## Art. XX.—*On Trinidad Pitch;* by S. F. Peckham and Laura A Linton.

The bitumen found on the Island of Trinidad in the so-called Pitch Lake and in its neighborhood, has entered commerce under the name of Trinidad Pitch. That which is found within the lake is called "Lake Pitch;" that found outside the lake is called "Land Pitch."

As it occurs it is a unique substance found nowhere else in nature. It consists of a mixture of bitumen, water, sand, decayed vegetation and gas in such definite proportions that within certain limits the composition of the entire mass is uniform. The bitumen has never yet been investigated in such manner as to determine its relations to other bitumens, but it appears to be of vegetable origin and convertible into solid asphaltum by processes of nature. In its natural condition about one-third of it is water. Deprived of water it is about one-third sand. When the bitumen is dissolved away from the sand under the microscope, the silica appears to be in exceedingly minute amorphous particles from $\frac{1}{10000}$ to $\frac{1}{1000}$ of an inch in thickness. When freed from organic matter by burning, the silica appears in small sharply angular grains, stained by iron and a small quantity of bluish clay. The organic matter not bitumen consists of fragments of vegetation and disorganized cellular tissue, with products of the decomposition of wood.

As the bitumen rises in the center of the so-called lake it is inflated with gas. When the masses are broken into the structure resembles vesicular lava. The gas cavities are of all sizes, some of them very large and in the aggregate occupy at a rough estimate from one-third to one-half the volume of the pitch. At any point in the deposit removed from the center of the lake, the gas, in part, has escaped from the asphaltum and the mass become more compact. Both within and without the lake the pitch is saturated with water. It is in this condition without viscosity and can be trodden upon or squeezed in the hands without adhesion to either hands or feet. In this condition it cuts like cheese, hence the name, "cheese pitch." When freshly dug the color is brown, but if left in the sun it soon darkens, finally becoming a bluish-black. If a mass of any considerable size is laid in the sun, it will melt to a thin pellicle upon the exposed surface, and retain the larger part of the water at a temperature sufficient to remove every trace of water if it were dried in the shade. A mass exposed to the air out of the sun, immediately begins to dry out and

in a short time loses nearly all of the water, which is in part readily re-absorbed if again exposed to dampness.

The evaporation of the water precipitates within the pitch a small percentage of saline matter, chiefly sulphates of the alkalies and alkaline earths, that the natural water holds in solution. The hygroscopic property of the pitch is no doubt largely due to the presence of these salts.

In selecting specimens that would fairly represent the character of the mass of pitch both within and without the lake, we were largely governed by the appearance of the pitch and the relation of the several localities to one another and the center of the lake.

No. 1 was picked up at random from the pitch taken from an excavation from which the cargo of the bark "Ella" was dug, during February and March, 1895. The excavation was upon a village lot about three-quarters of a mile from the lake towards Point La Brea.

No. 2 is from a village lot which we have named the "Photograph Lot." It was here that a pit was dug and photographs taken of the pit at intervals of ten days to determine whether any movement in the pitch was in progress by which a cavity dug in the pitch would refill. No. 2 was taken from the pitch removed from the pit. This lot had been excavated about six months previous and had nearly refilled, and was then being uncovered preparatory to the removal of a fresh supply of several thousand tons. It was about twenty rods nearer Point La Brea than No. 1.

No. 3 is so-called "Iron pitch" from the Photograph lot. This is pitch that has been melted and deprived of its water and gas. It is solid, of a bluish-black color, with a dull earthy fracture and is slightly sonorous when struck.

No. 4 was taken from a lot on the right hand side of the road approaching the lake, that was being excavated by Mr. Ghent. It came from a point 10 or 15 feet below the surface on the western border of the mass filling the ravine down which the overflow of pitch from the lake has taken place, and nearly on the opposite side of the road from the point from which No. 10 was taken.

No. 5 is No. 4, boiled to form Èpureè, in Mr. Ghent's boiling works near Point La Brea.

Nos. 6 and 7 were from opposite corners of a mass about 12 inches square and four inches in thickness. This mass was taken from a point on the northeast side of the lake on the outside of and near to the tramway, and was selected of convenient size from among a quantity that had been broken with a pick preparatory to removal in the tram cars or carts by the Trinidad Asphalt Co.

No. 8 is from an average from the same piece made up by breaking fragments from many points upon its surface.

No. 9 is from the center of the lake or near it. The mass was soft enough to flatten in the shade, but did not stick to the paper in which it was wrapped. After drying it became ridged and brittle.

No. 10 is an average from a large piece taken from an excavation being made by the Trinidad Asphalt Co. on the Bellevue estate near the road leading to the lake. The excavation extended along the road for perhaps 1500 feet and was narrow. The pitch was clean and pure but was covered by rank vegetation that grew upon and in the pitch itself, and not upon soil that covered it. This fact accounts for the high percentage of organic matter not bitumen, although the piece was taken several feet below the surface.

No. 11 is a decomposition product of the pitch from the photograph lot.

No. 12 is another decomposition product from the same lot. It resembled coke and may have been heated. It is the only material resembling coke that we saw in or around the lake and the amount was only a few pounds.

No. 13 is also a decomposition product resembling No. 11, from the south side of the lake. It was enclosed by a pellicle of sun-dried, melted pitch, within which it was of a light brown color with a columnar structure, like starch, and was very easily powdered. It had the external appearance of asphaltene that had been precipitated from solution.

No. 14 is from a pile of land pitch melting on the beach at Point La Brea, said to have come from the same lot as No. 1.

No. 15 was brought from the lake about 1865, by the late William Attwood of Portland, Me.

No. 16 is from the southeast side of the lake inside the road and was cut from the surface at a spot free from vegetation. The point was about half way from the tramway to the border of the lake.

No. 17 is from the west side about mid-way of the tramway loop, where men were loading tram cars. It was picked up from under the feet of the men.

No. 18 is iron pitch from the northeast side of the lake near where the left limb of the tramway, looking south, enters upon the lake.

No. 19 is refined land pitch, from the refinery of the Trinidad Bituminous Asphalt Co. at Jersey City, N. J. It came from the same lot as No. 2.

No. 20 is refined lake pitch, purchased in New York of the Warren, Scharf Co.

No. 21 is from the northeast side of the lake near the left limb of the tramway looking south.

No. 22 is from the northeast side of the lake near the right of the left limb of the tramway loop looking south, about one hundred feet from No. 21.

No. 23 is from the northwest side of the lake on the west side of the right limb of the tramway loop looking south.

No. 24 is from the south side of the lake near where the road leaves the lake.

No. 25 is from the northwest side of the lake on the west side of right loop of tramway looking south near a "blow-hole."

No. 26 is from the south side of the lake near where the road leaves it, about one hundred feet from No. 24.

No. 27 is Èpureè from the boiling works of the Trinidad Asphalt Co., at Point La Brea. It was made by boiling a mixture of No. 10, No. 8 and No. 9.

Nos. 6, 7, 8, 9 and 17 represent commercial lake pitch.

Nos. 16, 21, 22, 23, 24, 25 and 26 represent the contents of the lake occupying the annular space outside the tramway and embracing hundreds of thousands of tons. The area is about 60 per cent. of the surface of the lake.

Nos. 1, 2, 4, 10 and 14 represent an average of commercial land pitch.

Nos. 5 and 19 represent refined land pitch.

Nos. 20 and 27 represent refined lake pitch.

Nos. 3, 11, 12, 13 and 18 are rubbish so far as commerce is concerned, and are introduced here to show that there is rubbish in the lake as well as outside of it, and also the relation of alteration products to the commercial pitch.

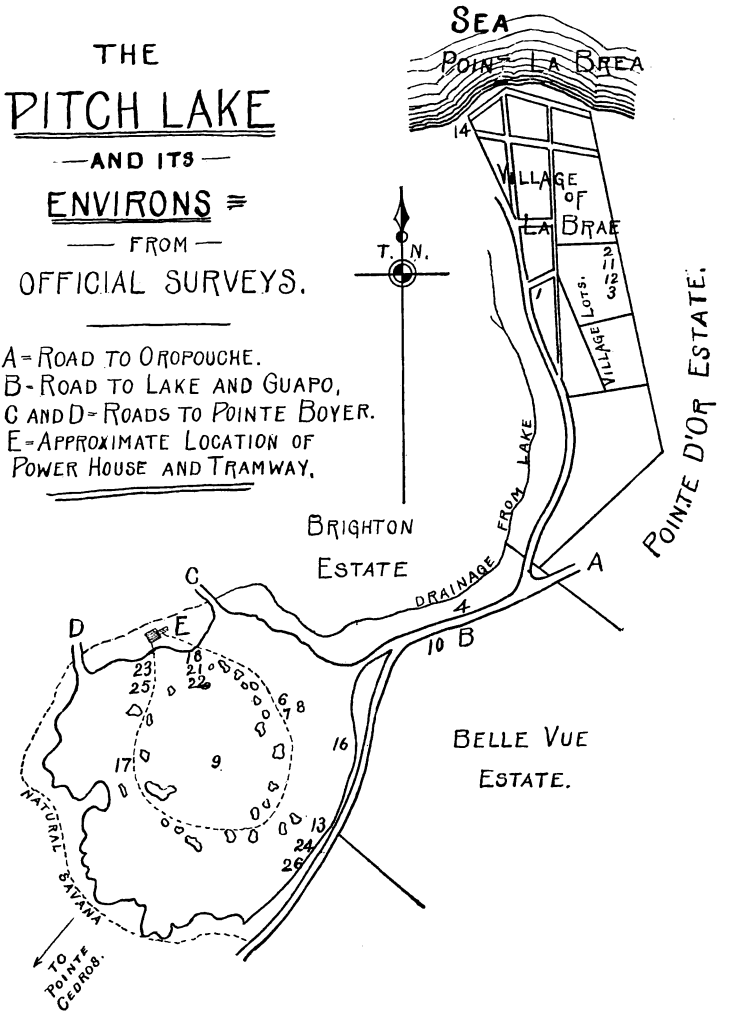
The locations of the several specimens are shown on the accompanying map.

No specimens were taken from near the border of the west side of the lake, because the pools of water were so wide as to make it quite difficult to get around among them. These specimens are believed to furnish a fair representation of the pitch as it occurs both within and without the so-called lake, and also the refined pitch and Èpureè made from the same.

As before stated, the condition of the pitch in the entire deposit is that of complete saturation with water. Water is reached everywhere within a few feet of the surface and often stands in the areas from which pitch has been excavated. Both outside and upon the borders of the lake it appears to render the re-filling of the areas less rapid. In and near the center of the lake, the enormous volume of gas constantly rising, forces the pitch into any excavation more rapidly.

The pitch is removed from near the tramway soon after it is dug, and before it has time to melt is weighed full of water

and immediately thrown into the hold of the ship. The pitch from other parts of the deposit is dug up in large pieces and removed in carts to the beach, where it is immediately put into lighters and transferred as soon as possible to the hold of the




ship anchored off shore. In either case the pitch reaches the hold of the ship containing from 25 per cent to 30 per cent of water and considerable gas, especially that removed from the lake. Before being discharged, heat, the motion of the ship

and the weight of the mass upon itself have rendered the mass within the hold of the ship nearly solid and the material is no longer the natural crude pitch, but something more or less removed from it by loss of water and gas.

In the case of samples like those taken by ourselves and packed in a trunk, labelled and carefully wrapped in paper, the loss of water was nearly complete before they reached New York. In fact it required only a week or ten days in Port of Spain to completely transform the cheese pitch from a moist, porous substance, cutting with a knife like cheese, to a hard brittle solid, readily broken into fragments that could only be cut with considerable difficulty, provided it was kept out of the sun. It is therefore manifest that commercial samples of crude pitch are not samples of natural crude pitch; nor is it possible to bring away from Trinidad samples of "cheese" pitch in the natural condition. We therefore determined to analyze the specimens selected free from water and gas, and thus render the results comparable.

The samples were severally coarsely powdered and air dried by placing them upon the laboratory table in the sun. In dry weather they soon dried to a constant weight. In damp weather they lost and gained within narrow limits indefinitely. Heated in an air bath to 50° C., they were soon brought to a constant weight. Heated at 100° C., to a constant weight, a varying loss of volatile oils invariably followed, which showed that determinations of water at 100° C. as a constituent of the pitch leads to vitiated results from two sources: first, the percentage of water is not constant in the same specimen but varies with the condition of the atmosphere; second, pitch that is apparently very dry gives off an appreciable amount of volatile oils below 100° C. The samples were therefore dried to a constant weight, at a temperature below 50° C. Of course, if, for any reason, the amount of water in a given specimen of pitch is desired, it is easily ascertained, but it should not be reported as a constituent of the pitch, as the varying percentage of water causes all of the other percentages to vary in the same specimen at different times.

The dried specimens were then exhausted with petroleum ether. In the present instance the petroleum ether used for all the specimens came from the same barrel and was of specific gravity 74° B. The exhausted residues were dried at 100° C. and the difference in weight was computed as petrolene. The dried residues were then exhausted with boiling spirits of turpentine, washed with ethyl alcohol and dried at 100° C. to a constant weight. The loss was noted. The dried residues were then exhausted with chloroform and dried and the loss noted. The loss by turpentine plus the loss by chloroform is

estimated as asphaltene. The distinction made by the use of these two solvents will be noted farther on. The dried residue from the chloroform exhaustion was then put into a platinum crucible and the organic matter burned off. The residue was inorganic or mineral matter, sand, and the small percentage of soluble and non-volatile salts present. The pitch was thus divided into that portion soluble only in petroleum ether, or "petrolene," that portion soluble only in boiling spirits of turpentine, and chloroform which together form "asphaltene," and with the petrolene constitutes the "total bitumen"; also the "organic matter not bitumen" and the "inorganic matter."

Table No. 1 represents the results of the analysis of the 27 specimens described above. Any attempt to classify them as to the locality from which they were obtained by means of these analyses will inevitably fail. Our analyses prove that an average of specimens will show an increase in the proportion of "mineral matter" and of "organic matter not bitumen," as the point from which the specimen is taken is removed from the center of the lake; yet, the exceptions to this rule are so numerous and marked, that no certainty can attach to the use of these criteria.

Great value is attached by some experts on asphaltum to the determination of the specific gravity and temperature at which the different specimens soften and flow. These tests might have some value if applied to a pure bitumen which had been proved to change in specific gravity, etc., as it underwent chemical and other changes; but no such investigation and proof in relation to any asphaltum has been attempted. Such a relation has been assumed but not proved. The fact that Trinidad pitch is a mixture so indefinite that it is almost, if not quite impossible, to select two pieces that have the same proportions (as is proved by Nos. 6, 7 and 8) is a sufficient reason why no such distinctions can be based upon such determinations. The average proportions of mineral matter to bitumen in the 5 samples of commercial lake pitch taken from near the center of the lake is 100 : 151. No two of them are exactly alike, and the extremes are, lowest 100 : 148, highest 100 : 155. The seven specimens from outside the tramway show greater uniformity, yet no two are alike and all are below the lowest of the five mentioned above. The average ratio of the land pitch is still a little lower, while the extremes of variation are 134 and 146. It is manifest that between these extremes of proportion of 100 : 134 and 100 : 155 a marked variation in specific gravity and flowing test must occur, as the sand is about twice as heavy as the bitumen. These extremes of variation include one-sixth of the average amount of bitumen present.

These observations apply with equal force to the ingredient of the mixture denominated "organic matter not bitumen." In the five specimens of commercial lake pitch the average amount of this material is 10·651 per cent. The extremes of variation include 1·482 per cent, which is 14·8 per cent or nearly one-sixth of the average amount present. The smallest amount is found in the average pitch from near the center of the lake, yet No. 17, which was picked up from under the feet of the men who were loading the tram cars on the west side of the tramway near the middle, contains nearly 12 per cent. This average lake pitch is found where the mass is in constant motion from escape of gas. Here there is no organic matter added by vegetation to the amount originally found in the pitch. The growth of vegetation upon and in the pitch itself is the source from which the excess of organic matter found in the lake pitch taken from points outside the center and from the so-called land deposits is derived. As this excess consists mainly of coarse roots it is removed by refining, so that when the pitch is ready for use the difference in the organic matter has largely or entirely disappeared. See numbers 2 and 19, 8 and 20.

Table No. 2 shows the results of a comparative examination of the bitumen contained in the different samples without regard to the amount present. The first division of this table shows the percentage of the crude pitch dissolved only by petroleum ether, boiling spirits of turpentine and chloroform respectively. The middle column gives the percentage of the total bitumen in the crude pitch. The next three columns give the percentages of the total bitumen present dissolved only by petroleum ether, boiling spirits of turpentine and chloroform respectively. The last column shows the percentage of the total bitumen dissolved by boiling spirits of turpentine. This item is represented by adding together the items of the first and second columns, as all of the material that is dissolved by petroleum ether is soluble in boiling spirits of turpentine. A comparison of these numbers along each horizontal line shows that there is no necessary connection between the amount of *crude pitch* dissolved by petroleum ether and the *quality* of the total bitumen. As an example, in No. 1, which is a land pitch, 100 parts of bitumen are mixed with very nearly 100 parts of sand and organic matter, not bitumen, while in No. 9 from the center of the lake 100 parts of bitumen are mixed with about 92 parts of foreign matter. Now while the percentage of crude pitch dissolved by petroleum ether from No. 1 is 2·333 per cent less than the percentage of No. 9 dissolved by the same menstruum, the *proportions* of the total bitumen dissolved in the two cases are almost identical,

viz: 66·5 per cent and 66·544 per cent. Again, No. 17 was broken off a piece of pitch as a negro raised it and threw it into a tram car. It fell under his feet and was secured as a piece of convenient size for a specimen. On analysis it gave 34·2 per cent soluble in petroleum ether, while the total bitumen was 52·997 per cent. These results give 64·531 per cent of the total bitumen soluble in petroleum ether and 89·372 per cent soluble in boiling spirits of turpentine. Of the five samples of commercial land pitch, Nos. 2, 4 and 10 contain 33·62, 33·736 and 33·730 per cent of matter soluble in petroleum ether. The average is 33·705, yet the average per cent of the total bitumen present soluble in petroleum ether is 64·283 per cent, almost identically the same as that yielded by No. 17. In fact No. 2 and No. 17 represent the extremes of location from the west side of the tramway to the village lot furthest from the lake and the difference in the percentage of the total amount of bitumen soluble in petroleum ether is only (·255 per cent) two hundred and fifty-five thousandths of one per cent—a difference wholly without significance. No. 9 was from the center of the lake and No. 1 from a village lot about 20 rods nearer the lake than No. 2, yet the difference in the amount of total bitumen present soluble only in petroleum ether, is only forty-four thousandths of one per cent. Arranged in a table these samples of commercial pitch appear as follows:

| | | |
|---|---|---|
| No. 1. | Land | 66·500 |
| No. 9. | Lake (center) | 66·544 |
| No. 2. | Land | |
| No. 4. | Land | |
| No. 10. | Land | |
| | Average | 64·283 |
| No. 17. | Lake | 64·531 |

Of the specimens representing the pitch filling the annular space outside the tramway and beyond, to the boundaries of the lake, Nos. 21 and 22 were taken from the bottom of an excavation on the right of the left limb of the tramway loop as it descends upon the lake and within 140 feet of each other. Nos. 23 and 25 were taken from points very near each other on the right or west side, of the right limb of the tramway loop. These four points are on the north side of the lake and near the border. No. 16 was taken from a point on the southeast side of the lake about half way from the tramway to the border of the lake. The spot was free from grass, yet it was within the area covered with vegetation. Nos. 24 and 26 were from points on the south side of the lake directly opposite Nos. 21, 22, 23 and 25 and about 100 feet apart.

The percentage of total bitumen soluble in petroleum ether is shown in the following table:

| | |
|---|---|
| No. 21 | 51·555 |
| " 22 | 65·809 |
| " 23 | 64·960 |
| " 24 | 62·974 |
| " 25 | 68·431 |
| " 26 | 70·691 |
| " 16 | 66·933 |

Nos. 25 and 26 from opposite sides of the lake and very near the border, are the highest in the list and higher than No. 9 from the center of the lake, and higher than No. 6 which is the highest commercial lake pitch. The differences and identities of these different groups, as well as between the individual members of the groups, can be readily traced by reference to table No. 2.

The portion soluble in petroleum ether is called " petrolene." It is a constituent and essential part of the pitch, and embraces all that is most volatile in the pitch, including those etherial or oily fluids that are given off at a temperature below the boiling point of water, and which are found in all specimens from all parts of the deposit (land and lake) that have not been previously heated or decomposed. It is contended that petrolene is the cementitious portion of the pitch, because the remaining portion of the bitumen is solid and insoluble in residuum oil. It might just as well be contended that water is the cementitious principle of glue and that glue has no cementing properties because it is not soluble in alcohol. The fact is, that the bitumen of Trinidad pitch consists of asphaltene dissolved in petrolene and that its cementitiousness is just as much due to one as the other. Sand cannot be cemented with either petrolene or asphaltene alone, neither can wood be cemented with either water or glue alone. The cementitiousness of the pitch depends upon the amount and quality of the bitumen present.

What meaning is intended to be given the word " dry " in connection with pitch is not very clear. It cannot be freedom from moisture, for no specimen of crude pitch is entirely free from water. As found in the deposit, the pitch both outside and inside the lake is saturated with water, and its condition after removal from the deposit depends entirely upon what is done with it. The use of the word " dry " appears to imply that the pitch from outside the lake has lost the whole or a large part of the most volatile oils originally contained in it. No proof whatever has been offered to sustain such assertions. It has been contended that the sun heats the land pitch to

140°–150° F. Outside the lake the deposit is covered with from 2 to 15 feet of earth, rubbish and vegetation. The large area in the center of the lake from which, for convenience, the commercial lake pitch is removed, is bare and black, exposed to the full rays of the tropical sun. Shallow pools of water on the surface of the lake appear to have a temperature of about 100° F. The pitch is probably hotter. It is therefore reasonable to suppose that if evaporation of light oils were taking place that the pitch in the lake would be "driest." Our examination has shown us that both land and lake pitch contain oils volatile under the boiling point of water in about the same proportion; small in both cases.

The use of both turpentine and chloroform as solvents for asphaltene is based upon observations made a year ago upon the methods employed for the technical analysis of asphaltum. Is was found that in the United States carbon disulphide has been almost exclusively used as a solvent for asphaltene, while in Europe spirits of turpentine has been used for the same purpose. Careful experiment showed that neither of these solvents would dissolve all of the bitumen from the specimens in our possession, among which were those from the valley of the Rhone. It was observed that turpentine left a large and varying residuum when applied to nearly all of the American specimens, including Trinidad, and that only a very small percentage was left from the Rhone specimens and those from the Indian Territory. It was also found that in either case chloroform alone effected a complete extraction of the bitumen. Later we received a specimen of Neufchatel asphaltic rock from which turpentine completely dissolved the bitumen. This led to an examination and classification of the various bitumens with reference to the action of turpentine. It was found that a large percentage of the asphaltene of Grahamite and a varying percentage of the asphaltene of Trinidad pitch and the asphaltums of California is insoluble in turpentine. It was also found that the asphaltene of the bitumens of Texas and the valley of the Rhone is almost wholly soluble in turpentine, and further that when the bitumen is removed from solution from these asphaltic rocks it is not a solid asphaltum but a semi-solid viscous fiuid, that does not become solid by exposure, but has remarkable stability in the atmosphere. These facts lead to the belief that the proportion of asphaltum soluble only in chloroform furnishes an indication of the extent to which a bitumen has been affected by "aging."

It has been asserted that land pitch had matured through geological time and reached a condition approaching "glance pitch." The word glance as applied to pitch has nothing to do with its age, or with any other property except its appear-

ance. The word glance is from the German word "glanz," which means glistening. Pure asphaltum that has been melted has a smooth glistening fracture like rosin or anthracite coal. It would be impossible to produce glance pitch by melting a material containing so much mineral matter as Trinidad pitch. Iron pitch is the nearest approach to it that can be found in the neighborhood of the Pitch lake, and that was found both within and without the lake. If it has been intended to convey the impression that asphaltum becomes glance pitch by aging, and that the land pitch is farther on the way through geological time towards glance pitch than that in the lake, it must also be admitted that so far as anyone knows to the contrary the whole phenomenon of the pitch lake may have been produced within five hundred years. Our analyses have not furnished the slightest evidence that the bulk of the pitch outside the lake has aged any more than that within it. Our analyses also show that the bulk of the pitch is in good condition throughout the deposit; and that the effects of aging are about equally distributed.

These analyses do not sustain the allegation that land pitch is any less uniform in composition than lake pitch. The following figures represent the extremes in the percentage composition of total bitumen in the five samples of commercial lake pitch and the five samples of commercial land pitch soluble in

| | Land. | Lake. |
|---|---|---|
| Petroleum ether | 3·445% | 3·601 |
| Boiling spirits turpentine | 9·746% | 7·110 |
| Chloroform | 9·622% | 9·716 |
| Total soluble in turpentine | 9·621% | 9·696 |

The correspondence between them is remarkable.

It makes no difference whether these results of analysis are taken as a whole, or compared severally, or in the different elements that make up each analysis, the same conclusion is inevitable, viz: that the entire deposit both within and without the boundaries of the lake is one and the same substance and in substantially the same condition.

There are five specimens in the collection that represent the rubbish of the deposit. Nos. 3 and 18 are respectively land and lake "iron-pitch," Nos. 11 and 13 are decomposition products from the land and lake respectively, that may be what has been called "chocolate pitch," No. 12 may be what has been called "grey pitch." None of these are commercial articles, yet they are shown by these analyses to have scientific relations to the commercial pitches full of interest. By comparing these five specimens with any other five in the tables, it will be found that they are low in material soluble in petro-

leum ether; high in material soluble in boiling spirits of turpentine and chloroform, and at the same time they are low in the percentage of total bitumen soluble in boiling spirits of turpentine. This apparent contradiction is easily accounted for when the high percentage of material soluble only in chloroform is observed. The proper interpretation of these results in reference to the aging of asphalt awaits the completion of investigations now in progress.

TABLE No. 1.—*Analyses of Trinidad Pitch.*

| No. | Petrolene. | Asphaltene. | Total Bitumen. | Organic Not Bitumen. | Inorganic. |
|---|---|---|---|---|---|
| *a.* | 33·600 | 17·150 | | 11·625 | 37·625 |
| *b.* | 33·635 | 17·200 | | 11·850 | 37·300 |
| 1. Mean | 33·617 | 17·175 | 50·791 | 11·737 | 37·462 |
| *a.* | 33·640 | 18·888 | | 11·347 | 36·123 |
| *b.* | 33·600 | 18·468 | | 11·652 | 36·280 |
| 2. Mean | 33·620 | 18·678 | 52·297 | 11·499 | 36·201 |
| *a.* | 33·637 | 23 621 | | 7·840 | 34·902 |
| *b.* | 33·511 | 23·034 | | 8·988 | 34·467 |
| 3. Mean | 33·574 | 23·327 | 56·901 | 8·414 | 34·684 |
| *a.* | 33·769 | 18·764 | | 10·564 | 36·903 |
| *b.* | 33·703 | 18·498 | | 11·138 | 36·555 |
| 4. Mean | 33·736 | 18·631 | 52·367 | 10·851 | 36·729 |
| *a.* | 33·600 | 18·000 | | 10·500 | 37·900 |
| *b.* | 33·650 | 18·500 | | 9 800 | 38·050 |
| 5. Mean | 33·625 | 18·250 | 51·875 | 10·150 | 37·975 |
| *a.* | 36·650 | 17·200 | | 10·800 | 35·350 |
| *b.* | 36·650 | 17·250 | | 10·775 | 35·325 |
| 6. Mean | 36·650 | 17·225 | 53·875 | 10·787 | 35·337 |
| *a.* | 36·392 | 17·151 | | 10·491 | 35·961 |
| *b.* | 36·392 | 17·245 | | 10·410 | 35·990 |
| 7. Mean | 36·372 | 17·198 | 53·570 | 10·450 | 35·975 |
| *a.* | 36·300 | 17·975 | | 9·900 | 35·725 |
| *b.* | 36 650 | 17·800 | | 9·850 | 35·700 |
| 8. Mean | 36·475 | 17·887 | 54·362 | 9·875 | 35·712 |
| *a.* | 35·950 | 18·050 | | 10·875 | 35·125 |
| *b.* | 35·950 | 18·100 | | 10·690 | 35·260 |
| 9. Mean | 35·950 | 18·075 | 54·025 | 10·782 | 35·192 |
| *a.* | 33·730 | 18·948 | | 11·390 | 35·930 |
| *b.* | 33·730 | 18·750 | | 11·667 | 35·842 |
| 10. Mean | 33·730 | 18·849 | 52·579 | 11·528 | 35·886 |
| *a.* | 21·200 | 30·375 | | 9·600 | 38·500 |
| *b.* | 21·525 | 30·250 | | 10·100 | 38·450 |
| 11. Mean | 21·362 | 30·312 | 51·674 | 9·850 | 38·475 |
| *a.* | 0 000 | 3·000 | | 43·525 | 53·475 |
| *b.* | 0·000 | 3·000 | | 43·550 | 53·450 |

| No. | Petrolene. | Asphaltene. | Total Bitumen. | Organic Not Bitumen. | Inorganic. |
|---|---|---|---|---|---|
| 12. Mean | 0·000 | 3·000 | 3·000 | 43·537 | 53·462 |
| *a.* | 19·200 | 33·050 | | 9·650 | 38·000 |
| *b.* | 19·300 | 33·575 | | 9·475 | 37·750 |
| 13. Mean | 19·250 | 33·312 | 52·562 | 9·562 | 37·875 |
| *a.* | 31·800 | 18·725 | | 11·925 | 37·550 |
| *b.* | 31·750 | 18·525 | | 12·355 | 37·370 |
| 14. Mean | 31·775 | 18·625 | 50·400 | 12·140 | 37·460 |
| *a.* | 32·176 | 43·649 | | 5·570 | 18·605 |
| *b.* | 32·450 | 43·300 | | 5·960 | 18·290 |
| 15. Mean | 32·313 | 43·474 | 75·787 | 5·765 | 18·447 |
| *a.* | 35·375 | 17·475 | | 11·000 | 36·150 |
| *b.* | 35·425 | 17·600 | | 10·925 | 36·050 |
| 16. Mean | 35·400 | 17·537 | 52·987 | 10·962 | 36·100 |
| *a.* | 34·200 | 18·775 | | 11·275 | 35·750 |
| *b.* | 34·200 | 18 820 | | 11·440 | 35·540 |
| 17. Mean | 34·200 | 18·797 | 52·997 | 11·357 | 35·645 |
| *a.* | 22·275 | 22·225 | | 8·925 | 46·575 |
| *b.* | 22·225 | 22·475 | | 8·950 | 46·350 |
| 18. Mean | 22·250 | 22·350 | 44·600 | 8·937 | 46·462 |
| *a.* | 39·350 | 17·175 | | 9·225 | 34·250 |
| *b.* | 39·300 | 17·400 | | 9·100 | 34·200 |
| 19. Mean | 39·325 | 17·287 | 56·612 | 9·162 | 34·225 |
| *a.* | 38·150 | 18·750 | | 8·100 | 35·000 |
| *b.* | 38·125 | 18·921 | | 7·923 | 35·031 |
| 20. Mean | 38·137 | 18·835 | 56·973 | 8·011 | 35·015 |
| *a.* | 26·925 | 25·325 | | 11·375 | 36·375 |
| *b.* | 26·925 | 25·275 | | 11·100 | 36·700 |
| 21. Mean | 26·925 | 25·300 | 52·225 | 11·237 | 36·537 |
| *a.* | 34·750 | 18·035 | | 10·970 | 36·245 |
| *b.* | 34·700 | 18·050 | | 10·875 | 36·375 |
| 22. Mean | 34·725 | 18·042 | 52·767 | 10·922 | 36·310 |
| *a.* | 34·400 | 18·550 | | 11·500 | 35·550 |
| *b.* | 34·425 | 18·575 | | 11·325 | 35·675 |
| 23. Mean | 34·412 | 18·562 | 52·974 | 11·412 | 35·612 |
| *a.* | 33·275 | 19·325 | | 11·100 | 36·300 |
| *b.* | 33·100 | 19·700 | | 11·150 | 36·050 |
| 24. Mean | 33·187 | 19·572 | 52·699 | 11·125 | 36·175 |
| *a.* | 34·950 | 16·100 | | 10·600 | 38·350 |
| *b.* | 34·850 | 16·100 | | 10·475 | 38·575 |
| 25. Mean | 34·900 | 16·100 | 51·000 | 10·537 | 38·462 |
| *a.* | 35·600 | 14·650 | | 11·100 | 38·650 |
| *b.* | 35·125 | 14·675 | | 11·325 | 38·875 |
| 26. Mean | 35·362 | 14·662 | 50·024 | 11·212 | 38·762 |
| *a.* | 34·725 | 20·175 | | 8·425 | 36·675 |
| *b.* | 34·775 | 19·625 | | 8·925 | 36·675 |
| 27. Mean | 34·750 | 19·900 | 54·650 | 8 675 | 36·675 |

TABLE NO. 2.—*Analyses of Trinidad Pitch.*

| No. | Percentage of Crude Pitch only soluble in | | | Total Bitumen. | Percentage of Total Bitumen only soluble in | | | |
|---|---|---|---|---|---|---|---|---|
| | Petroleum Ether. | Boiling Spts. Turpentine. | Chloroform. | | Petroleum Ether. | Boiling Spts. Turpentine. | Chloroform. | Total in S. Tur. |
| 1. | 33·617 | 10·887 | 6·287 | 50·791 | 66·500 | 21·250 | 12·250 | 87·750 |
| 2. | 33·620 | 10·494 | 8·183 | 52·297 | 64·276 | 20·066 | 15·658 | 84·342 |
| 3. | 33·574 | 13·802 | 9·819 | 57·195 | 58·702 | 24·131 | 17·167 | 82·833 |
| 4. | 33·736 | 10·511 | 8·120 | 52·367 | 64·422 | 20·071 | 15·506 | 84·493 |
| 5. | 33·625 | 15·575 | 2·675 | 51·875 | 64·819 | 30·022 | 5·159 | 94·841 |
| 6. | 36·650 | 12·800 | 4·425 | 53·875 | 68·132 | 23·700 | 8·168 | 91·832 |
| 7. | 36·372 | 11·683 | 5·514 | 53·570 | 67·896 | 21·862 | 10·242 | 89·758 |
| 8. | 36·475 | 15·750 | 2·137 | 54·362 | 67·096 | 28·972 | 3·932 | 96·068 |
| 9. | 35·950 | 12·310 | 5·762 | 54·022 | 66·544 | 22·788 | 10·668 | 89·332 |
| 10. | 33·730 | 15·670 | 3·179 | 52·579 | 64·151 | 29·812 | 6·036 | 93·963 |
| 11. | 21·362 | 15·200 | 15·112 | 51·674 | 41·340 | 29·415 | 29·245 | 70·755 |
| 12. | | 1·700 | 1·300 | 3·000 | Alteration Product | | | |
| 13. | 19·250 | 20·487 | 12·825 | 52·562 | 36·621 | 38·976 | 24·403 | 75·597 |
| 14. | 34·775 | 11·875 | 6·750 | 50·400 | 63·055 | 23·547 | 13·398 | 86·602 |
| 15. | 32·313 | 21·249 | 22·225 | 75·787 | 42·636 | 28·038 | 29·326 | 70·674 |
| 16. | 35·400 | 12·300 | 5·237 | 52·937 | 66·935 | 23·162 | 9·903 | 90·097 |
| 17. | 34·200 | 11·575 | 7·222 | 52·997 | 64·531 | 21·841 | 13·648 | 86·372 |
| 18. | 22·250 | 9·735 | 12·615 | 44·600 | 49·921 | 21·837 | 28·252 | 71·758 |
| 19. | 39·325 | 11·285 | 6·002 | 56·612 | 69·465 | 19·933 | 10·602 | 89·398 |
| 20. | 38·137 | 12·538 | 6·297 | 56·973 | 66·959 | 22·016 | 11·025 | 88·975 |
| 21. | 26·925 | 18·612 | 6·687 | 52·224 | 51·555 | 35·640 | 12·805 | 87·195 |
| 22. | 34·725 | 13·175 | 4·867 | 52·767 | 65·809 | 24·968 | 9·223 | 90·777 |
| 23. | 34·412 | 13·100 | 5·462 | 52·974 | 64·960 | 24·720 | 10·320 | 89·680 |
| 24. | 33·137 | 14·237 | 5·275 | 52·699 | 62·974 | 27·016 | 10·010 | 89·990 |
| 25. | 34·900 | 9·200 | 6·900 | 51·000 | 68·431 | 18·039 | 13·530 | 86·470 |
| 26. | 35·362 | 9·862 | 4·800 | 50·024 | 70·691 | 19·714 | 9·595 | 90·405 |
| 27. | 34·750 | 10·712 | 9·187 | 54·650 | 63·526 | 19·592 | 16·882 | 83·118 |

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