THE OIL REGIONS OF PENNSYLVANIA.

[For the Scientific American.]

GEOLOGICAL FORMATION.

That section of Western Pennsylvania known as the Oil Regions, is exceedingly simple in its geological compositlon. Like much of Western Virginia, Eastern and Southern Ohio, Southern Indiana, and Northern Kentucky, its surface was once a nearly level table-land, at least 400 feet higher than its principal river beds are to-day. In the course of ages, however, those rivers and their tributaries wore their channels down to the present depth, leaving the country on each side cut up into ridges or steep hills, with more or less extensive plateaus on their summits. Near the Ohio, as it passes between West Virginia and the State of Ohio, the stratification is almost horizontal, indicating that the hills have not been upheaved by the internal forces of the earth, but left exposed by the action of water. Further, it is noticeable at numerous points on both sides, that near the river the summits are narrowed almost to a ridge, while further inland they grow broader; the action of tributary streams being there less powerful in the work of erosion or denudation. The valleys and bottoms are also less deep and wide as we recede rom the banks of the great river.

The general course of the Alleghany lies nearly 100 miles more to the eastward than that of the Ohio in the section referred to. In the former case the rocks have an inclination of a few degrees (never exceeding ten) to the westward. There is this further difference between the two States. In West Virginia, the principal rocks are *clay shales* of different colors, alternating with coal-beds, some of these being above and others below the river level. In Western Pennsylvania the formations consist of *shales* and *sand-stones*, arranged in alternate layers, with boulder drift deposited pretty generally over the surface of the country. This drift consists of water-worn blocks of gneiss, quartz, and other primitive rocks, none of which belong to the hills or mountains in that part of the country.

Passing through the drift, the first layer of rocks consists of sandstone, rather coarse in texture, sparkling, of a grey or nearly white color, and falling from the summits to the bases of the hills in huge quadrangular blocks, exceedingly tempting to the eye of the practical man. These lapses of the upper rocks are caused by the soft shales underneath being carried away by the action of wind and water, so as to undermine the overhanging crags, whose threatening aspect imparts a degree of sublimity to much of the scenery of the Alleghany.

The sandstone is known as the Vergent or Portage variety, though said to differ slightly from that stone as found in the State of New York. Like the shales it contains numerous fossiliferous remains, the imprints of stems, leaves, bark and berries of trees, casts of the shells of various marine creatures, chiefly bivalves. The writer has observed the faces of many of the slabs of rock thus covered, and traces of such remains are said to become still more frequent as one descends the terraces leading from the Alleghany valley to Lake Erie. On the border of French Creek, above these fossil-beds, is a layer of a coarse yellow sandstone, used for building purposes. The vergent sandstone contains more or less lime in its composition. The shales also contain abundant organic remains, and are known to be highly butuminous in places. The soil formed from the decomposition of these rocks is a stiff clay, but probably more productive than it has received credit for being, the difficulty in cultivating it arising from the number of huge boulders of grey sandstone covering the slopes.

It will thus be seen that the sandstones ordinarily spoken of by well diggers as first, second, third, and fourth, are really the second, third, fourth, and fifth. These men make no account of the layer of each lying above the valley, having got the impression that the heights were formed by upheaval.

FIRST DISCOVERY.

The first discoveries of oil were made in the bed of sandstone commonly termed the first rock. To reach this deposit, less than 100 feet had to be bored; but the yield, through pretty abundant at first, soon began to show symptoms of exhaustion, and ultimately the wells ran dry. At this time a hue and cry was propagated all over the country that the oil discovery was an egregious humbug, if not a swindle. In 1860 and 1861 several wells were carried down to the second (really the third) sand-rock, the borings being usually made from 250 to 300 feet in depth. This layer yielded better than the former, the springs holding out from six months to two years. Even a few of those wells are still paying expenses, though having decreased decidedly from their former products.

In 1863 and last year, attempts were made to reach the third sandstone, at various depths, from 450 to 550 feet, according to elevation. The success which attended works that had been run down to that depth on Oil Creek has led to a pretty general movement in the same direction this spring, on the part of those owners of wells which had given out. Some hundreds of them are now being bored and reamed out to the depth of 550 feet in the bottoms, and 600 to 750 on upper ravines and hill-sides. Along the Alleghany, for some miles above Oil City, this experiment has proved a failure in almost every instance, while on Oil Creek it is as commonly successful.

DEEPENING THE WELLS.

Near Titusville a well is now being deepened, the design, it is understood, being to run it through the *fourth* sand-rock to the depth of 1200 or even 1500 feet, so as to reach the tempting liquid anyhow. The world will regard the results of this experiment with much interest.

There is a general *upward* movement, as well as a downward one, the present season. All the ravines entering Oil Creek, Pithole Creek, Cherry Run, &c., are being punctured by the borers; even derricks are erecting on the precipitous hill-sides and the table-lands above. In some cases oil has been reached, and even good springs been tapped there, but those in the second rock will probably be found to resemble the springs found in the first rock (so called) in the summer of 1859.

The belief is now very general among oil men, that the uplands will yield as freely as the river-bottoms, provided the veins are struck, which, so far, is rather a matter of *luck* than the result of scientific research. If the theory laid down above, as to the formation of the hills, be accepted, there will appear every reason short of actual experiments to suppose that as good results can be brought about in one locality as in another.

Per contra, the discovery of oil on the *hills* will call for the introduction of heavier machinery to pump it from the bottom of the deeper wells which must be constructed. The sinking of these, too, will require not only a heavier outlay in itself, but relatively in proportion to the greater depth reached. Some experts consider that *flowing* wells need not be expected at elevations of 300 or 400 feet above the river-beds; though this seems only matter of conjecture rather than of knowledge based upon ascertained facts.

FUTURE PROSPECTS.

But one of two things is certain, namely; either a cessation finally in that natural product, or such an extension of it, by means of new wells and discoveries of oil in other localities, as to reduce the boring for it to a level common with all branches of industry. Before that time it is likely enough to undergo depressions as well as elevations—to experience conditions in which the article will be called a drug, and those engaged in producing it *fools*, by the outside world. Persons who visit the oil regions, especially the numerous creeks and rivers which discharge their waters into the Alleghany, Oil Creek, French Creek, &c., are struck with the immense number of derricks arising in all directions this year. They stand along the headwaters of Cherry Run like the masts of vessels, as closely by each other in places as they can be erected and find room to stand. It is no difficult matter to stand in one's step, and count from 50 to 100 within half a mile. On one farm near the head of Pithole Creek, at least 250 feet above the Alleghany, the writer was informed that a single company had engaged to sink 25 wells the present season.

INTERFERENCE.

The mutual effect upon each other of wells so closely sunk, cannot be calculated in advance. The great Philips well, which at one time yielded nearly 4000 barrels per day, was weakened and finally overcome as a flowing well, by the sinking of another within 75 feet. The theory usually entertained is, that the force of the gas being spent in two directions, it is unable to give due effect to either, and resort must be had to the pumps. In other cases, it is said that the sound of gas and water escaping through a well has been heard in an adjoining one, proving that both had tapped a common source. At the same time this rule is not universal. The writer was informed by an experienced borer, that his flowing spring of 200 barrels a day was sought to be reached by a neighbor at two points, the first eleven, and the second only seventeen feet from his own well. Numbers two and three were sunk fully as deep as number one, but the former failed to get a drop of oil, while the latter was rewarded with only one barrel per day, and both wells were abandoned.

MACHINERY AND COST.

In accordance with the changes taking place in and about the wells this spring, more powerful machinery is being introduced. The engines used to bore and pump were at first contemptibly small, the boilers being barely 24 inches in diameter, and 5 or 6 feet in length, with a capacity of 7 or 8 horse-power; no boilers of less than 30 inches diameter are now called for, and those of 35 inches are largely in demand, with from 12 to 15 horse-power. The derricks are mostly erected 50 feet high, or 15 feet taller than formerly, an upper story being added to many of the old ones.

The cost of boring wells has done more than keep pace with the greater depth reached and heavier machinery used. At first about $1,500 sufficed to erect the derrick, pay for the engine and fixtures, together with the labor of doing the work. No individual or company need *now* expect to put down a well in the bottoms for less than $7,500, unless using an engine already working on the ground, while on the uplands the cost will run up to $10,000, according to situation. A good-sized engine delivered on the ground costs about $2,500.

EFFECT OF BLOWERS.

To cooperate with nature in raising oil, the *blower* has recently been introduced with good success in some wells, which had not only ceased to flow, but given out under the pumps. This arrangement is very simple. It consists of a long iron pipe, usually about one inch in diameter, made in sections and screwed together, after which it is let down into the well. The lower end is made to turn *upward*. Through this pipe a strong current of air is forced down, which, on reaching the bottom, assists materially the gas in forcing up the oil and water. The famous old Sherman well, which used to flow 600 barrels of oil daily, and more recently yielded one-third of that quantity in obedience to the pump, now gives between 60 and 70 barrels with the aid of the "blower," after having been several months dry. Among others, the Noble well, directly across Oil Creek, having also dried up, is being refitted with a blower, from which good results are expected.

FARMING IN THE OIL REGION.

There is no likelihood of any agricultural operations going on this season in the oil regions. Farmers prefer to pocket from $2,000 to $5,000 per acre for their fields and migrate elsewhere, to plowing, and sowing, and reaping, among the boulders covering the surface of their grounds. To the writer it has long appeared certain, that by boring distances of from 12 to 18 inches with a *plow-share*, a very large flow of oil could certainly be reached, through potatoes, turnips, cabbages, beans, peas, and other garden products. One thousand gardeners at the East, some of whom can hardly make ends meet there, could enrich themselves by raising "truck" and even milk in Petrolia. The only obstacle would arise from the difficulty of leasing land, but this could be overcome.

MECHANICS IN DEMAND.

Blacksmiths, wood-choppers, and engineers are still in demand; the first to sharpen tools. Their wages vary from $2 per day up to twice that figure, with board and lodging; but he who goes out to Oildom in such capacity, must make up his mind to forego most of the comforts and enjoyments of civilized life, excepting a brisk appetite and good digestion, for Petrolia is eminently a healthy country, in spite of the coarse fare, indifferent shelter, and (often) lack of cleanliness prevailing among its population. All other visitors must expect with terrible

roads, plain fare, hard beds, and extravagant charges. Such is Petrolia.

UTILIZATION OF THE GAS.

Of *economy*, as usually practised in older countries, Petrolia has as yet known little. Until wood commanded from $10 to $12 per cord, and coal more than $20 per ton (it is now about $28), no attempt was made to convert the columns of gas escaping from the wells into an agent for driving the engines. This has, however, at last been accomplished with the most complete success on the Watson flats, below Titusville, where half a dozen pumps are driven by gas. The writer has heard no complaints about the capturing of this (hitherto) fugitive slave interfering with the productiveness of any of the wells. All visitors, as well as the men concerned about these works, expressed their admiration at this beautiful arrangement, so simple and economical in itself. Of the still superfluous carbureted hydrogen, one well manager, or proprietor, took sufficient from it to heat up his premises, by letting it into the stove and using it for culinary purposes.

On the other hand, the same experiment made last winter at one of the wells ("the Yankee"), on Cherry Run, is said to have resulted in reducing its productive power nearly two-thirds, or from about 60 to 25 barrels per day, by checking the escape of gas from the tube, and thus weakening its power to expel the oil. So seriously was this felt that the attempt was abandoned, and the flow of oil returned to its former amount. The owners of that well have leased a large number of lots to other interests, and since that trial they have made it a point to insert a clause in every lease, prohibiting the lessees from thus appropriating the gas on the premises.

Other discoveries, and recent changes made in the oil regions, the writer proposes to point out in another article.

FACTS ABOUT PEAT.

We have received from Messrs. Leavitt & Hunnewell, of 49 Congress street, Boston, Mass., a large pamphlet of 120 pages, which is a compilation of facts in relation to peat as an article of fuel. The following selections will give a good idea of the contents, and may interest some of our readers:—

FORMATION OF PEAT BOGS.

It is found, on examination, to be composed of vegetal matters; generally mosses, and species of aquatic plants in different stages of decomposition: and from this circumstance, as well as from the general appearance of the localities where peat abounds, its formation is generally accounted for somewhat as follows:—

Where pools of water collect, the soil under which is retentive, the water, not being absorbed, stagnates, and, provided the surface evaporation is not great, forms a pond. Around the borders of this pond various kinds of aquatic plants—sedges, rushes, &c. —soon make their appearance, and, by reproduction, gradually creep in towards the center, until the whole surface becomes covered. In process of time, when several races of these have succeeded one another, and mud and slime have accumulated at the roots and around the decaying stems, a spongy mass results, which is well calculated for the propagation of mosses.

Under a constant supply of moisture, these various species thrive, continue to luxuriate, and, by progressive growth, ultimately give rise to a composition in every respect similar to that constituting the various peat-bogs.

That some such natural process has been the cause of the production of heat, appears from its composition, and the localities in which it is found. These are chiefly in the temperate zones, where evaporation is slow. and the atmosphere is generally more or less saturated with humidity.

It may be conceived, that, in the origin of these formations, the retention of the water, whether from rain or springs, in extensive basins, led at first to the development of vegetal growth in the manner above indicated; and that, the necessary moisture being supplied in abundance, the accumulation became so rapid, that ultimately the surface assumed the appearance of land; and, as decomposition proceeded, a degree of solidity was given to the mass, equal to the support of denser bodies, such as shrubby plants.

It would appear that this organic growth was rarely restricted to the original basin, but that, as it accumulated, it spread over adjacent land, which in time became a morass.

Evidence conclusive of this exists in the fact, that whole forests of almost every description, such as oaks, firs, ash, birch, yew, willow, &c., have been overwhelmed in its gradual but steady advancement, and are found in all positions at the bottom of peat-bogs.

Generally this formation is met with in climates of a moist nature, in level countries, where imperfect natural drainage exists; although it is found in considerable beds in upland districts.

In mountainous districts, in addition to the imperviousness of the rock to the moisture, the constant formation of clouds upon those elevated regions favors the growth of the mosses and plants, the decomposition of which contributes to the increase annually of these deposits.

In America, peat is rarely found in these elevated positions, and then only in small quantities: but in Great Britain, and on the Continent, the deposits are numerous and extensive; and, as a general thing, they are esteemed of superior quality for fuel. Instances of this kind are frequent in Ireland, Scotland, Northern Germany and Holland, while others are found high up the Alps, in the Vosges and in the Jura.

METHODS OF PREPARATION FOR FUEL.

Where peat-bogs abound, and the inhabitants make use of it as fuel for domestic purposes, the process of preparation is very simple, and has varied little, if any, for ages.

The surface layer, or turf, which contains the living plants and their roots in the natural state, is stripped off to the depth of six, nine, or twelve inches.

The material is then cut with a kind of spade known as the slane, which has a blade about eighteen inches long by six inches broad, with a wing on the side, bent upwards at right angles to the blade, so as to form, with the latter, two sides of a square.

With this the peat is cut in long square masses, and laid upon the sward, where it spontaneously loses its water, partly by infiltration into the soil, and partly by evaporation.

After these blocks are partially dried, having been turned at intervals so as to expose the different sides to the sun and air, they are found to be reduced very materially both in size and weight, and to have acquired a good degree of consistency. They are then piled or cobbled up in heaps on the sward, care being taken to dispose them in such manner as will admit of a free circulation of air through the mass; and, after remaining exposed in this manner for some weeks, they are generally removed to some airy place of shelter, where the process of drying may continue, and the fuel be convenient of access when the season arrives for its consumption.

Such is the mode generally adopted, both in this and other countries, when the peat is of sufficient density and elasticity to bear being so handled without breaking.

When, however, the material is brittle, and will not admit of being used in this way, it is dug out with ordinary spades and shovels, and all roots, sticks, stones, and such like bodies, picked out. It is then spread upon the greensward, or, in some cases, upon suitable ground covered with a layer of straw or hay, in a mass, to the depth of eight to eighteen inches, with a breadth of about four or five feet, and to such lengths as may suit the convenience of the laborers. In this condition it is brought to a homogeneous mixture by harrowing, raking, working over with hoes, spades, or other tools, or by the treading of men or animals, until it is of about the consistency of stiff mortar, when the surface and sides are smoothed, and it is left in this state to drain and dry.

After remaining for one, two, or three days, according to the weather, and acquiring a somewhat greater degree of consistency, it is rendered still more compact by beating the surface with shovels, spades, or paddles adapted for the purpose; and in some parts of Europe this is accomplished by treading, which is there mostly done by women and children, who attach flat boards, about six inches broad and twelve to fourteen inches long, to their feet.

By this time the peat has acquired such solidity that it will bear a person's weight upon it without sinking.

The surface is then marked off, or cut by the sharp edge of a board, or a large knife adapted for the purpose, to the depth of one or two inches, into squares; the sides of which are from three to six inches, according to the size desired for the fuel when it shall have been thoroughly dried, and ready for use.

In this condition it is left to dry; and, as evaporation proceeds, the squares contract, the cuttings gradually open down to the bottom, and the mass is separated into blocks of somewhat uniform size, standing on end, and of pyramidal form, the base being still quite moist, and covering nearly the whole surface, while the top, which has been most exposed to air and sun, has contracted, to nearly or quite one-quarter of its original size, and is dry and hard. The blocks are then turned once or twice, in order to give a more uniform exposure; and, at the expiration of a few days of good weather, they are in condition to be removed, and stored for use; care being taken however, that it be in a sheltered but airy location, and that it be not too closely packed; for, notwithstanding it may have the appearance of being quite dry, it will be found to have still retained a very considerable amount of water, and, if too closely packed, is liable to a fermentative process, which injures the quality, and has been known to raise the temperature so high as to cause spontaneous combustion.

RECENT PEAT.

Professor Lyell, in his "Principles of Geology," says,—"It is a curious and well-ascertained fact, that many of the mosses (bogs) of the North of Europe occupy the place of immense forests of pine and oak, which have, many of them, disappeared within the historical era. Such changes are brought about by the fall of trees, and the stagnation of water caused by their trunks and branches obstructing the free drainage of the atmospheric waters, and giving rise to a marsh. In a warm climate, such decayed timber would immediately be removed by insects or by putrefaction; but, in the cold temperature now prevailing in our latitudes, many examples are recorded of marshes originating in this source. Thus, in Mar Forest, in Aberdeenshire, large trunks of Scotch fir, which had fallen from age and decay, were soon immured in peat formed partly out of their perishing leaves and branches, and in part from the growth of other plants. We also learn that the overthrow of a forest by a storm, about the middle of the seventeenth century, gave rise to a peat-moss, near Lochbroom, in Ross-shire, where, in less than half a century after the fall of the trees, the inhabitants dug peat. Dr. Walker mentions a similar change, when, in the year 1756, the whole Wood of Drumlaurig was overset by the wind. Such events explain the occurrence, both in Britain and on the Continent, of mosses where the trees are all broken within two or three feet of the original surface, and where their trunks all lie in the same direction.

"Nothing is more common than the occurrence of buried trees at the bottom of the Irish peat-mosses, as also in most of those of England, France, and Holland; and they have been so often observed with parts of their trunks standing erect, and with their roots fixed to the sub-soil, that no doubt can be entertained of their having generally grown on the spot. They consist, for the most part, of the fir, the oak, and the birch. Where the sub-soil is clay, the remains of oak are the most abundant; where sand is the substratum, fir prevails.

"In the Marsh of Curragh, in the Isle of Man, vast trees are discovered standing firm on their roots, though at the depth of eighteen or twenty feet below the surface. The leaves and fruit of each species are frequently found immersed along with the parent trees; as, for example, the leaves and acorns of the oak, the cones and leaves of the fir, and the nuts of the hazel.

"The durability of pine-wood, which in the Scotch peat-mosses exceeds that of the birch and oak, is due to the great quantity of turpentine which it contains, and which is so abundant that the fir-wood from bogs is used by the country people, in parts of Scotland, in the place of candles. Such resinous plants, observes Dr. Macculloch, as fir, would produce a fatter coal than oak, because the resin itself is converted into bitumen.

"In Hatfield moss, which appears clearly to have been a forest eighteen hundred years ago, fir-trees have been found ninety feet long, and sold for masts