that these oil and gas sands have their *horizons*, that is, their *definite places in the geological scale*. This is, perhaps,

the most important of the facts that we find established by our later experience. They are not found hap-hazzard, here, there or anywhere, but they have their own range and limits. I have already stated that the gas rocks of any one series are not strictly continuous, but still the several fragments or representatives of each, lie on one stratigraphical plane. They fall into line, in other words, just as do our coal seams, our ore-beds, our sheets of limestone or any other of our great landmarks, and with no greater range of intervals than they. The remarkable order and system which characterize our geology in all other fields, making the Appalachian Coal Field the simplest and least confused portion of the whole crust of the earth to read and interpret, this order and system prevail in these buried elements as well, and prediction can therefore be made by due calculation as to about where they will be struck, if struck at all, in new territory just as such predictions can be made for a coal seam or any other element of economic interest.

4. Not only have we learned the vitally important fact that these treasure-holding rocks have their places in the scale, but we have learned *where these places are*. There is more than one, and the series stretches through many hundred feet but they have their upper and their lower limits, and we know what they are. It is a great point gained where we can say that not one large source has been found below the corniferous limestone of Devonian age, and not one really important supply above the lowest coal. This restricts by so much the range of profitable investigation. It has cost a great deal, of course, to establish these limits and we cannot say that the limits are not liable to be extended. They are not necessarily fixed for all time, but within them, so long as they are maintained, the safe and prudent line of exploration must be found. These limits are both geographical and geological. We learn from them in what territory we can find encouragement for work and how deep it is wise to sink. The promise of a territory can be gauged by its relation to these limits and by what is included within them.

5. One step further we can take. Fifty years ago Hildreth reasoned soundly as to the origin of these interesting, but at that time, troublesome products, petroleum and gas. He recognized the fact that such bodies can be directly derived from vegetation. Petroleum, he felt obliged to refer to *coal* as a source, but for

gasious hydro carbons, he recognized the availability of vegetable growth of any sort.

We have learned that coal is *not* the main source of petroleum, and that without a doubt both petroleum and gas come from a common source, through the same general line of decomposition and chemical change. Without understanding all of the steps, there is a general consent in referring both to a vegetable source and to a vegetable source other than coal, the great accumulations of both oil and gas lying far below all the deposits of the carboniferous age.

Do we find any strata in the interval to which we are limited that could yield these products? The answer is clear and positive. When the discovery of the great stores of buried oil in Venango County, Penna., was made, 30 years ago, there were several establishments in Ohio at work in the distillation of rock oil from cannel coal and also from *black slates* of Devonian and subcarboniferous age. One great stratum in particular, the Ohio black shale, 300 feet in thickness traverses the State from Lake Erie to the Ohio Valley, with a breadth of outcrop of 10 to 20 miles. It carries from 8 to 20 per cent. of bituminous matter in it. It takes fire under favorable conditions, burning through a dry summer in the hills as a coal mine would do. By distillation, we easily produce from it both gas and oil. Here. there is a stratum that can meet the demand. Newberry was the first to point out and insist upon the adaptations of this great sheet, when it descends below proper cover, to generate these substances whose origin we seek to know, and the most sagacious study of the problem since this explanation was first proposed has gone to support and strengthen it. There are two other explanations that have been offered of these wonderful accumulations. Dr. Sterry Hunt has urged the availability of the organic matter of limestones for this purpose, and would find the source of Pennsylvania oil and Ohio gas alike in the deeply buried Devonian and Silurian limestones of the scale. There are some interesting facts in this connection, but Dr. Hunt stands alone, so far as I know, in maintaining this explanation as an adequate one–to me it is altogether inadmissible. I will not stop to consider it now, as it is scarcely a factor in the present discussion of the subject.

An explanation that seems to me equally unsatisfactory and un-

tenable is urged by some good geologists. It maintains that the oil, gas and salt are indigenous to the rock in which we find them. To account for the supplies with which a Venango oil sand is charged, for example, a raft of buried vegetation is supposed to have been originally contained within it, which by its slow decomposition has given rise to the wonderful fountains of oil that astonished the world. There are here again a few facts that have suggested the explanation, but they seem to me exceptional and inadequate. I am sure that the facts of our own supply will not bear out this theory. The old maxims *ex nihilc*, *nihil fit*, applies here. Out of nothing, nothing comes. These oil sands are as clean, as free from all traces of vegetable growth, as any strata in our whole series, in every case where I have had opportunity to examine them, in outcrop or by chips brought up from the drill hole.

We are shut up, I take it, to the first explanation. It is a true cause, it is adequate—there is no need of another.

As a summary of this part of the subject, let us say that oil and gas are in all probability derived from the beds of bituminous shale, carrying a noticeable per centage of vegetable substances. From these shales, by simple means in our laboratories, we are able to derive the products which we are discussing, and all things point to a similar process and a like result in the great laboratory underneath.

If now we put together the facts which have been separately stated, we see that to find the suitable condition for an oil or gas field underneath us, we must have considerable bodies of bituminous shale, underlying sandstone or conglomerate masses or bands, which are themselves covered with and thus bedded in impervious shales. The whole series must further be of Devonian or subcarboniferous age. The sole significance of this last condition obviously is that only in the rocks of these two series do the proper conditions occur in this region for the production and storage of gas and oil. These geological ages do not monopolize these products the world over.

I have now come to the point in which we can more intelligently examine the geological scale of Ohio as a source of fossil hydrocarbons. Incidentally I have already touched upon one essential element in the scale, viz.: the great bed of bituminous shale that spreads a broad band of outcrop from the river to the lake, and

that dips down to the eastward and southward beneath our whole series of sub-carboniferous and coal measure deposits, furnishing a vast supply of bituminous matter that awaits an easy transformation into gas or oil to all of Eastern Ohio and Western Pennsylvania.

This stratum, as I have shown in other discussions, is a compound and complex one, but one of its main characteristics everywhere, above drainage and under the deepest cover alike, is its stock of vegetable matter that renders the shales that compose it *black* shales. Here then the first condition is met—a source of gas and oil is found. What of the second and equally essential condition, a sand-rock receptacle?

In this respect Ohio has not, so far as now known, the same advantages as Pennsylvania. That fortunate State has found 3 great series of oil rocks, each of them consisting of more than one element, in different portions of its Devonian area, the Venango, the Butler and the Bradford sands.

All of these series are entirely wanting in Ohio, or at best, so far as proved, they have a very feeble and fitful development. The reason for this failure it is not hard to find. *We have not room for them* in our series. There is a great reduction in thickness of these rocks as we follow them westward. Three thousand feet in Western Pennsylvania are represented by three hundred feet in Central Ohio. Things are somewhat better in Northeastern Ohio, however. There are here not less than fifteen hundred feet to balance the three thousand feet further east, and the oil rocks of the Venango field appear to be occasionally met with.

[*Unfinished.*]