REPORT

UPON A

MINERAL FORMATION

IN

WEST VIRGINIA,

BY

PROFESSOR HENRY WURTZ.

TO THE

Ritchie Mineral, Resin, and Oil Co.,

BALTIMORE, MD.

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REPORT

GENTLEMEN :

Having visited and examined with care the extraordinary vein of mineral found upon your property, in Ritchie County, West Virginia, I have the honor to report the following as the observations made by me, and the conclusions derived therefrom.

I shall first remark, that no person having before visited this vein, so far as I can ascertain, who was qualified to view it with the eyes of a chemist and mineralogist, my own conclusions diverge widely, almost *toto cælo*, from those hitherto held in common acceptation.

GEOLOGICAL DISCUSSION.

The geological features both of this special formation and of the neighboring country are simple enough. The rocks are the ordinary blue sandstones and shales of the carboniferous age, the shales frequently reddened by peroxydation of their ferrous carbonates and oxyds; and lie on the south-eastern synclinal slope of one of the many trough-shaped basins which make up the vast Appalachian coal-field, the direction of the synclinal axis of the basin being, as usual, about north-east and south-west, and the dip of the rocks generally north-westerly, in some places showing by the clinometer as much as 15° or 17° inclination from the horizon; in others much less.

Careful examination did not enable me to detect any in-

dication of the passage of an anticlinal axis, such as is stated to have produced the fissure at Hillsboro', New Brunswick, filled with the so-called "Albertite;" and this vein fissure has evidently been produced by simple shrinkage of the including rocks, or at least by a movement apart of these rocks in a *lateral* direction only, by whatever cause produced. In fact the course of this fissure, by my compass north 76° east, at the ravine, and as much as 80° east of north at a point a quarter of a mile west of the ravine, seems to disconnect the disrupting force which formed it from that which has produced the north-east and south-west rolls of the strata.

I had no opportunity to explore across the country in the direction of the north-west dip, and have few data, therefore, from which to judge of the position of the rocks at this place in the Appalachian carboniferous series. The following conclusions, however, seem tolerably clear, from a hasty glance which was taken at the rocks along the line of the North-West Virginia Railroad, between the stations of Cairo and Petroleum, the former of which lies some seven miles north, and the latter some ten miles north-westerly, from your locality. The place where the synclinal axis of the basin crosses the railroad, seems to lie just west of Cairo, and this axis, marking the bottom of the basin, must, therefore, pass between this locality and Petroleum. Proceeding westerly from the bottom of the basin along the railroad, the sandstones and shales are found rising in the north-western slope of the basin, gently at first, but more and more rapidly on approaching Petroleum, until at that station the up-tilt is in places as much as 45°. The small stream at Petroleum, called Oil Spring Run (in the bed of which numbers of oil wells are in successful operation), and the larger stream to which it is tributary, seem to occupy a valley formed by an anti-clinal fissure, and in places along this valley the rocks on opposite sides were observed dipping in opposite directions. This anti-clinal, which is regarded by Professor Lesley as the same which crosses the Ohio River below Pittsburgh, at a point some

hundred and fifty miles north-east from this place, brings up with it a seam (or rather two seams separated by a thin bed of fire-clay) of coal, which, it is probable, belongs to the lower of the three groups of coal seams made out by the Professors Rogers in their surveys of Virginia, inasmuch as the oil wells in the bed of the stream, so far as I was informed, have passed through none lying beneath it. In any case the conclusion is inevitable, that these petroleum coal-seams underlie, though it may be at a considerable depth, the out-crop of your vein; a fact which—whatever *possible* bearing it may be supposed to have upon the origin of this peculiar mineral—has certainly an important bearing upon the value and resources of your property as a mining tract; for on sinking upon your vein these seams of coal must, sooner or later, be intersected by your shafts, and their contents become available, at least for your own uses, for locomotive, pumping, and hoisting engines. I recommend that further examination be made by you into this subject, by having a thorough geological reconnoissance of the neighborhood made. I may allude to a circumstantial report that reached my ears of the passage through a six feet vein of coal, thirty feet below the surface, in boring an oil well, at a place two miles north-east from your locality. If such report be true, this coal would probably underlie portions of your tract.

Since the coals which are mined at Clarksburg are stated by the Professors Rogers to belong to the upper group, they can scarcely underlie your locality, else they should be found cropping out somewhere between it and Petroleum station. A statement was made to me of the existence of a small out-crop of coal, on high ground near Cairo Station, which may belong to either the middle or upper group. These enquiries, of much practical import to you, can be properly pursued only by deliberate and exhaustive geological examination of the surrounding country. Such examination would be much facilitated, and rendered peculiarly satisfactory, by obtaining from the numerous oil wells sunk throughout the surrounding

country all reliable information concerning the materials penetrated in boring them.

DESCRIPTION OF THE VEIN.

To proceed to a special description of the vein itself.

The deep narrow ravine formed by the small tributary to McFarland's Run, at the bottom, where the out-crop of the vein crosses it nearly at right angles, is sixty feet wide from rock to rock; the direction of the ravine being about No. 15° W. Here the solid mineral *in situ*, originally covered by but a few feet of debris from the steep slopes intersected by it, has been well exposed by two shallow open cuts into the two hills, and two shafts sunk into the mineral itself on either side of the ravine. An exceedingly satisfactory view of this singular formation is here presented and very brief examination sufficed to develope peculiar characters separating it from all others hitherto put upon record.

The following is substantially from my notes taken on the spot relating to the exposure on the western side of the ravine.

The structure shews four distinct, though somewhat irregular, divisional planes, having a general parallelism with the walls. Next to the walls the structure of the mineral is coarsely granular, with an irregularly cuboidal jointed cleavage, very lustrous on the cleavage surfaces; that in immediate contact with the walls usually adhering thereto very tenaciously, as if *fused* fast to the granular sandstone.

This portion forms practically a sort of "selvage" for the vein, though of the same material with the vein itself. Next these two outside layers, which vary irregularly from two to three inches or more in thickness, is found on each side of the vein, a layer averaging from fifteen to sixteen inches in thickness, which is composed of a variety highly columnar in structure and very lustrous in fracture, the

columns being long, and, at this place, at right angles to the walls. It is this variety that is described by Professor Lesley; who saw only hand specimens, as it would appear. Finally, in the centre of the vein, varying in thickness, but averaging about eighteen inches, is a mass differing greatly in aspect from the rest, being more compact and massive, much less lustrous in fracture, and with the columnar structure much less developed, in places not at all. The fracture and lustre of this portion of the vein are clearly *resinous* in character.

It is very remarkable that this curious vein structure has heretofore escaped detection. Professor Lesley, whose information however was derived at second hand, says that the mineral has "not the slightest appearance of layers, but the aspect of complete uniformity and homogeneity;" and Nelson Beall, Esq., states from personal inspection, that "there was not the slightest indication of any stratification appearing to show that it was not a solid mass of one kind of material." Another eye-witness, named Richardson, "Civil and Mining Engineer," it seems did observe obscurely the lack of entire homogeneity in structure, but says that the vein is "divided into two parts by an irregular vertical joint, one portion being granulated while the other portion is fibrous or somewhat flaky," a description which conveys little notion of the true state of the case.

The general aspect of the mass, as well as all the results of a minute examination of the accompanying phenomena, lead irresistably to the conclusion that we have here a fissure which has been filled by an exudation, in a pasty condition, of a resinoid substance derived from, or formed by, some metamorphosis of unknown fossil matter contained in deep-seated strata intersected by the fissure or dike. It is not necessary to suppose a degree of heat higher than would give the material a fluidity greater in degree than that of semi-fused pitch, or inspissated tar. Such a soft doughy mass, though flowing but slowly, would *in time* be forced by a very moderate pressure into every portion and into every crevice of the fissure. The peculiar structure

described is such as would result from the fissuring of a fused or semi-fused mass of any material of a vitreous or resinous nature by the refrigeration produced by contact with the cold, and it may be wet, walls of the fissure; the outside granular layers being due to rapid cooling, the columnar fracturing at right angles (or nearly so) to the walls (as, for example, in the case of a dike of columnar basalt) to a more gradual reduction of temperature; connected, without doubt, with the well known tendency of such materials as are susceptible of the vitreous or resinous fusion, to assume in time a concretionary or nodular structure. This tendency is strongly apparent in the brilliant variety of this resin, having produced multitudes of those curious markings on fissured surfaces which were mistaken in the case of the albertite for *fossil impressions*, of which more anon. The dullness of lustre, and the comparative freedom from distinct and brilliant columnar cleavage, of the interior of the mass, are due of course to the extreme slowness with which it cooled, just as a piece of transparent glass, if cooled with extreme slowness from fusion or semi-fusion, will, as is well known, lose its brilliancy and vitreous fracture, becoming like porcelain biscuit. Many analogous phenomena are familiar to chemists. With regard to the transverse columnar structure or "pencil cleavage," as it is called by Lesley, which is found extending in many places, though somewhat obscurely, even through the central compact core of the dike, I may add that, although I believe it intimately connected, as in the case of a basaltic dike with the concretionary or "globuliferous" tendency, yet it is admitted by high authority, that in basaltic dikes "the cracks separating the columns from one another are due to contraction in cooling,"* and I wish in this connection to revert to an experiment related in my former report, under date of February 22, 1865, in which a portion of this resinoid, having been fused under pressure in a gas retort was allow- to pour out on a stone pavement, and after solidifying was

* Dana's Manual of Geology, page 627.

found to have formed a cake which was very similar in aspect to the original material before fusion, and which was much fractured in planes at right angles to its walls.

Very slight examination and consideration of the facts and conditions presented to us by this formation, suffice, in my mind, for the total subversion of the prevalent hypothesis implied in the current designation of "crystallized petroleum." In the first place such application of the term "crystallized" is a perversion of the word, there being here no structure which would for a moment be admitted by an adept to be of the nature of a crystallized structure; and in the second place the idea that the material ever was in the condition of fluid petroleum, is not merely visionary and groundless, but there are the strongest reasons why it could never have been more fluid than a very thick semi-fluid pitch; of which reasons one of the most obvious is the entire absence of any penetration of the material into the surrounding porous sandstones. Also, no such substance as this, or any thing approximating to it chemically, was ever known to be formed, or to have been formed, by the oxydation and inspissation of petroleum; and the formation from liquid petroleum, in such a fissure, to the depth of hundreds of feet, by any process of oxydation from the surface, of a mass so uniform as this, is an idea which I believe will receive but meagre acceptation among those chemists whose minds are free from the trammels of pet hypotheses. Instead of the great subterranean "Sea of Petroleum," of which some have fondly imagined this dike will prove to be an oxydated and solidified arm or outlet, my own hope would rather be that you should find your solid sheet of mineral resinoid extending downward, uniform in quality and undiminishing in width, through the carboniferous deposits, to and even below some fossiliferous shales, reposing far in the profound depths of the Devonian.

Some additional details relating to the different openings and the appearances presented by the mineral in them, are as follows:—

On the western side of the ravine the opening which has

been made into the vein is about twenty-five feet in horizontal depth, exposing a clean breast of the mineral twenty feet in height above the water in the shaft at its foot, having the sectional structure above described, and averaging about four feet and eight inches in width ; the dip being vertical, as nearly as could be determined. The walls on both sides of the ravine are composed of a coarse-grained blue sandstone, such as is common in coal districts, weathering superficially to the depth of a few inches to a yellowish tint, which has led to its being inaccurately described as possessing in the mass a "yellowish green color."

Just at the foot of this cut into the west bank a shaft has been sunk thirty-four feet in depth. In this place the columnar or "pencil" structure of the mass was found to differ curiously from that observed elsewhere in being not strictly at right angles to the walls, but *inclined* about 20° from the right angle on a horizontal plane. The four vertical divisional planes were here very well defined—width of mineral four feet six inches. A *boring* was sometime since commenced at the bottom of this shaft, the derrick being still standing ; but the work was almost immediately suspended, and the whole depth reached was but forty feet from the surface at the bottom of the ravine. In reference to such borings I may suggest that it is extremely improbable that the dike-fissure will prove to be in all parts absolutely vertical in position, and that the chances are therefore very great that but little depth would be attained in such boring without passing entirely out of the vein itself into the country-rock, and that such borings as would be necessary to throw much valuable light upon the character of the formation in depth would probably have to be numerous and tedious, and might be more expensive, while far less satisfactory, than the sinking at once of a deep shaft, vertical or inclined as the case might be, through a vein of such a friable mineral.

Proceeding over towards the east side of the ravine, the commencement of another shaft appears, sunk to the depth of twenty-eight feet, filled, like the one above mentioned,

with water. Of the appearances encountered in sinking this shaft some statements were mentioned to me by Mr. J. Carville Stovin, the engineer under whose direction the work was executed, which appeared to me so interesting and important, that I requested Mr. Stovin to reduce them to a written statement, which writing I have appended hereto. (See Appendix A.) It may be briefly summed up as describing a detached fragment three and a half feet long of the north wall of the dike, found imbedded in the mineral twenty-four inches distant from said wall, and twenty-nine inches vertically below the *hiatus* in the wall, marking its point of detachment; while exact measurements both of itself and of the cavity left on removing the mineral which occupied its original space, showed that it had become entirely inverted in position during its descent. The pitch-like semi-fluidity, which I have contended for, is here strongly illustrated, by the small depth of descent of this mass of quartzose sandstone, through a material whose density could not have been half of its own, while its distance from the wall and inverted position suggest that at the time of its detachment the dough-like mass was still rising, or in some sort of motion at least, in the dike fissure.

Mr. Stovin's remarks about mutations of dip, illustrate also the remarks made above about the uncertainty of boring operations into this outcrop.

The opening made into the eastern bank of the ravine is forty feet in horizontal depth, exposing a breast of mineral twenty five feet in height, with a width of from fifty four to fifty five inches. I observed several small horses of the wall rock buried in the mineral. The divisional planes were here less distinct than elsewhere. The dip of the dike seemed a degree or two northerly from the vertical plane, though frequent slight irregularities of the walls prevented certainty on this point, rendering my measurements with the clinometer rather inconclusive.

CHEMICAL AND MINERALOGICAL DISCUSSION OF THIS SUBSTANCE.

This mineral, from a mineralogical point of view, is not only new in itself, but cannot be classed with any other substance heretofore known to chemists.

Its characters are as follows:

SPECIFIC GRAVITY.

This is variable, in consequence of the innumerable cleavages, rifts and fissures, which pervade every portion of the mass. Attempts were made to obtain uniform results by weighing it in small fragments, previously digested in alcohol, to expel air from it; its resistance to being wetted by water being similar to that of powdered rosin and the like substances; but as yet without success. For the purposes of calculation, I have adopted, for the present, a determination made by me upon a mass of the mineral, which gave 1.145, water being 1.000. According to this, one cubic inch of the mineral weighs 289 grains; one cubic foot weighs 71.39 lbs., avoirdupois, or 71 lbs. 6¼ oz.; 1 lb. avoirdupois, contains 24.19 cubic inches; one ton of 2,000 lbs. contains 28 cubic feet; one ton of 2,240 lbs. contains 31.37 cubic feet; one fathom cube, or 216 cubic feet, weighs 15,420¼ lbs. And the weight of mineral per fathom in length and depth, at the level of the bottom of the ravine, where its average width is at least 55 inches, is 11,779.5 lbs.

CHEMICAL COMPOSITION.

An organic analysis made under my direction by Dr. J. Maier, of the selected sample of the clean, brilliant columnar variety, gave

Carbon,	76.45.
Hydrogen,	7.83.
Oxygen, (with traces of Nitrogen)	13.46.
Ashes,	2.26.
	100.00

The ashes being deducted, this analysis gives for the pure mineral.

Carbon,	78.22
Hydrogen,	8.01
Oxygen (with Nitrogen),	13.77
	100.00

Sulphur is difficult to detect, being present as a mere trace.

A comparison here with the composition of some other minerals, with which this one has, from time to time, been supposed to be identical or similar, will be interesting :

	Carbon.	Hydrogen.	Oxygen.	Authority.
The Mineral from W. Va.,	78.22	8.01	13.77	Wurtz & Maier
Asphalt from Cuba,	82.67	9.14	8.19	Wetherill
" " (?)	81.60	9.60	8.90	Regnault
Albertite from N.Brunswick,	86.12	9.87	4.91	Wetherill
Bituminous Coal, mean of 67 analyses,	82.20	5.50	12.30	Bischof
Middletonite,(an English fossil resin found in Newcastle, & other Caking Coals,)	86.44	8.01	5.56	Johnston
Wood—the material forming the cells of all plants,	44.44	6.17	49.39	Payen

In order to make the comparison between these results more striking and satisfactory, I have reduced them all to the same standard, adopting as such standard the proportion of carbon contained in the Cuban asphalt by Wetherill's analysis.

		Hydrogen.	Oxygen.
For 82.67 of Carbon.	The Cuban Mineral contains,	9.14	8.19
	" N. B. " "	9.20	4.71
	" W. Va. " "	8.47	14.55
	" Bituminous Coal "	5.63	12.37
	" Middletonite "	7.66	5.32
	" Wood "	11.48	92.89

Little of a salient character is here apparent except the wide and irreconcilable differences in composition between our mineral and the other carbonaceous fossil matters tabulated. I shall postpone further remarks upon this highly interesting subject until a future time, when I hope to have made further analyses and examinations.

CHEMICAL BEHAVIOR.

It is in the behavior of this mineral with solvents, and chemical agents generally, that the most distinguishing peculiarities have been found, establishing it as a substance *sui generis*.

To the action of acids, alkalies and oxydating agents generally, it is strangely indifferent. Concentrated boiling nitric and muriatic acids, and even *aqua regia*, have no action whatever upon it; nor has boiling sulphuric acid, if somewhat diluted. Oil of vitriol, however, even in the cold, forms a brown solution. The most concentrated caustic alkaline solutions are totally without action upon it, and it may even be kept immersed in melted caustic potash of soda without material change.

This behavior with alkalies is very remarkable, and probably hitherto without precedent, in the case of a substance containing so much oxygen. From analogy, one would almost have expected it to saponify with alkalies.

Alcohol does not dissolve a trace of it. Naphtha, benzole and ether dissolve part of it, but with considerable slowness. Oil of turpentine gradually swells it up into a tar-like magma, and then dissolves most of it; but its true solvents are *chloroform* and *sulphuret of carbon*, each of which apparently dissolves nearly the whole mass of the mineral with great rapidity.

Experiments by Dr. Maier, made in comparison with albertite, upon their solubilities in these two liquids; equal weights of the minerals being repeatedly acted upon in the cold for a number of days by equal weights of the solvents; gave:—

	Albertite.	W. Va. Mineral.
Solubility in Chloroform, . .	22.65 per ct.	77 77 p. ct.
" Sulphuret of Carbon	37.40 "	81.76 "

My own experiments, however, have indicated a considerably greater degree of solubility than this for the W. Va. mineral. These, however, are not yet complete; though I may state confidently that I have succeeded in dissolving in sulphuret of carbon everything in our mineral

except the mineral matter (ash) and small traces of coaly matter.

BEHAVIOR WHEN HEATED.

When heated in the open air it endures a temperature far above that of the fusing point of the true asphalts (which is usually below, and never much above, the boiling point of water) without change; but when heated above 400° F. it begins to decrepitate, smoke and soften, behaving very much like a highly caking coal.

The vapor given off under these circumstances I have found to be chiefly water. There is little or no smell, such as all asphalts give out when heated, and I may remark that no odor is given out when this mineral is broken, rubbed or scraped, or even from a mass of it lying in hot sunshine. The argument deducible herefrom, that it never could have been produced by the atmospheric oxydation of any other substance, and more particularly of petroleum, will be appreciated by chemists, at least. If the heat is now raised still higher, empyreumatic vapors appear and indications of pasty fusions in the centre and lower portions of the mass, though not upon the upper surface, the fact being that under ordinary atmospheric pressure the material is incapable of fusion without decomposition, but that under a very slightly increased pressure, even such as is developed by its own pasty cohesion at the caking temperature, a pitchy semi-fusion takes place. While in this condition the resinous (or rather *vitreous*) character of the material may be made strongly apparent, for by a little dexterous manipulation these central semi-fused portions of the mass may be drawn out into long, delicate threads, like semi-fused glass, sugar, or sealing-wax. I do not think that this peculiar quality was ever observed before in any carbonaceous fossil matter, even in any of that class called "fossil resins." To my great surprise however I found that by exceedingly careful manipulation with albertite, I could thread it out in the same way, though with far greater difficulty than with our mineral.

This is not the place for a scientific treatise, and I must omit many of the most important facts and arguments on which I have based the conclusion that this West Virginia mineral is neither coal, nor asphalt, nor albertite, but that it is chemically and mineralogically distinct from all and either of these; and that it constitutes a new and peculiar mineral species. Let us, therefore, perpetuate in connection with it the name of the gentlemen whose enterprise and perseverence have been so prominent in bringing this interesting and immensely valuable mineral product before the public; thus doing a work which is important in a scientific as well as a practical point of view; and call this mineral GRAHAMITE.

In conclusion of this branch of the subject, I will say that I have been obliged to follow the lead of mineralogists generally, who classify under the head of mineral and fossil resins all homogeneous mineral substances of a carbonaceous nature which do not come under either of the heads of *coal*, or of *asphalt* or bitumen, and call this a "mineral resin," though it is clear to me that this class of fossil resins will have to be subdivided into several others, differing as much from each other as any of them differ from asphalts or coals. The whole subject, in fact, is as yet obscure.

II.—PRACTICAL CONSIDERATIONS.

In considering this mineral deposit from a practical point of view three questions press upon us. *First*, as to the *quantity* of material available to you; *Second*, as to its uniformity in point of *quality;* and *third*, as to the uses which may be devised for it.

As regards the quantity, the following considerations present themselves. Careful measurements of the length of the out-crop, so far as it has been exposed, were made by me; such measurements being of course on a horizontal plane. From the ravine, measuring easterly, this length

was found to be 1,220 feet; and measuring westerly, to the furthest point exhibiting unmistakable indications of the out-crop, it was 1,892 feet, making altogether with the width of the ravine (60 feet) 3,172 feet, nearly five-eighths of a mile.

The additional distance, on the westerly extension of the out-crop, to another opening in which evidence of a continuation of the out-crop is *said* to have been recognized; was 700 feet more; but I failed to convince myself of the existence of this evidence, and there was no time to re-open the pit or remove the water from it. From personal knowledge therefore, I cannot speak upon this point, and must assume, in my estimates, the length of out-crop actually observed by myself, namely five hundred and thirty fathoms.

The lateral thinning out of the vein is apparent at each extremity of the out-crop, the width at the most westerly opening being but eight inches, and at the most easterly but thirty inches; the usual lenticular form of the upper edge of such dike fissures being thus exemplified. As to any change of width of the dike, in depth, this is only to be inferred as highly probable from this very fact of a lateral thinning out; and consequent correspondence to the usual lenticular form; the explorations in depth being as yet too limited to afford us any criterion, unless we will accept those made for us by nature, in excavating the deep ravine; the results of which would indicate a very important *thickening up* in depth. As regards the lateral thinning out, I wish to remark that the considerable width still found at the extreme known out-crop easterly; namely, thirtyinches; indicates with considerable certainty that the longitudinal limit of the dike in this direction has not been ascertained; especially when it is considered that the horizontal elevation of this easterly opening, as shewn by the grade of the railroad, can be but a few feet above the ravine; and it would seem reasonable that a lateral thinning out of a dike from fifty four to thirty inches, requiring a distance of one thousand two hundred feet nearly horizontally, should

extend much further before reaching its vanishing point. Indications were found by me further on in this direction, of a continuation of the out-crop, obliterated by aqueous agency. I have judged it safe, however, to assume the average width of the dike, at the level of the ravine, throughout the length actually measured by me (530 fathoms), as forty inches. Calculating then on the basis of the specific gravity adopted as above 1.145, I make for each fathom in depth of this vein, at and below the level of the ravine, allowing for no thickening up, 4,540,429 lbs., or over 2,000 tons of the grahamite. If, however, my view is correct of the way in which this substance has been converted into the form of a dike, (namely by the action of heat upon strata of rock containing fossil matter, the pasty fusion of this fossil substance and partial gasefaction of itself and its contained water, with the uncontrollable expansion resulting therefrom, having opened a fissure through which the doughy mass, puffed up by bubbles of steam and other gases, escaped to the surface, or at least near enough to the surface to relieve the tension, and allow the steam and gases to escape gradually through the porous sandstone) it would follow that the thickness of the dike must increase in depth.

I may remark that this theory of mine seems the only one which reconciles an important difficulty besetting the other hypothesis, namely the interference of water, which must necessarily have filled a pre-existent fissure, and opposed an obstacle to the subsequent infiltration of another fluid, at least if the latter were impelled by gravity alone. The supposition that the fissure itself was formed simultaneously with, and by, a fluid mass, containing within itself its own elastic expansive force; escapes this difficulty. I may also point out that it is not necessary to suppose that the *heat* which produced this expansive force was the central heat of the earth; for it is more probable that both the steam or gases, and the heat which expanded them, arose from a spontaneous decomposition (of the nature of fermentation) in the bed of fossil matter from which the grahamite exuded.

Some will no doubt maintain these original beds of fossil matter to have been neither more nor less than the beds of bituminous coal which crop out on the banks of Oil Spring Run; and which, as I have shown, must underlie this locality. Many objections to this view occur to me. One is the general *negative* objection; which some may regard as weak; that no similar dike or exudation has ever yet been observed to proceed from a bed of bituminous coal.* Another much stronger one is that the coal beds at Petroleum are so highly charged with *sulphur* as to render them useless for most purposes; they containing seams of solid pyrites two inches in thickness; while grahamite is free from sulphur. Did space allow, other important arguments might be adduced; but I will content myself at present with pointing out that even if this supposition of the origin of the grahamite from coal-beds be correct, there is no reason for supposing that the depth of the dike-fissure, or extent of the mineral in depth, will be limited by such beds; for there is no reason for believing that the expansive force was not exerted downwards as well as upwards, and the disruption and injection of the mineral may have extended as far below as above the strata from which it was derived.

The only known case in which the analogies are marked enongh to justify a comparison, or give any reasonable clue to the probable character of the grahamite dike in depth, is that of the albertite of New Brunswick, a mineral which, though differing, as we have seen, greatly in chemical character, from grahamite, yet I believe has probably had geologically a similar origin. It is well known that the albertite vein, though very irregular, yet generally increases in thickness with the depth. The rocks in which the albertite is found are described, however, as being greatly contorted

*I do not overlook the extraordinary statement of Lesley made on the verbal authority of Prof. Hall, (see Lesley's Manual of Coal and its Topography, p. 165,) of a "leader of coal" proceeding from a coal bed downwards into a limestone quarry, and there spreading out into a layer; but cannot see how the meagre description we as yet have of this case can justify the drawing of any analogy.

and disturbed, and the parallelism with this case seems therefore a very unreliable one.

As to the mass of the grahamite which lies above the water level; that is, above the bottom of the ravine; I can as yet unfortunately give you no reliable estimate; as there was not time to run a level over the out-crop; and until a contour of the out-crop shall have been thus obtained, such an estimate would be based largely on conjecture. I must, therefore, decline making it at present.

UNIFORMITY OF QUALITY.

On this head, as my chemical analyses and examinations are not yet completed, I shall only say that their whole tendency is to indicate that, in chemical character and composition, there will be found to be, practically, no substantial variation in any portion of the vein.

UTILIZATION OF GRAHAMITE.

I.—*Manufacture of illuminating oils and gas.*

In my report of February last I recounted some experiments bearing upon these subjects, and subsequent investigations have led to little modification of the views there expressed. I shall, however, recount as briefly as possible my present impressions on this head. I opine that there can be no reasonable doubt that the proportion of oil that can be obtained from grahamite is greater than from any other known mineral occurring in large masses; but, at the same time, I believe the true method of manufacturing oil from this new and peculiar material would require retorts and machinery differing from those ordinarily in use. To a certain extent, the same remarks are applicable to the making of gas, but I fully believe that certain mixtures of this material with the poorer varieties of gas coal would give compositions of the highest value for this purpose.

But I have simply to add, that my investigations into

the nature of the grahamite have impressed me strongly, and ineradicably, with the conviction that the adoption of the policy of using up this material for any such purposes, as the production simply of light or heat, (except probably in some special cases which we shall come to below) would at some period in the near future, be greatly deplored. I should consider the following suppositious parallel as not in the least degree overwrought. Suppose a man were to find upon his land a bed of the finest and whitest porcelain-clay. Desiring to establish a brick-kiln, and finding the porcelain-clay conveniently at hand, he proceeds to make bricks of it; his neighbor tells him that he can find plenty of common brick-clay close at hand, and that if he will take a little trouble, go to a little expense, and wait a little time; and take some of his pure white clay to persons competent to ascertain its value for glazing paper and other fabrics, as a pigment for making fine earthenware, &c., his profits would in the end be immensely greater; and he were to reply that he knew nothing about these things, but that he knew it would make bricks, and would pay him in this way as much as he wanted, etc., etc.

It is thus that I wish simply to illustrate my view that the policy of converting the grahamite into illuminating agents would be what is called "Burning your candle at both ends."

II.—*Suggestions as to new uses of grahamite.*

For some weeks I have been engaged in my laboratory in laborious experiments in this new and highly interesting field of investigation; but the time has been inadequate for more than a partial examination of a few of the subjects proposed. Some of the most important I have been forced as yet altogether to neglect. The following is a condensed account of the results so far attained:—

The class of compositions which I have discovered of the crude grahamite with coal tar and with crude turpentine, and some other like substances, have been investigated to a considerable extent, and have been found by many experiments to have properties adapting them well for the follow-

ing purposes :—for a substitute for black sealing wax ; for a cement for sealing the corks of bottles, far superior to those now in use, inasmuch as neither alcohol, nor ammonia, nor the most concentrated caustic alkalies, nor acid liquids, would have the least softening or corroding action thereupon ; as a very superior roofing cement, as an immensely superior substitute for coal tar pitch, for making compositions with waste combustibles for a fuel for steam purposes, and for heating stills. I shall devote some little space to this latter object, considering it of paramount importance, so much so that I have occupied myself in translating, as an appendix to this report,* part of an elaborate article of fifty pages in a recent number of a French scientific journal, describing the production of such composition in France and Belgium, where these manufactures have reached a great development. The experiments I have made have justified me in believing that my composition of grahamite, with about ten per cent. of coal tar, would make with a washed culm of anthracite or Cumberland coal, such as is obtainable in certain districts here, in almost unlimited quantities for the mere cost of washing it and transporting it, compounded in the proportion of ten parts of culm to one of the cement, in a crushed form and pressed in hot moulds, would give an exceedingly hard, firm and durable cake, equal, for certain purposes, as for steam fire engines, alcohol and petroleum stills, &c., to more than double its weight of any coal in the market.

The washing of the culm in rapid sluices could be carried on in localities where water and other conditions are favorable with extreme rapidity and economy, and would ensure the almost total separation of sulphur and slate, and the conversion of the culm into a condition of great purity. In the case of anthracite culms, at least, the drying of the washed material, (which in the case of the porous soft bituminous culms mostly operated on in France and Belgium,

* Translation omitted in the publication of this Report, on account of its length.

is an important item of expense), would be very rapid and easy. The grahamite cement is very easily crushed, even in the hottest weather, which is not the case with pitch. The mixed composition after incorporation in the usual way, could be heated by permeating it throughout with superheated steam, after the plan recommended by Gruner: and then moulded into any required form. The composition which results in this way is very like that which might be produced by incorporating and cementing together the culm with *black sealing wax*. It would burn first with a great flame, enabling the heat to be raised rapidly and regulated easily, and would leave an intensely hot and powerfully radiating mass, composed of a most intimate mixture of coke and anthracite, enduring for a long time and burning entirely up, without leaving any ash of importance. There would be so little sulphur in such a fuel that the grate-bars would last indefinitely, and so little ash that the linings of the fire-place would not be injured; and the proportion of coal-tar is so small that little odor would be given out while burning. For domestic purposes even, I believe it would in certain cases be available, and would be preferred as a substitute for Cannel coal. The hottest sunshine would not cause it to cake, nor would the highest heat encountered in the fire-room of a steam-boiler or a still-house.

I have now in progress, experiments upon the manufacture of such coal-bricks on a small scale.

One of the cements of this class, made with coal tar, I have found highly adapted for japanning or enameling iron and other metals, giving an enamel which is very brilliant, and hard, while at the same time it will endure a high temperature without becoming adhesive or emitting an unpleasant odor, and protects the metallic surface not only against water, but against alkalies and acids. Cooking utensils, stove-pipes, boilers, sheet iron for roofing purposes, &c., may be mentioned as examples of cases in which these properties will come into play.

I have succeeded in devising an easy, simple and cheap mode of coating metallic surfaces with grahamite, which is

first, to brush the surface over with a thin varnish of coal-tar, then sprinkle or sift the powdered grahamite over it, until it is uniformly coated, then to bake the article in an oven heated to a sufficiently high temperature to drive off all the volatile portions of the coal-tar, which leaves a very lustrous, strongly adherent coating of a compound of the grahamite with a minute quantity of pitch.

The manufacture from the grahamite of brilliant translucent *varnishes* is an object which has occupied of late the greater part of my time. The concentrated solutions in oil of turpentine and some other solvents make fine varnishes, but in combining the mineral with linseed oil, into a complete solution, I have met with some difficulties. Ultimately, however, I discovered that if it be first mixed in powder with oil of turpentine, allowed to stand for a time, and then ground fine with boiled oil, a very fine transparent brown varnish results. The color of this varnish may be modified considerably by mixing other colors with it, and by laying it on over other colors, as in the samples already submitted to you, and it may be made the basis of paints of various colors which dry to very lustrous surfaces, as if subsequently varnished. Such mixtures as these are suitable for application to leather, cloth, paper, &c., for making such fabrics as "patent leathers," enameled cloths, and papers, &c., which will be flexible and waterproof.

The rapidly drying solutions in naptha, oil of turpentine, sulphuret of carbon, &c., I have found to be perfectly well adapted for water-proofing and stiffening paper, felt, &c., for hat bodies, book-binding, roofing-paper, &c.

By a method, somewhat similar to that described above for coating sheet metal, I have coated ordinary bricks, or rather filled their external pores, with fused grahamite, so that they may be immersed in water without absorbing it. Such bricks would, I believe, be valuable for some purposes.

My success has also been complete in preparing my new *lubricating compositions* with a basis of grahamite, instead of the soft bituminous coals I have hitherto used, and this

application, were there space to spare, I believe, I could show to be one of the most important of all.

A recurrence to former reports will show that there are many very important applications proposed by me which are not alluded to in the above, and which are now in course of investigation.

I must not close this report without mention of the magnificent forests of white oak and other valuable timber which clothe large portions of your property. As the probability is, that in consequence of the very fragile character of the mineral, your mines, as in the case of the Albert Mine in New Brunswick, will require much timber, this is a matter of no slight importance to you. I may also remark, as pertinent to this report, that any quantity of fine building stone in large blocks may be quarried out very conveniently and economically immediately alongside of your vein. I refer, of course, to the sandstone which constitutes the walls of the vein itself.

I remain, Gentlemen,

Most respectfully,

(Signed) HENRY WURTZ,

Analytical Chemist and General Scientific Expert.

No. 39 Nassau St., New York,
October 2*d*, 1865.

APPENDIX.

A.

CAIRO, RITCHIE COUNTY, WEST VIRGINIA, *July 27th*, 1865.

Professor HENRY WURTZ, New York,

DEAR SIR—In answer to your inquiries, I beg to state that in May last I sank a shaft in the lode of mineral known as the Ritchie Asphaltum, situated near McFarland's Run, in this County and State, for the purpose of testing the depth of the deposit.

The size of the shaft was ten feet in the clear, by the width of the lode, which was at at that point four feet eight inches.

The mineral was reached at a depth of five feet, and in sinking in it, at fourteen feet from the surface, a "Horse" (a fragment of rock so termed by miners) was reached, embedded in, and surrounded by the mineral, measuring three feet six inches long by one foot six inches deep, in the shape of a wedge, being six inches thick on one edge and, on the other, one inch.

It was found lying eighteen inches from the north-east side of the shaft, two feet five inches lower than the cavity from which it had fallen, and two feet south of it. This cavity by accurate measurement, I found to be precisely the same dimensions and shape as the "Horse," and to be filled with the mineral.

The thin end of the "Horse" being downwards (the reverse of its original position), and two feet from a plumb line, shows that in its descent it must have turned completely over.

We continued the sinking of the shaft, until driven out by a stream of water running from a fissure in the north side of the rock, at a depth of twenty-eight feet, too powerful to be reduced with tubs.

The mineral dipped north at an angle of seventy-eight degrees, for a distance of sixteen feet from the surface, and then reversed its dip at about the same angle.

The width of the Lode was not uniform, for, although it was not at any place less than at the start, at one point it measured six feet.

Respectfully Yours,

(Signed) J. CARVILLE STOVIN,

Mining and Civil Engineer.

NOTES.

The following Reports comprise, substantially, all that was known in regard to the vein of Ritchie Mineral Resin, prior to this time, several of which are referred to by Professor Wurtz, in his report. Some certificates are also added of the practical results obtained from the mineral in the production of oil and illuminating gas. It will be perceived, that Professor Wurtz's description of the vein differs materially, in many particulars, from these writers, especially as to the nature and origin of the mineral.

Extract from a late publication of the American News Company, descriptive of the oil region of W. Virginia.

RITCHIE COUNTY.

"Ritchie County is destined to be the centre of the oil producing territory in West Virginia. Although oil wells have not been as extensively developed in this county as they have been in Wood and Wirt Counties, there are certain unmistakable signs of the great richness of the region. Oil is found oozing from the ground in every part of the county, and the great *vein of crystallized Petroleum* recently found here, indicates how abundant must be the sources of supply beneath the surface of the earth. This vein was described by Professor Lesley, in a paper read before the American Philosophical Society in Philadelphia, but its statements were so remarkable that many scientific men distrusted the accuracy of the facts which had been communicated to Professor Lesley. But few additional notices of the vein have been made public; the proprietors of the property not having published anything on the subject, their object being apparently to develope the vein extensively themselves, and with that view they have been constructing a railroad fourteen miles long, and now nearly completed, to bring the products to market.

"We have availed of all the information that we have been able to obtain in regard to this singular mineral—so important in its bearing upon the character of the oil territory of West Virginia—and we give it now in full, even at the risk of some repetition, to show that the substantial facts concerning the vein are indisputable."

CRYSTALLIZED PETROLEUM.

"Sherwood's guide book of West Virginia, gives the following description of this vein: "Petroleum coal (as it is called), was recently discovered,

about eight miles from this station (Cairo), by Mr. Frederick Lemmon, in a small ravine between two steep hills (some three hundred feet high). The vein is about four and a half feet wide, and lays in a vertical position, extending to near the top of each of these hills. The oil is extracted directly from the coal, which so far has proven to be the richest coal (in oil) ever discovered—yielding one hundred and sixty gallons of crude oil of very superior quality, to one ton. Eminent, geologists have given their opinion that this coal is the Petroleum oil (called Rock oil) crystallized, and that at the same depth in the earth there is a vast reservoir of oil in its pure state."

Dr. Gesner, in his "Treatise on Petroleum Oil," says:

"A vein of bitumen has recently been discovered near Cairo, Parkersburg, Virginia. It is represented as a perpendicular mass, jutting out from the side of a hill two hundred and ninety feet. The strata of the hill are nearly horizontal, and they are cut at right angles by the continuous vein of the bituminous mineral, which is four feet eight inches in thickness. The position of the vein has been ascertained by the proprietors, who have sunk a shaft upon the line of the outcrop. A sensible description represents that it appears the hill has been split, a perpendicular chasm opened, and afterwards filled with asphaltum in a liquid state, and which has since hardened into a compact material. Coal never occurs in this manner, but is always interstratified with its associate sandstones, shales and fire clays. In all its geological relations and character, the Cairo deposit is like the asphaltum of Albert county, New Brunswick. The bitumen veins of Cuba have similar positions in the earth. The Cairo asphalt will no doubt be found valuable for the manufacture of oils. The samples received from this new mine are bright, glossy and brittle. They are rich in oil, and yield at the rate of one hundred and seventy gallons per ton. This bitumen is evidently Petroleum, which has at some remote period issued from the earth and been hardened by evaporation, and exposure to the oxygen of the atmosphere. The oil springs frequently occur in the immediate vicinity of the coal."

Extract from a Report of Charles S. Richardson, Civil and Mining Engineer, incidentally referring to the Ritchie Petroleum Vein.

"In the adjoining estate has been discovered one of the most extraordinary mineral deposits ever known in this country, a deposit of so strange and unusual a character, that if its presence was only once generally known, it would attract the attention of scientific men from all parts of the Union. This is nothing more or less than a perfectly true "Lode" running nearly east and west, filled in with solid crystallized Petroleum or mineral oil—not coal, for it will melt in a ladle like pitch, neither is it asphaltum, for its fracture and lustre differs materially from that substance. The lode is 4 feet 6 inches wide, and has a vertical dip. There is no admixture of any other earthy substance with the mineral as far as the excavations have been extended. It appears to be divided into two parts by an irregular vertical joint, one portion being granulated, and the other fibrous or somewhat

flaky. The walls are regular, smooth and well defined in contrast with those on the north side.

"Shoad pits have been sunk at intervals in both directions for over a mile across the mountains on the back of the lode, by which its course has been found to be regular.

"A trial shaft was next sunk on its dip to the depth of 37 feet; and there appeared to be no diminution in the quantity or quality of the mineral.

"From an analysis made by a Philadelphia chemist, I gather the following particulars of the properties of this mineral: that it produces 169 gallons of crude oil to the ton, which on refiniug only loses fifteen per cent; that is to say 100 gallons of crude produces 85 gallons of burning oil, showing that as a material for the production of hydro-carbon, it is of very great value."

PROFESSOR LESLEY'S REPORT.

The following extracts are from a very elaborate report published in the printed proceedings of the American Philosophical Society:

"Professor J. P. Lesley communicated a notice of a remarkable coal mine or Asphalt vein, cutting the horizontal coal measures of Ritchie County, West Virginia.

"Mr. Lesley said, that through the kindness of R. H. Gratz, Esq., of Philadelphia, a descriptive letter and a map had been submitted to him, which exhibited geological facts of more than ordinary interest to those who are studying the origin of the rock oil deposits of the West.

"The curious points of the case require careful investigation; but there seems to be no good reason to doubt the essential correctness of the statement.

"The coal-beds of West Virginia pass horizontally through the prong-like ridges from valley to valley. Some of these ridges run as narrow on top and as regular as railroad embankments, for three or four miles, and in nearly straight lines, between equally straight vales terminating bowl-shaped against some cross ridge.

"It is across such vales and dividing ridges, that the Asphaltum vein of Ritchie county makes a straight course, two thousand three hundred and twenty-three feet long, as at first measured, but since then traced in both directions still further, so that now it is known to extend more than two-thirds of a mile.' .Explorations beyond this line have failed to find it. Its outcrop, four feet ten inches thick, was discovered crossing a ravine fifty feet wide at the bottom, and rising on each side with slopes of nearly forty-five degrees. On one of these hillsides, at a height of ninety feet, the outcrop showed the same thickness, but at a height of one hundred and eighty-five feet, it was found to be but two feet six inches thick. It is not certain that this diminution is in a vertical direction; it may be lateral; for the slope between the ninety and the hundred and eighty five feet levels is more gradual, especially upon the western side.

"In the bottom of the ravine, a vertical shaft was sunk to a depth of thirty-four feet upon the vein, which continued uniformly four feet ten inches thick, the asphaltum being filled in pure and clear, without the least admixture of earthy or foreign ingredients, between the smooth and almost perfectly vertical walls of yellowish-greenish sandstone, lying in horizontal layers, through which this gash or fault was once no doubt an open fissure, communicating with some reservoir of coal oil which still, it may be, lies beneath it undisturbed. The most interesting part of the phenomenon for structural geologists is this gash.

"The substance which fills this gash-fault in the coal measures of North-West Virginia, resembles the glossiest, fattest caking coals, and has a decidedly prismatic structure; breaks up into pencils, with flat lustrous faces and sharp edges, but the faces not set at any fixed angles to each other, so that the effect upon the eye is rather that of a fibrous than of a prismatic structure. At the same time there is not the slightest appearance of layers, but the aspect of complete uniformity or homogeneity. Pieces are taken out, it seems, a foot in diameter; and that portion of one of these pieces which I have, shows a plain face on one side, as if it had encountered one of the walls, and is covered with a delicate film of a dead black substance like charcoal dust, which is probably the dust of the vein substance itself.

"Pieces lying at the surface of the ground are said to yield as much oil as specimens taken out six or eight feet down. By the ordinary dry distillation the substance is reported to yield as much oil as the Albert coal. By a different process, the first and only trial, at which six hundred pounds in one charge was used, forty-four and a half gallons of superior oil was obtained.

"By an assay made by Mr. B. S. Lyman of Philadelphia, (the amount of hydro-carbon soluble in benzole being about one half of the whole) the volatile matter (mean of two assays) was 47.11 per cent., coke (52.71. 53.07) 52.89, ash (1.65, 1.81) 1.73.

"*There seems to be no escape from the conclusion that the substance filling this vertical vein is a product of the gradual oxydation of coal oil once filling the open fissure. It is not impossible, therefore, that the lower regions of the fissure are still filled with liquid oil;* and that we may see in this instance an illustration of the condition of things far beneath the surface of the coal oil regions of Western Pennsylvania and Eastern Ohio.

"The vast quantities of oil delivered by the flowing, the blowing and the spouting wells require fissures of this kind, either never opened up clear to the surface, or else once opened and now reclosed, or else filled in with detritus. The different depths at which closely neighboring wells begin to spout or to flow, oblige us to imagine similar fissures at oblique angles.

"If Sterry Hunt's hypothesis be accepted, that the corniferous limestone is the mother rock of the oil, such fissures become still more needful to bring the oil to the surface, from the vast depths at which the corniferous limestone underlies the true coal measures."

GEOLOGICAL AND MINERALOGICAL REPORT OF PROFESSOR W. F. ROBERTS.

"McFarland's Run is a noted locality in the great oil formation of West Virginia. A vertical crevice filled with crystallized or solidified petroleum in a direct line is found crossing the deep cut gorges of small streams, and rising to the summits of the ridges bounding them.

"In the month of June last I made a special visit to this part of the country for the express purpose of making a full and particular examination of this phenomenon, if I may so term it, in geology. I traveled from Cairo station on the Parkersburg branch of the Baltimore and Ohio railroad, over a road then in process of grading by the Ritchie Coal Oil Company for a branch railroad to connect their property containing this solidified petroleum deposit with the main road, and during this journey, I could not detect anything remarkable or different in the general geological structure of the country to that shown in some of the other oil producing sections in the West Virginia "oil belts" with the exception of an opening made on the line of the road on the Ritchie Coal Oil Company lands near McFarland's run, where there is a vein of a peculiar substance, resembling somewhat some of the most glossy kinds of bituminous coal.

"Having secured specimens, I continued round the point of the hill, and entered a deep cut gorge formed by a small run, a branch of McFarland's, and at about half the distance from the head of the run, I reached a shaft sunk upon the line of a fissure, or crevice in the strata, in this peculiar kind of substance, of the same quality and characteristics, of the specimen taken from the place above referred to. This crevice is a vertical one, four feet four inches wide, and the strata adjoining it on both sides is horizontal, a common micaceous sandstone, in their plys of a yellowish green color, of the carboniferous formation.

"The shaft, I was informed, was sunk thirty-four feet and the crevice continued of the same width downward. It was perfectly filled with solidified Petroleum. The course of the dike or opening in the horizontal coal strata runs in a course S. 75½ W. and to N. 75½ E. which I traced in both directions. I traced the openings which had been made in the line of this crevice up the steep sided ridges and over their summits, and I found from the specimens visible at the several shafts, that the solidified or crystallized Petroleum rose to the surface, or nearly so, in all places. The west hill bounding the ravine where the dike crossed over, I judged to be about three hundred feet above the level of the ravine where the deep pit was sunk. The east hill-side is about two hundred feet above the ravine. Developments of shafting have been made, proving the continuation of this Petroleum-filled crevice in solidified form, more than one mile in a direct line, and bounded by a flat or horizontal formation of shales and sandstones of the middle carboniferous series, similar in all respects to other ridges in oil-producing sections of West Virginia. The walls of the crevice are perfectly smooth and regular, and exceedingly well defined.

"The crystallized petroleum has a fibrous structure. It is very glossy in appearance, of the color of the purest specimens of richest and fattest bituminous gas coal. It melts under heat readily, and runs like pitch. This peculiar mineral has been wrongly called "Asphaltum" Its fracture, lustre, and general appearance are altogether foreign to the Albert coal, or to any other mineral of that class. By experiments made upon this crystallized petroleum it has yielded from one hundred and forty to one hundred and sixty-nine gallons of oil to the ton.

"How deep this solidified material may continue down beneath the level of the valleys is not determined. The crevice may get much wider and still be filled with this solid Petroleum. One thing is, however, certain, that it has its source from some immense subterranean lake or large opening in the strata of the lower measures of liquid Petroleum. The numerous gas and oil springs closely contiguous and ranging with this dike show that there are beneath the surface large cavities filled with oil.

"At the junction of the streams which meet in the Southern part of this tract is excellent boring territory, room enough for a large number of oil wells. The geological structure of the strata shows great disturbance underneath the surface, and here may be seen the pure oil oozing out from the oints of the rocks, and gas springs bubbling up on the surface of the water, throwing off oil in rainbow colored tints. The nature of the formation, the geological structure of the strata and the contour of the surface, as well as other indications, show that this tract of land is located in an exceedingly rich Petroleum section of country, where proper developments should be prosecuted without delay. One thing more may with propriety be mentioned, that this solidified Petroleum in all places where it has been shafted upon is free from any deleterous foreign substance. It is as pure as oil generally is found in the best oil producing localities of West Virginia."

REPORT OF NELSON BEALL, ESQ.

"The extensive deposit of mineral bitumen in West Virginia is situated in Ritchie county, between the North and South forks of Hughes river, about eight miles in a direct line from Cairo station on the Northwest Virginia Railroad, thirty-one miles east of Parkersburg, and three hundred and forty-eight miles by rail from Baltimore. When the mineral was first discovered, samples were sent to the Eastern cities for chemical analysis to determine its character and quality, the results of which were highly favorable. To approximate as to the quantity of the deposit, an experienced miner was sent to explore the extent of the vein, when it was ascertained it could be traced in a straight line N. 72° W. at a few feet below the surface, about four thousand five hundred feet horizontally, rising from the lowest point of the ravine where it was first opened, westerly three hundred and ninety-five feet to the top of the hill downwards in that direction, and also eastwardly over the point of the ridge one hundred and eighty-four feet elevation. The vein lies in a precisely vertical position between a horizontal soft sandstone rock. Its width at the bottom is four feet and eight inches, whilst at an elevation of about one hundred and sixty feet on the east ridge it is only about three feet wide, thus indicating the probability that it gradu-

ally widens as it goes downwards. The miner proceeded to sink a shaft in the vein, carrying it down thirty four feet below the lowest point of the ravine when a spring of mineral water was struck, and further operations suspended as being unnecessary. There was no evidence of a limit to its depth or the slightest indicatien of any stratification appearing to show that it was not a solid mass of one kind of material. A superior quality of oil is gathered from the surface of the water of this spring, when during the dry seasons of the year, it collects in standing pools in the valley. A sample of this oil was sent to the eminent chemist, Dr. T. Ogden Doremus, of New York. The presence of this Petroleum would seem to establish the truth of the theory that the vein itself is crystallized Petroleum, and that its original source of supply still exists in a liquid form in a reservoir of great extent and at a vast depth below the surface of the earth. More than two hundred thousand tons of this mineral can be mined above water level, at a cost not exceeding one dollar per ton on a production of one hundred tons per day. An additional one dollar per ton will place it in the cars of the Baltimore and Ohio Railroad at Cairo, whence it can be sent to Baltimore, or to Parkersburg on the Ohio river.

"Thirty-two barrels of this mineral were sent North last spring, and nearly all of it was retorted, a large portion being put through on a commercial scale in the City of Brooklyn, and resulted as follows:

Yield of one ton.		
Illuminating Gas, 7,000 feet	@ $20,	$14 00
140 Gallons Oil,	@ 60,	84 00
17 Bushels Coke,	@ 12,	2 04
Whole product in value from one ton,		$100,04

"The above results were obtained through an improved process of using superheated steam for the distillation of the oil, by which method all the incondensible gases can be saved and utilized for purposes of illumination in towns and cities. The illuminating power of the gas according to the experiments by Professor Bogart at the Metropolitan Gas Works, was 47 candle illuminating power, the standard gas of that company being 16 candles. The specific gravity of the oil was 29½°, and its value was computed to be one-third more than ordinary Petroleum. It yielded in refining, the unsually large quantity of thirty-one pounds paraffine to the ton of bitumen.

"The foregoing description of the vein can be relied upon as being as near the facts as one can arrive at. I give them from my own personal knowledge, having been originally the pioneer in the exploration of this remarkable geological phenomenon.

I append to this the analysis of the mineral, by Professor R. Ogden Doremus, of New York." NELSON BEALL.

ANALYSIS.

New York, 13th Decr., 1864.

"The sample of coal brought me for an ultimate analysis, affords, on examination, the following results:—100 parts of Ritchie coal dried at 212°F, yields of—

Carbon,	75.96.
Oxygen,	12 75.
Nitrogen,	00.69.
Hydrogen,	8.45.
Ash,	2.15.
	100.00,

100 parts of Ash yields of—

Silicic Acid,	64.749.
Per Oxide Iron,	32.190.
Carbonate Lime,	2.325.
Carbonate of Potassa,	0.734.
	99.998.

I have the honor to remain, your obedient servant,

(*Signed*) R. ODGEN DOREMUS, M.D.,

Prof. Chemistry N. Y. Free Academy, and
" " N. Y. Bellevue Hosp. Med. Coll.

From the Petroleum Recorder and Oil Trade Review.

CAIRO, Ritchie County, West Virginia, January, 22d, 1865.

"Having been requested to give my opinion of the value of lands in Ritchie County, West Virginia, as oil territory, I proceed to do so with much pleasure, premising that, as I believe their chief value is derived from their proximity to the Great Vertical Asphaltum, or Bitumen Lode, of this county (owned by a company now engaged in developing it, by the construction of a railroad fourteen miles long, and of which I have the honor to be the engineer), I preface my remarks with an extract from a report I have made upon that mineral vein.

"The Great Vertical Asphaltum or Bitumen Lode of Ritchie County, West Virginia, when generally known, will be considered one of the wonders of the world, both on account of its singular vertical position, as well as its being the largest deposit of that mineral at present discovered. The Lode is situated upon McFarlands Run, which is a small tributary of the south fork of Hughes River, and eight miles in an air line running south four degrees west from Cairo Station, on the Parkersburg branch of the Baltimore and Ohio Railway, making it about twenty-eight miles southeast from Parkersburg. The mineral is found lying in a vertical fissure, in a yellow sandstone rock, and is about five feet wide, divided into two distinct parts by an irregular joint or seam, one portion of it being fibrous, the other granulated; both, however, being entirely free from impurity or admixture of any kind. The Lode outcrops on McFarland's Run, where it was at first discovered, and runs from thence in a line south, seventy-six degrees east, and north seventy-six degrees west, for a distance at present known to be one and a half miles. The mountains on the two sides of the Run rise with a gradual slope four hundred feet high, and the fissure in the rock, which is entirely filled with the mineral, runs right through it and to within from five to eight feet of the top surface. A shaft was sunk in the lowest part of the Run to test the depth of the deposit; but, after going down nearly forty feet, water came in from a fissure in the rock, causing a suspension of the work, but enough was seen to show its entire uniformity.

"Of course there are numerous theories broached to account for the production of so singular a deposit, but the only reasonable one appears to be that it is the result of the oxydation of the liquid pretroleum that has been

forced up and injected into this fissure by some violent convulsion of nature. If this be the correct theory, and I firmly believe it to be so, beneath this substance there must still exist petroleum yet in a liquid state, and such being granted, it would not be unreasonable to conjecture that the petroleum discoveries in the neigborhood of the Burning Springs, &c., on the Little Kanawha River and lying *south*, as well as those lying on Bull and Cow Creeks, &c., near the Ohio River, lying *north* of this lode, vast and extensive as they undoubtedly are, will sink into insignificance with those of this County, and prove to be but the mere drippings from the fountain head. I am not altogether singular in this opinion, for some of the shrewdest and most practical operators are rapidly securing lands adjacent to the lode, and steam engines are already on their way to test thoroughly the matter. There is now almost ready for opening a branch railway from Cairo to the mine running through the Asphaltum Company's tract of eight thousand acres, and as the mineral has been proved to contain one hundred and forty gallons of oil to the ton, even should the lode be no longer or deeper than at present known, there is enough of the mineral to yield one million barrels of petroleum.

"Now, as will be perceived by this report, the lode has been traced for one and a half miles, but it by no means follows, as a matter of course, that it should not be found to extend further, even although surface signs of it are wanting, for in its forced journey upward it would of course meet with rocks of various degrees of hardness, and break through only where it met with the least resistance. My opinion is, therefore, after the most deliberate study and observation, that, like the Albert coal of the British Provinces, below the surface it will be found both longer and of a greater width. But should this be an error there can be no doubt but that liquid petroleum will be found to exist in most of the lands in the neighborhood of the Asphaltum Lode, for it is well known that mother earth carefully conceals in her bosom her most valuable treasures, and only openly displays to the eyes of mankind just enough to excite his cupidity and to stimulate him to search for her hidden stores; and as this chasm in the rocks, visible for one and a half miles, and over four hundred feet high, is filled with petroleum, once in a liquid state, and injected from the vast reservoir below, and which must underlie the whole region, we can judge, *ex pede Herculem*, how enormous must be the substance of which that visible can be but the shadow."

J. CARVILLE STOVIN, *Mining and Civil Engineer.*

Certificate of John Howarth, Patentee of the Process for the "Distillation of Oils by the Use of Super-heated Steam."

BOSTON, December 31st, 1864.

I have made a continued series of experiments with the "Crystallized Petroleum," from Ritchie County, West Virginia.

These experiments were conducted in three different sized Retorts, which were charged with 180 pounds, 325 pounds, and 600 pounds each, respectively.

The following products were obtained from an average of seventy separate charges from one ton of the Crystallized Petroleum, of 2,240 pounds.

Crude Oil of specific gravity of 28° to 30°.	138 gallons.
Illuminating Gas of 47 Candle light, as per Mr. Bogart's experiments	4,000 to 7,200 feet.
Coke of a superior quality	1,120 pounds.

The oil is very superior, it refines very easily; yielding to chemical treatment and distillation, with the same facility as the oils from the Petroleum Wells.

The Crude oil gives by distillation and purification, the following results:

100 gallons of Crude Oil will give specific gravity, 40° burning oil .	48 gallons.
Specific gravity, 28° Lubricating oil, ...	32 "

The Lubricating oil contains 8 per cent. of its weight of paraffine, which gives it priority (over all other *coals, shales, &c.*) for its rich yield in paraffine, and will give it a marked character in the markets as a lubricator, over other oils.

In my experiments made at Washington, during the past summer, I found that *the Gas* from *one Ton of Rock Oil Petroleum,* when the heats of Retorts were kept at a desirable temperature for the largest quantity of oil, was *united* with its *due equivalent* of *hydrogen* gas, to bring its illuminating standard to 18 candle light, gave 10,000 feet, this result would be increased when the temperature of Retorts was increased.

A ton of the Crystallized Petroleum, when used wholly for gas purposes, and united with a due equivalent of hydrogen gas, will give over *thirty thousand feet* of 18 candle gas, and I have no doubt the Crystallized Petroleum will be found to be of far greater value to our present Gas Companies, for enriching their gas, than any of the foreign Cannel Coals, now imported for this purpose.

JOHN HOWARTH.

The foregoing statements of Mr. Howarth, in regard to the products of Ritchie Coal, I can fully confirm from a series of experiments made at my Oil Works, under my observation, and as evidence of confidence in the result, am now about putting in twenty-four retorts at my works in Salem, which will require about thirty-six hundred tons of coal per annum, and which will supply me with fourteen hundred gallons of oil per day.

BOSTON, December 31, 1864. E. SECCOMB.

Certificate of J. C. Burdick, an Experienced Refiner of Petroleum Oils.

This is to certify that I have made various experiments in the City of Brooklyn, N. Y., in the distillation of Oil and Gas from Crystallized Petroleum, from Ritchie County, West Virginia, extending over a period of several months, and the average results of the trials made, in charges varying from 107 pounds to 212 pounds, were as follows:

From one Ton, 2,240 pounds	140 gallons oil.
" " "	7,000 feet gas.
" " "	1,113 pounds coke.

All of these products were of a very superior quality.

BROOKLYN, January 2, 1865. JARED C. BURDICK.

Report of Photometric Experiments, made by A. L. Bogart, with the Ritchie Rock Oil Gas.

OFFICE 592 BROADWAY, NEW YORK,
March 10th, 1864.

I have made a series of Photometric experiments, with an illuminating gas, the product of a distillation from coal taken from the Crystallized Rock Oil Mine, Ritchie County, West Virginia, and respectfully submit the following report:

FIRST EXPERIMENT.—The Ritchie Rock Oil Gas with three feet fish-tail burner, against English standard sperm candle.

Time.	Pressure.	Sperm Consumed, 5 m.	Gas Consumed per hour.	First Candle Power.
5 m.	4-10.	12 grains.	1 452.	8.80-100.

120: 8.80: : 144: Second Candle power 10.54.
1452: 1054: : 5: Third " " 36.22.

SECOND EXPERIMENT.—Metropolitan Gas Company's Gas against the Ritchie Rock Oil Gas. Two feet fish-tail burners at each end of Photometer bar, 140 inches apart.

Time.	Pressure.	Consumed of Metropolitan Gas.	Consumed of Ritchie Coal Gas.	Difference of Light in favor of Ritchie Coal Gas.
5 m.	6-10.	219-1000 cubic ft.	119-1000 cubic feet.	2.80=100 to 1.

Had the Ritchie Gas burned an equal amount, the difference in the illuminating would have been as per example.

119: 280: : 219: 5.15-100 to 1.

THIRD EXPERIMENT.—Ritchie against Metropolitan Coal Gas Burners, three feet fish-tail at each end of bar, 140 inches apart.

Time.	Pressure.	Consumed of Metropolitan Gas.	Consumed of Ritchie Coal Gas.	Difference of Light in favor of Ritchie Coal Gas.
5 m.	6-10	304-1000 cubic ft.	151-1000 cubic feet.	1.87-100 to 1.

Difference in favor of the Ritchie burning an equal quantity as per example.

151: 187: : 304=3.76-100 to 1.

FOURTH EXPERIMENT.—Ritchie Gas, with three feet fish-tail Burner, against Metropolitan Gas, with a standard Argand Burner, lights 140 inches apart.

Time.	Consumed Metropolitan Gas. } Pressure, 6-10.	Consumed Ritchie Gas. } Pressure, 10-10.	Difference of Light in favor of Ritchie.
5 m.	365-1000 cubic feet.	207-1000 cubic feet.	1.60-100 to 1.

Difference in favor of Ritchie Gas Burning, same amount.

207 : 160 : : 365 : 2.82-100 to 1.

REMARKS.—In testing the illuminating power of the Ritchie coal gas, made by your new process, it will be seen, by an examination of the several experiments as are herewith reported, that we compared it with the gas made by the Metropolitan Gas Company, which is reputed to be equal, if not superior, to any now made in this city for public use. Other tests were also made in comparison with an English standard sperm candle. The experiments were made with a "Bunsen" Photometer, in a room expressly fitted and furnished with every appliance known to experts for this purpose.

The standard candle power of a gas, is the light emitted by its combustion when the gas is burnt through an Argant burner with a seven inch chimney, at the rate of five cubic feet per hour, and compared with the light given by a sperm candle consuming at the rate of one hundred and twenty grains per hour, or two grains per minute. For all ordinary gases, the Argand burner, having fifteen holes, each hole being the twenty-fourth part of an inch in diameter, is used. With this burner a perfect combustion could not be made with the rich gases produced from the Ritchie coal. An Argand can be made, however, to consume perfectly five or six feet of these gases, by increasing the number and decreasing the size of the holes, and until this is done, or some other method adopted, a perfect standard test of their illuminating power cannot be obtained.

Experiments prove, as will be observed by comparing the result of those incorporated in this report, that the same proportionate amount of illuminating power is not obtained in the use of small sized burners, say from one to four feet per hour, and the weaker gases suffer the most in comparison. Hence the necessity of making five cubic feet the standard test. Under these circumstances you will observe that these experiments afford you but an approximate value of the real illuminating power of the gases made under your process.

The largest burner we were able to use and render the carbon perfectly incandescent, consumed but $2\frac{4}{10}\frac{1}{0}\frac{2}{6}$ cubic feet per hour.

From the result of these experiments the illuminating power of the Ritchie rock oil gas has proven three times that of the ordinary gas now used in this city.

Very respectfully,

Your obedient servant,

A. L. BOGART,

Analytical Chemist and Gas Engineer.

Experiment with the Ritchie Mineral, at the Manhattan Gas Light Company's Works.

The experiment described in the following certificate shows remarkable results, though not as favorable as the preceding, owing to a want of experience as to the degree of heat best adapted for retorting this peculiar mineral —the charge being worked off in one hour and twenty minutes, applying the usual working heat which requires four hours for the carbonization of ordinary coals,—thereby diminishing, by this rapid treatment the illuminating power of the gas and the density of the coke. Besides the gas experimented with by Mr. Bogart, was produced by the method of using super-heated steam, in the process of making oil, the volatile products being expelled at a low temperature, the gas proves to be much richer in illuminating power.

OFFICE MANHATTAN GAS LIGHT CO.
New York, July 19th, 1865.

I have examined the sample of coal from Ritchie County, W. Virginia, with a view of ascertaining its value as a gas coal, and have obtained the following results:

One hundred pounds was carbonized at an ordinary working heat; it produced, in one hour and twenty minutes, 670 cubic feet of gas, or at the rate of 15,000 cubic feet per ton of 2,240 lbs.

The illuminating power of the gas, with a fish-tail burner burning at the rate of three cubic feet per hour, was equal to 14.07 candles. This would give for a consumption of five cubic feet, with the same burner, an illuminating power of 23.5 candles, each candle burning at the rate of 120 grains of sperm per hour.

With a bats-wing burner, burning at the rate of five cubic feet per hour, the candle power was 28.7 candles.

The yield of coke per ton of 2,240 lbs. would be 44 bushels, weighing 1,056, lbs. Thirty-three per cent. of the coke, however, is very fine, or is what is technically known as "breeze."

The coke makes a very clean, hot fire, leaving but little clinker or ashes.

When in the second charge, gas was extracted from the coal, at the rate of 12,000 cubic feet per ton, the illuminating power (with a bats-wing burner burning at the rate of five cubic feet per hour), was 29.5 candles.

There was not a sufficient quantity of coal to enable me to determine what degree of heat was best adapted ior the proper carbonization of the coal, neither could I, for the same reason, determine practically the amount of sulphur contained therein.

The analysis of the coal is as follows:

Volatile matter,	53.5
Fixed Carbon,	44.5
Ash	2.0
	100.0

Very respectfully,

JOS. A. SABBATON.