breeds, which closely resemble the buffalo, the head and robes being quite equal, if not superior. Besides the breeding of absolutely thoroughbred buffalo, it is the plan to breed "from selected native or imported Scotch cattle a half-breed that will supply the demand for a perfect buffalo-head; a robe equal in all respects, if not superior, to the best now in the market; and a beef possessing the venison-like taste and nutritious qualities of the pure stock of the plains." The three strong points of the new animal are to be his noble head, his pelt, and his flesh.

AS HAVING A BEARING on the value of the work of the U. S. fish commission, we are glad to give the following figures. The aggregate catch of shad on the Atlantic coast the present year is the largest that has been made since 1872. The Potomac River fisheries show an increase of nearly 100,000 shad over last season. The largest proportion of the catch in the Chesapeake and its tributaries is, however, made by the pound nets in salt or brackish water. The Hudson River was first stocked by the U. S. fish commission with the young of the Atlantic salmon in the spring of 1884. Well-grown sea-run fish weighing from ten to sixteen pounds are being taken at the Troy dam, and there is every reason to expect that the salmon will be permanently established in the Hudson River and its tributaries. The rainbow or California trout which was first introduced on the east coast in 1879, and which has been planted in a number of streams in Pennsylvania, Virginia, Tennessee, Alabama, and North Carolina in the last two or three years, is now being taken by anglers in various localities. Quite a number of specimens have recently been taken in the Holston River in the vicinity of Marion, Va., some of them measuring over eighteen inches in length. This stream was stocked with yearling California trout in the spring of 1884.

PETROLEUM AND NATURAL GAS AS FOUND IN OHIO.

THE introduction of natural gas into Pittsburg and other towns of western Pennsylvania within the last two years, and the marked advantages to manufacturing industries accruing therefrom, have made a great impression on surrounding districts, and especially upon Ohio.

In the last-named state an eager search for the new fuel has been entered upon, and is still going forward at a number of the industrial centres. As a result, many interesting geological facts have been brought to light, some of which have great economic importance. Additions have also been made to our knowledge of petroleum and natural gas. A few of the leading facts that have been established in this connection, and some of the conclusions that seem warranted from them, will be given here.

1. Petroleum and natural gas do not need to be considered apart: they are products of the same strata. Every gas-rock is an oil-rock as well, and all rocks that contain oil contain gas also. These products are often intimately associated in the reservoirs, appearing simultaneously when the rock is pierced by the drill; but in some cases gas only is produced.

When, however, the rock which produces so-called dry gas is followed far enough, it is always found to contain oil as well. Generally the two products are at no great remove from each other. Their separation seems referable to geological structure, as will presently be shown, the gas occupying the higher portions of the common reservoir.

2. The origin of petroleum and gas from organic matter as opposed to the so-called chemical or inorganic theories of their origin, is strongly supported by the facts here furnished. The chemical theories require temperatures high enough to leave ineffaceable marks on the strata from which the petroleum is derived; but no such marks are found in the borings of even the deepest Ohio wells, and some of these wells nearly exhaust the paleozoic scale. There are no igneous intrusions, and no disturbances whatever of the sort that accompany metamorphic action; but from top to bottom the series is normal in all respects, affected only by light dips and low folds.

It is also found that different strata in the same series contain petroleum and gas of different characters: in other words, the character of the product is definitely related to the character of the receptacle and of the strata directly associated therewith.

3. Petroleum exists as such in Ohio rocks. It is actual, and not merely potential. There is no proof that it is now forming. For any thing that appears, the stock contained in the rocks may have been formed contemporaneously with the beds that contain it. There is, it is true, in addition to this petroleum content, a considerable percentage of organic matter in some formations, as in the black shale, which can be converted into gas and oil by destructive distillation, and, so far as we know, by this process alone; but, as shown in the preceding section, there is nothing whatever to lead us to believe that the process of destructive dis-

tillation has ever been applied, least of all that it is being applied, to Ohio rocks. The claim is sometimes made for an agency of manufacture called 'spontaneous distillation;' but, so far as can be seen, this is a human invention, and not a natural process. Instead of furnishing an explanation, it begs the question at issue. Destructive distillation we know, and chemical decomposition, in its various phases, we know; but what is 'spontaneous distillation' as an agency for the formation of petroleum from organic matter?

4. The wide diffusion of petroleum and its derivatives is well illustrated by the facts recently developed in Ohio. It is a mistaken view that these substances are of rare occurrence. Valuable accumulations, of course, are rare, but their presence in measurable quantity is well-nigh universal in the paleozoic rocks of the Mississippi valley. Prof. N. W. Lord, chemist of the Ohio geological survey, has recently examined the black shale of the state with this reference. He finds in normal shale more than two-tenths of one per cent of heavy oil. This amount he has weighed, but, from the nature of the processes he was obliged to use, he is certain that he has not obtained all that was present in the shale. Petroleum as such, or compounds derived from petroleum, as asphaltic grains or films, are also found in all of our principal limestones. Dr. Hunt reported, a number of years ago, more than four per cent of petroleum, or bituminous matter which was undoubtedly derived from petroleum, in the Niagara limestone of Bridgeport, near Chicago. These figures can be duplicated in some phases of the upper Silurian limestones of Ohio.

5. The amount of petroleum stored in the rocks is seen to be enormous. Take the figures of Professor Lord, already quoted. Two-tenths of one per cent of petroleum in a rock represents more than twenty thousand barrels to the square mile for every foot in depth. But the black shale is on its outcrop three hundred feet in thickness, and in the interior the formation is from four to six times as thick. Three hundred feet of shale would contain, to the square mile, six million barrels of petroleum. Suppose the rate given above is too high: divide it by two, by four, by eight, and even the last result would show nearly as much petroleum as has ever been taken from any square mile of the Pennsylvania fields.

6. The old dispute as to whether petroleum is mainly derived from bituminous shales or bituminous limestones has become 'a past issue,' largely through recent developments in Ohio. No question relating to the geology of petroleum has been more warmly or ably discussed. As so often happens, both sides were right in their main affirmations, and both were wrong in what they denied. The petroleum and gas of eastern Ohio, and, by the same token, of western Pennsylvania and New York, are unquestionably derived from the great shale formation of Devonian and subcarboniferous age that underlies this territory, and they are stored in sandstones overlying or interstratified with these shales. The petroleum and gas of north-western Ohio are as certainly derived from good normal Trenton limestone that is at least five hundred feet thick, and underneath which no shales are known to exist.

That the oil and gas of eastern Ohio are derived from the shales, and not from the sandstones in which they are now found, becomes evident from the fact already noted; viz., that the underlying shales always contain a measurable amount of petroleum, while the Berea grit, which is the main Ohio reservoir, is everywhere, in outcrop and under deepest cover, a clean, sharp sandstone, remarkably free from organic remains of all description. *Ex nihilo, nihil fit.* If the source of oil were to be found in a sandstone containing organic remains, the Logan conglomerate (Pocono) should be a much more productive rock than the Berea grit. It is ten times as thick, and several times as coarse, and contains a profusion of sandstone casts of tree-trunks; but it is underlain with light-colored instead of black shale. It is the great salt-water sand of eastern Ohio, and is but rarely petroliferous on any considerable scale.

7. The gas and oil derived from bituminous shales are found to differ in composition, to some extent, from limestone oil and gas. In particular, the latter are never free from small percentages of sulphur compounds, none of which appear in the gas or oil of the shale. These compounds advertise themselves wherever they occur, and make the most noticeable characteristic of these oils.

The composition of Pittsburg gas is reported as very variable, even from the same well. All the observations on the limestone gas of Ohio show it to be remarkably steady and uniform.

Mr. S. A. Ford, chemist of the Edgar Thompson steel-works, gives a number of important facts concerning the composition of Pennsylvania gas in a recent number of the *American manufacturer* (Natural gas supplement, April, 1886). He gives the composition of what he counts average Pittsburg gas, as follows:—

Pittsburg gas.

Hydrogen	22.00
Marsh-gas	67.00
Ethylic hydride	5.00
Olefiant gas	1.00
Nitrogen	3.00
Carbonic acid	0.60
Carbonic oxide	0.60
Oxygen	0.80

The composition of the limestone gas of northwestern Ohio (Findlay gas) is quite different, as appears from the following analysis made by Prof. C. C. Howard of Columbus, for the Ohio survey: —

Findlay gas.

Hydrogen	2.18
Marsh-gas	92.60
Olefiant gas	0.31
Nitrogen	3.61
Carbonic acid	0.50
Carbonic oxide	0.26
Oxygen	0.34
Hydrogen sulphide	0.20

There are 125.8 grains of sulphur in 100 cubic feet of this gas.

Analyses made a year apart show that the constitution of the gas has remained practically unchanged during this interval.

The reference of the gas or oil of shales to limestones, or of the gas or oil of limestones to shales, is seen, in the light of these facts, to be inadmissible. The two series are distinct. These facts also furnish an additional argument against the chemical theory of origin of the petroleum series. Such an origin would seem to insure identity of composition to at least the oils of a single district.

8. Gas and oil are accumulated in more or less porous rocks that act as reservoirs. These reservoirs may be continuous with the source, or they may be distinct. In the case of limestone oil and gas, the first of these conditions is found. The stocks that are held in sandstones come under the second head.

While there are many horizons of gas and oil in Ohio rocks, covering the three main elements of the series, — viz., sandstone, limestone, and shale, — there are two of paramount importance; viz., the Trenton limestone and the Berea grit. The Trenton limestone nowhere rises to the surface in Ohio. It was first discovered to be a storehouse of high-pressure gas at Findlay in November, 1884. It is now yielding both gas and oil in large amount in at least three counties of northern Ohio, — viz., Hancock, Allen, and Wood, — and it promises to become by far the most important source of these products in the state. The section by which it is reached in the productive districts is as follows: —

200′–400′	*Limestone*, upper Silurian	Waterlime. Niagara. Clinton.
800′–1000′	*Shale*, mainly lower Silurian	Medina. Hudson River. Utica.
500′	*Trenton limestone*	Gas and oil accumulated in uppermost beds, often at upper boundary, and never more than 40 feet below.

The main production of this new horizon has, so far, been limited to points where its upper boundary ranges between three hundred and five hundred feet below sea-level. It has been reached in at least a hundred drill-holes within the last year, through a district which would include from eight thousand to ten thousand square miles. The composition is shown by the following analyses of the gas-rock of Findlay and the oil-rock of Lima, which are one and the same thing.

	Findlay.	Lima.
Carbonate of lime	47.05	52.66
Carbonate of magnesia	33.38	37.53
Residue, mainly siliceous	11.73	4.15

The rock is highly crystalline and porous, and the greatest porosity seems to belong to the most productive portions.

The Berea grit becomes petroliferous from the moment that it takes cover. The oil of Mecca and of Grafton is derived almost from the outcrop of the rock. In the first instance, indeed, it has only the bowlder clay for a roof; and, in the second, there are but from forty to sixty feet of Berea and Cuyahoga shale above it. It is only where it descends deeper, however, that it holds large stocks of gas or oil. The lightest cover under which large accumulation has been found in Ohio is six hundred feet, while in the Macksburg field, which is at present the main centre of production from this horizon, the stratum is at least twelve hundred feet below the valley level. The section found here is approximately as follows: —

Coal-measure strata	500′–800′
Conglomerate measures	200′–300′
Logan conglomerate (salt-water sand)	200′
Cuyahoga shale	300′
Berea shale	30′–50′
Berea grit	5′–25′

There are two distinct oil-sands in the coal-measures, and one in the conglomerate group in this section, in addition to the Berea.

These reservoirs, whether sandstone or limestone, are permeable, and often communicate freely through considerable space. The gas-wells of Findlay are quite unequal in production, ranging between one hundred thousand and twelve million cubic feet per day; but when shut in, all show the same pressure. This pressure is now a little less than four hundred pounds to the square inch. It is called the rock-pressure. A large well, when shut in, comes up to this point quickly, and a small well slowly, but all get to the

same point. The flow of the well seems to depend on the porosity of its immediate reservoir. Free communication is also shown in adjacent portions of the Berea grit, but there is nothing to indicate an indefinite or universal permeability. The changes in the grain and thickness of the stratum would naturally divide it into basins approximately distinct from each other.

9. Every oil-rock has a more or less impervious cover, generally fine-grained shale. To constitute an oil-group, three elements are essential; viz., a source, a reservoir, and a cover. The first and second may coalesce, as has been already shown, but the third must be distinct and well-characterized. First in order of importance, as a matter of course, is the source, but so generally is petroleum distributed through the rocks of our scale, that its presence may almost be taken for granted. Practically, the character of the overlying mass is a chief factor. Almost any rock of the Ohio series, if covered by a heavy mass of shale, shows oil or gas when reached by the drill. The Utica, Hudson River, and Medina shales cover the oil-bearing Trenton limestone: the Berea and Cuyahoga shales overlie the petroliferous Berea grit. The corniferous limestone, which is covered by the heavy deposit of the Ohio shale, ought by this order to be also a source of oil. It has been found to be so in Canada, but not yet in Ohio.

10. One other factor is found to be of prime importance in oil and gas production; viz., geological structure. Source, reservoir, and cover may each be complete in itself, and yet no accumulation of either product may result. Illustrations are found in both of the main Ohio horizons.

For many thousand square miles, the relations of the several elements of the series that has proved petroliferous in north-western Ohio are absolutely identical. A hundred wells have now been drilled in this field, and the records of the series traversed are monotonous repetitions of one another. From one you can learn all. Not only is there the same order, the same thickness, the same color, but there is substantially the same chemical constitution of each stratum throughout its entire extent. In all cases there is some accumulation of gas and oil, but generally slight, at the top of the Trenton limestone.

But at one point, as the drill has now shown, in a drift-covered plain, where all the facts were hopelessly obscured to other reading, the steepest dip known in Ohio rocks has been brought to light. Two terraces of Trenton limestone, with their superincumbent strata, are made known to us, one of which is about 310 feet (306, 312, 314) below tide, and the other of which is about 475 feet below. The slope of 165 feet that connects them occupies a little more than a half-mile in breadth. What effect does this marked structural feature seem to have on oil or gas accumulation? On the upper terrace, every well that has been drilled has found a fair supply of gas without oil. The wells of the lower terrace are all oil-wells, though containing considerable gas also. And what of the wells on the slope? That depends on what part of the slope they occupy. On the upper edge, from 330 feet below tide to 350 below, there is a belt of the most remarkable and valuable gas-wells ever struck in the state. The famous Karg well produces, by the lowest measurement, 12,000,000 cubic feet per day. The Trenton limestone was found in it 347 feet below tide. In the next well in order of production, the surface of the limestone was 350 feet, and in the third well 330 feet, below the sea.

Seven wells have been drilled on the slope in which the limestone is between 330 and 350 feet below tide. One of the number is a small producer, but the smallest of the six remaining wells yields more than 1,000,000 cubic feet of gas per day.

Descending the slope still farther, we come to a group of three wells, in which the Trenton limestone lies respectively 394, 403, and 405 feet below tide. All of them were vigorous gas-wells when first drilled, but they also yielded more or less oil from the first. Little by little, however, their character has been changed, oil and salt water overpowering the gas, until now almost their sole value is found in the oil that they produce.

The facts above given come from the Findlay field. Similar facts are found at other centres of production of Trenton oil and gas.

Equally satisfactory testimony as to the all-important influence of structure on gas and oil production is supplied by the facts of the Berea grit. This remarkable stratum, the first persistent sandstone to be reached in ascending the geological scale of the state, has a bold outcrop from the Ohio valley to Lake Erie, and thence eastwards toward Pennsylvania. Scores of quarries are located along this outcrop, from which is derived some of the most valuable building-stone of the country. The stratum dips gently down from its outcrops at the rate of from fifteen to thirty feet to the mile. It holds its continuity underneath the whole of eastern Ohio. Its area in this state, therefore, is not less than twenty thousand square miles. Slight rolls traverse it, breaking up the monotony of its descent. These rolls, or interruptions of dip, connect themselves at once with gas and oil accumulation. A single example, and the one most carefully worked out, must suffice.

In the vicinity of Macksburg, north of Marietta, the light south-eastward dip of the strata is found to be interrupted, and for nearly a mile a terrace-like structure prevails. This is masked, it is true, by the immense erosion which the country has suffered, and only comes into view when the best-known elements of the exposed section as coal-seams are followed by means of the level. All of the strata ever reached by the drill, as well as all that are above the surface, are equally affected by this structural irregularity.

But this terrace is an oil-field, and has been for twenty years. Oil was first found here in shallow wells, from two hundred to three hundred feet deep in the upper Mahoning sandstone. But adventurous drillers, one after another, struck new sources of oil. A second oil-sand, and a third, were discovered at five hundred and seven hundred feet respectively. Finally the drill was sunk deeper still, until, at thirteen hundred feet, the Berea grit was found, holding a stock of oil large enough to make the Macksburg field for the first time a factor in the general market. It has produced as many as three thousand barrels per day since then, and is now yielding twenty-five hundred barrels per day.

But the shallow and the deep productive wells are alike definitely limited to the terrace that has been described. In other words, four oil-sandstones become productive in the same area when the structure is found favorable. That they do not communicate with each other is evident from the fact that the oils which they severally contain differ from each other in gravity, in color, and in chemical constitution.

The depth of the Berea grit below sea-level in the terrace is 735 feet. Of twenty-four wells, occupying four square miles in this field, sixteen reach the Berea between 733 and 737 feet, and six are found by their records to be exactly 735 feet.

On the north-western margin of the terrace, at elevations of 728, 720, 713, and 704 feet, gas is found, but no oil. After many hundred wells have been drilled on all sides, the terrace which has been revealed by the engineer's level is alone found productive.

The grain of the sandstone is in every way as promising, and its thickness as great, outside of the field as within it; and the sections both above and a thousand feet below the Berea grit appear identical in productive and in barren territory alike. It is hard to resist the conclusion that the Macksburg oil-field is dependent upon the structural irregularity here described, the other elements, of course, being presupposed.

May not a like explanation be applied to the oil and gas fields of Pennsylvania and New York as well? Is it not possible that their productive areas are also dependent on structural disturbance, slight though it may be? These areas have been sometimes explained as resulting mainly from the coarseness of grain of the oil-sands. Lenticular deposits of gravel have been suggested, arranged in north-east and south-west lines for the several petroliferous horizons. It is hard to see how any one of these long tongues of gravel could be accounted for, laid down so far from the shore of the sea in which it was deposited. It is much harder to understand how, as the geological ages went by, one after another of these peculiar deposits should be laid down on these self-same lines. It is certainly much easier to conceive of the oil-sands as wide-spread sheets of sand and gravel, that become the reservoirs of oil and gas when lifted into elementary folds. This is certainly true of the Berea grit in Ohio, and this great stratum, it is now definitely settled, constitutes one of the main oil-sands of Pennsylvania. Under this view, the arrangement of the several oil-fields in north-east and south-west lines becomes easily intelligible. These oil-fields are simply conforming to, as they are determined by, the main structure-lines of western Pennsylvania.

EDWARD ORTON.

THE HEALTH OF NEW YORK DURING MAY.

THE population of the city of New York on May 1 was estimated at 1,432,094. Assuming the normal increase to be 799 each week, there would be, June 1, a population of about 1,435,290. Of this number, 2,759 died during the month of May, a mortality less by 206 than occurred during the preceding month. Of children under five years of age, there was a saving of 110 lives as compared with April. The greatest mortality from all causes which occurred during any one day was on the 20th, when 107 persons died. Of this number, 24 were children under one year of age, 29 under two years, and 34 under five years. Consumption caused more deaths on that day, as indeed it usually does on most days of the year, than any other single disease, its victims being 24. The deaths during the month from diarrhoeal diseases were 73, an increase of 16 over the month of April. Diphtheria also caused a considerable increase. its deaths being 165 against 124. Scarlet-fever maintained the same position among the mortality-factors which it had occupied for the two preceding months: the deaths from this disease in March were 42; in April, 49; and in May, 44.

It will be remembered that while rain fell on