PAPER II.—ON THE COAL-LIKE SUBSTANCE, OR "ALTERED BITUMEM," FOUND IN THE EXCAVATIONS AT FORT NO.3, POINT LEVIS, AND THE PRESENTLY ACCEPTED THEORIES ON THE ORIGIN OF COALS, BITUMENS, AND PETROLEUM SPRINGS, WITH AN ACCOUNT OF THE "CARBONIFEROUS SYSTEM" OF BRITISH NORTH AMERICA.

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(Read before the Society, 29th November, 1865.)

When it was announced in the Quebec journals, during the past season, that coal had been discovered in the excavations at Fort No. 3, at Point Levis, the report was received by many with total disbelief, by several with doubt, and by others with implicit faith. Such as believed in Sir Wm. Logan, or received dogmatically what he had said or written—or was believed to have said or written—laughed in scorn, affirming that Sir William had proved conclusively that coal could never be found in Canada. Those who doubted, though they admitted that from the absence of the carboniferous system of rocks, it was not very probable that coal would be found under the received condition, yet believed that it was not impossible, from what had occurred in the adjoining Province of New Brunswick, that coal, or at any rate a substance possessing many of the most valuable properties of coal, might be found in sufficient quantity to make it of economic importance. The third party, having no faith in Sir William, or the science which he has done so much to elucidate and adorn, but believing all things possible, not only believed that coal had been found, but would have been equally ready to admit that a deposit of gold, silver, and precious stones had been discovered, similar to that in the tunnel through Mount Cenis, of which such *authentic* accounts have reached us.

Believing that vague and, in the minds of many, very erroneous views prevail on the subject, I have thought it might be interesting to the Society to have it brought under review; and as I am aware that some of the members have not hitherto devoted their attention to geology, in treating my subject I shall endeavour to divest it, as much as possible, of technicalities.

It is frequently, and very properly asked, how can any geologist undertake to say that coal cannot be found in one district, and as certainly that it may in another; that gold would be found in abundance in a locality which he had never visited, and which was only known to him by reports as to its general features; and that it would be vain to seek for it in another district. The answer to this is: that geology is based on observation and deduction, and that its students have been able to classify, in distinct series, the various strata of which the crust of the earth has been found to be formed. It will be convenient for me to recognise two grand natural divisions: the igneous, or volcanic and plutonic, and the aqueous or neptunic. The igneous, as the name implies, have been produced by the agency of fire, and are the lowest in the series; they are also called azoic, for no traces of animal or vegetable life being found in them; they comprehend all the granites and certain porphories. The aqueous are also designated *sedimentary* or stratified, from their having been deposited at the bottom of the sea, in strata or layers; they are likewise known as "*fossiliferous*", from their containing the remains of contemporaneous animals and plants. Between these two great divisions we have a very important series, the metamorphic or "*changed*" rocks, which may have been orignally sedimentary, and containing organic remains, but have been so completely changed by the action of fire, or some other agency, as to have lost their orignal structure, and all traces of organism.

When we come to consider the received theories of the origin of coal, you will at once see that we need not look in the first division for coal, but must search for it among the stratified rocks; and I think that I will be able to adduce facts which may justify the expectation that in the neutral ground of the metamorphic rocks, we shall find some *metaliferous* and some *carboniferous*. "The oldest geological formations," says Dr. Dawson, "are of marine origin, and contain remains of marine animals, with those of plants supposed to be allied to the existing seaweeds. Geology, however, cannot assure us, either that no land plants existed contemporaneously with these earliest animals, or that no land flora preceded them. These oldest fossiliferous rocks may mark the commencement of animal life, but they testify nothing as to the existence or non-existence of a previous period of vegetation alone. That there were plants before this period, we may infer almost with certainty from the abundance and distribution of carbonaceous matter in the form of "graphite" in the Azoic or Laurentian rocks of Canada; but of the form or structure of these plants we know nothing."

Among the systems of stratified rocks we find an extensive series, surmounted by a system called the "*newred*", and underlaid by another called the "old red sandstone; and to this, the term carboniferous or *coal*-bearing has been applied. This system is of inestimable importance in an economical point of view; it is also of great interest to the geologist, from the singular and interesting fossils which it contains, which bear testimony to the changes which the earth's surface has undergone, and to the character of its animals and vegetables during a very long and important period of its history.

On the western coast of the county of Cumberland, in the Province of Nova Scotia, fronting Chiegnecto Bay, there is an extensive range of cliffs, which have been cut and kept clean by the action of the water, and which furnish the finest and most complete section of the carboniferous systems to be found in the world. So wonderful is this section, that, as early as 1842, the now well-known "South Joggins" attracted the attention of Sir Charles Lyell and Sir Wm. Logan—both of whom visited the locality for the purpose of verifying their theories on the formation of coal. In 1852 Sir C. Lyell, accompanied by Dr. Dawson, again visited the Joggins, and made a detailed examination of that portion where the coal seams are most frequent. Of this examination Dr. Dawson, in his "Acadian Geology," has furnished a most minute and interesting account: and it is the best view I have found of the carboniferous system and the formation of coal, I have thought it advantageous to give you an epitome of it. I may here mention, however, that Sir Wm. Logan had some time before made a detailed examination, and had estimated the total vertical thickness of the carboniferous formation at no less than 14,570 feet, or about three miles, and found them every where *devoid of marine organic remains.*

After describing 7636 feet of strata, which consisted of sandstones, marly clays thick bed of limestone and gypsum, Dr. D. says, they reached the commencement of the true coal measure, extending over 2800 feet; and this, for the matter of convenience, Dr. Dawson has described under 29 sections, the sum of which is as follows:—The entire section contains 76 beds of coal, and 90 distinct stigmaria underclays. All the coals, *except two,* rest on stigmaria underclays; and there are 16 stigmaria underclays without coals. Erect plants were observed at 22 levels. There are 24 bituminous limestones, 17 of which are immediately connected with seams of coal.

Referring to the term "stigmaria underclay," used above, it may be here explained that underclay is technically applied to the bed of clay which *generally* underlies a coal seam. "Stigmariae" are very peculiar fossil roots, of very frequent occurrence in the coal measures, and now ascertained to be the roots of an extinct tree called the sigillaria, which is considered to have been a principal agent in the formation of coal. The stigmaria derived its name from the pits or spots left by its rootlets;—the sigillaria, from the rows or leaf-scars which extend up its trunk. The roots of the stigmaria at their departure from the trunk are four, which divide, at equal distance, into eight, sixteen, and thirty-two branches, each giving off an immense number of rootlets.

Believing the underclays to have been soils, we have reason to conclude that the coal seams were originally vegetable matter accumulated in the manner of peat; for, on a minute examination of the coal, it is found to be composed in part of woody fragments sometimes retaining their structure so perfectly as to enable us to ascertain the kind of wood to which they belonged. These appearances are best seen in the coarser and more impure coals; in the purest, the vegetable matter is reduced, by chemical change and pressure, to an almost homogeneous mass.

At the commencement of the section, Dr. Dawson found a soil, four feet in depth, supporting a layer of vegetable mould which had been compressed into half an inch of coal; above the coal rested a dark-coloured limestone, filled with innumerable little shells of the *cypris*—the modern representatives of which reside in countless numbers in ponds and river estuaries. The bog, then, from subsidence, had become a pond or lagune, in which cyprides and other aquatic animals must have existed for some time, to form two inches of hard bituminous limestones. The lagune was dried up, and on the rich marly soil grew another forest; and the result was a thicker seam of coal, which in its turn was inundated and covered by a considerable thickness of shales and bituminous limestones, in which are perceptible the cypris and the scales of small fishes, bivalved, *modiolae* allied to the common mussel, and a small whorled shell, *spirorbis*. These limestones alternate with shales, indicating irruptions of mud. In the highest of these beds, which probably had become a swamp, trees took root which in time were buried by an irruption of sand, in which they, and an undergrowth of *calamites*, still stand in an erect position.

Time will not permit us to enter more fully into the subject. So refering you to the "Acadian Geology" for further details of much interest, I can only here say the whole series of the Joggins furnish repetitions of the facts already given; and a short history of one group will suffice to give an idea of the successive changes which have produced the whole section. As to the time required for the production of such vast deposits, it must have been so great that some have not ventured to define it: Sir Charles Lyell estimates it from three hundred and fifty thousand to two millions of years. Here is the history of the groups:—First, there was deposited under the water a stratum of clay, which from the withdrawal of the water or the emergence of the solid bed, became a soil suitable for the support of vegetable life. Here grew the sigillaria, a tall branchless tree, whose trunk was covered with a thick, smooth, and very indestructible bark, ribbed and regularly clothed with long, flat, dependent leaves, reaching a height of forty feet. They grew in dense groves and many species have been discovered. Under the sigillaria grew a thick growth of *poacites*,—plants with long striated leaves, six inches broad and three feet long, like gigantic iris plants. There were, also, probably several varieties of ferns, of which two hundred and fifty species have been found; many of them strikingly tree ferns. In process of time a peaty bog was formed. On this peaty soil grew trees, supposed to be coniferous *lepidodendra*, of which forty specimens have been found; but, in the present instance, now only represented by a stump of mineral charcoal, which, being about one foot in diameter, probably required for its growth about fifty years;—these trees were killed by the inundation of the bog. During their decay sigillariæ again sprung up to the diameter of two feet, when they were in turn overwhelmed by sediment, which buried their roots to the depth of about eighteen inches. At this level, calamites attaining the diameter of four inches, and sigillariae one foot, again grew. These plants were again embedded in a somewhat coarser sediment, but so gradually that sigillariae grew at two higher levels, before the accumulation of mud and sand attained the depth of nine feet, at which depth the original large sigillariae that had grown immediately over the clay, were broken off, and their hollow trunks filled with sand. Before being filled with sand, these hollow stumps must have projected from a swamp or terrestrial surface; as in them were found remains of reptiles and land shells, as well as many fragments of calamites, poacites and lepidostrobus, evidently introduced before the sedimentary matter. In one of these Sir C. Lyell and Dr. Dawson found the jawbone, containing teeth, of an animal called "Dendrerpeton Acadianum," and the shell of a land snail (pupa?) The remaining beds of this group give evidence of the condition of swamp for a long time after trees last noticed were completely buried. They include, in a thickness of twenty-eight feet, three underclays supporting coaly beds, and one with erect stumps. One of the coaly beds, which alternates with laminae of shale, is filled with flattened trunks of sigillaria and lepidodendron, indicating how small a thickness of coaly matter may mark the time required for the growth and decay of many successive forests.

The whole series of events recorded in the Joggins, indicate "gradual and long-continued subsidence, with occasional elevatory movements, going on in an extensive alluvial tract teeming with vegetable life, and receiving large supplies of fine detrital matter. On the one hand, subsidence tended to restore the original dominion of the water: on the other hand, elevation, silting up, and vegetable and animal growth, built up successive surfaces of dry land. For a very long period these opposing forces were alternately victorious, without effecting any very decided or permanent conquest—but, in the end, the whole series was dislocated and upheaved by one grand convulsion; and thus we have been enabled to read how these successive systems were "founded, flourished and decayed."

We have remarked that, in the series, there were 76 beds of coal and 90 distinct stigmaria underclays; and that all the coals, except two, rest on stigmaria underclays; and that there are 16 underclays without coal. This is a very important observation, because, up to this discovery, it was believed that coal could not be formed without stigmariae; and I find that Sir C. Lyell has recorded that, according to Sir Henry de la Beche, the coal beds in South Wales all present one characteristic feature, in having each of them what is called its *underclays*. And Sir Wm. Logan first announced, in 1841, that they were regarded by the colliers of South Wales as an essential accompaniment of each of the one hundred seams of coal met with in their coal field.

Having shown how coal is supposed to be produced, I shall now speak of the discovery of the various mines now worked in British North America; and shall commence by giving an account of the Albion mine, at Pictou, Nova Scotia, it having been the earliest worked, and being, up to this date, the most important, both as regards the thickness and extent of the seam, and the quantity of coal which it has yielded.

As early as 1817 coal—the existence of which had been known to the aborigines—was discovered on the East River of Pictou, Nova Scotia, by the Rev. Dr. McGrigor, a Scotch immigrant, who used it for domestic purposes. It was also worked at the outcrop, for several years, by Adam Carr and Ralph Patrick, Scotch miners, and by the late Robert McKay, Esq., a native of the county. Mr. McKay was a young man of intelligence and enterprise, and entered into a contract with certain parties in Halifax to supply them with coal—then a very rare article in the Province. He engaged all his capital and credit, and during the winter succeeded in excavating about 200 chaldrons, which he unfortunately placed on the "interval" of the river, for the more convenient shipping in the spring; but on the breaking up of the ice, the flood swept away, or covered with mud, the whole of his wealth. Messrs. Carr & Patrick were more fortunate, and for several years continued to supply blacksmiths and a few others with coal, at *ten* shilling a chaldron.

In 1826 a monopoly of all the mines and minerals in Nova Scotia and Cape Breton was granted by George IV. to his brother, the Duke of York; who sold his right to Messrs. Rundell & Brydge of London, who formed a company called "The General Mining Association," which in the same year commenced operations, under the superintendance of Mr. Richard Smith, an eminent English mining engineer, on the farm of Dr. McGrigor, which had been purchased by the Association. Operations were commenced on the largest scale and with all the appliances of modern science, and resulted in the development of coal seams far exceeding in thickness anything hitherto discovered in the old world. The coal measures of the Albion mines were found to consist of the same materials, and to contain many of the same fossils, as were subsequently found at the Joggins, already described; but they differ in the arrangement. Instead of a great number of thin beds of coal and bituminous shale, there are here a few beds of enormous thickness, as if the coal-forming process, so often interrupted at the Joggins, had been allowed to go on for a very long period without interruption. The sections of the Albion mines are not perfect; they show however, five or six seams of coal, and an immense thickness (800 feet) of black shales, with cypris and remains of ferns and other leaves. There are also *underclays* and ironstones abounding in stigmariae. The vertical thickness of the two large seams of coal—the *main* and deep seams—is 37½ feet and 22½ feet respectively. The main seam has been very extensively worked, and its outcrop can be traced for several miles; but it is remarkable that it bears its character as a seam of good coal only for a limited distance. And the measures were till lately supposed to be cut off to be the northward, by a line of disturbance running along the south side of an enormous bed of conglomerate, which succeeds these coal rocks in ascending order, or *apparently so.* The seams are not of equal quality; and the coal hitherto exported has been obtained chiefly from the upper part of the main seam, from twelve to nine feet of which are worked at the depth of 400 feet from the surface. The *deep* seam of coal, of excellent quality, lies 150 feet below the main seam. The General Mining Association also opened pits at Sydney and Bridge-port, or Lingan, Cape Breton; and at Joggins, in the county of Cumberland. They have met with several great disasters, but they have always risen superior to them. In 1832 they had got their works, at the Albion mines, in admirable working order, when an explosion of fire-damp occurred and fired the mine; and the superintendent turned the East River into the shaft before it was extinguished. The water was not pumped out in less than two years, and at an enormous expenditure. The trade which they had just established with the United States, was for a time seriously interrupted. Some ten years after, a second most serious explosion and fire took place ; which was extinguished by stopping the vents, and filling in earth some twenty or thirty feet into the main shaft. The fire was thus extinguished; but great damage was done to the works, which had to be abandoned for some time, and new shafts were in consequence sunk. At this time the demand for coal had so increased that it far exceeded the supply—notwithstanding which the Association threw every obstacle in the way of private enterprise; but public feeling, in oppostion to the monopoly, at length became so general and powerful that the Association had to yield. Under their charter, they had to pay a fixed royalty of £5000 sterling, and six pence per chaldron on every chaldron raised beyond a certain amount. It was agreed to give the Association the right of mining over two miles at Pictou, Sydney and Cumberland—the lines and courses of the areas to be at the option of the Association. The £5000 royalty was given up, and no more royalty per chaldron was to be exacted from it than from any new companies that might be formed.

In 1851, the coal shipped or raised by the General Association amounted to 59,574 chaldrons, or a little over 89,000 tons. Now to show the great stimulus that was given to mining operations, by abolishing the monopoly, we will compare the return of 1860 with that of 1851. We find that in 1860 there were raised 172,947 tons, of the value of £85,682 sterling—61,725 tons of which were shipped to the United States. I shall make one further statement. Returns presented to the Legislature at the

Session of 1864, shew that there were raised in 1863, 429,321 tons *from twenty-two mines;* 286,758 tons of which were shipped to the United States, 65,773 to the Colonies, and 72,758 tons were consumed in the Province I may also mention that, out of 397,608 tons raised in 1862, no less than 325, 111 tons were raised and shipped by the Association; thus falsifying all their predictions as to the ruin which would overtake them should the monopoly be abolished. In the three first quarters of 1864, there were raised 406,699 tons from 24 mines, and I believe the year's return fell little short of 500,000 tons. The demand has increased with the supply; and 1865 would have shown at least as large a return as 1864, but for the falling in of the Dalhousie pit at the Albion mines.

There is another very important fact which must not be overlooked. The General Mining Association, in laying off their two-mile area at Albion mines, influenced by the general belief of geologists, that the bed of conglomerate cut off the coal measure to the north, *made that bed their northern line.* To their surprise, a twelve-feet seam of very superior coal, called the Fraser Mine, was discovered almost immediately to the north of the conglomerate; and the works are in progress to develop it extensively, under the name of the "Acadia Mine," by a company, of whom Mr. Hugh Allan of Montreal, and Mr. Cyrus Field of New York, are prominent members. Again: a few months ago, almost adjoining the Acadia mine, another seam of 18 feet was discovered by Mr. French; and lastly, Mr. Campbell of Halifax, in an adjoining claim, and only eighteen feet below the surface, discovered a seam of pure coal 25 feet thick; a sample of which I here produce. Perhaps nothing in the history of coal mines can equal this seam of coal. It has been discovered, too, at a most opportune time—just as the Dalhousie pit had fallen in and the General Mining Association were unable to supply the demand; and, to complete the good fortune of the discoverer, when Government had determined to construct the unfinished portion of the Halifax and Pictou Railway, within a most convenient distance of his discovery.

The Pictou coals are bituminous—yielding a large quantity of gas, but likewise a large quantity of ash. They are well suited for steam, gas and iron works. The texture is laminated, and there is much mineral charcoal on the surface. Its specific gravity may be stated at 1.325, and a cubic foot weighs 82 lbs., rather less than 28 feet being equal to a ton of coal.

The Sydney coal is more highly bituminous than that of Pictou, but contains a very large quantity of sulphur, which unfits it for smelting; and it is objectionable as a steam coal, from its formation of clinkers and its speedy destruction of furnaces and boilers. It is a very excellent domestic coal, leaving little ash, but producing much smoke, quickly fouling chimneys.

The Spring-Hill mine, at the Joggins, consists of a seam of three feet six inches and one foot six inches, separated by a clay of a few inches. It is a fair, free-burning bituminous coal.

The fixed price of the coal, delivered on board ship at the wharves of the General-Mining Association, is $2.50 per ton of 2240 lbs.

The other mines now worked yield coal of very different qualities; but all may be pronounced good bituminous coals. No anthracite has yet been discovered; and, if geologists are to be relied on, there is little likelihood of any being found. But this account would be incomplete if I were to omit mention of the "Fraser" oil-coal mine, which was discovered in 1859, and which I visited in 1860.It is situated a short distance north of the Albion mine and the conglomerate, and consists of two seams —one four feet and the other eighteen inches thick. The dip enables it to be worked on the inclined plane. Seventy yards down the incline a seam of bituminous coal commences, one and a half inches thick. The oil-coal occupies a position within the true coal measure. One ton yields 7 gallons of crude oil, and, near the outcrop, 200 gallons. 2400 chaldrons were raised during the year 1859, and sold at the wharf at $9 per ton. But the discovery of the oil-wells in Pennsylvania and Canada, made competition hopeless, and the works have been stopped. I must here note for reference hereafter, when I come to speak of the deposit at Hillsborough, in Albert county, New Brunswick, that the Fraser mine is found geologically *far above* the Albert oil-coal *seam*. The importance of this fact can only be appreciated when we come to consider the theory of the origin of oil and common coals: the common coals being considered to have their origin in the destruction of land plants, and petroleum from marine plants. Time will not permit us to dwell longer on the coal-fields of Nova Scotia. I must, therefore, direct your attention to those of New Brunswick.

It will be unnecessary to say anything further on the common coal formation, as that has already been pretty well discussed in connexion with Nova Scotia coal. So I shall at once bring under your notice the Albert mine, in Albert county, New Brunswick—a substance at one time considered so peculiar, that one-half of the scientific world pronounced it coal, and again petroleum; and ended by saying, that it was neither one nor other, but "*Albertite.*" This locality was visited and carefully examined as late as 1863, by Professor Bailley, of Fredericton, New Brunswick, whose official report I shall refer to; it has also been visited, during the past summer, by Professor Hind, of Toronto, and it is necessary that his views should not be overlooked.

Professor Bailley first visited the Albert coal mines, and he thus speaks of them:—"So singular is their history—so lengthy are the reports and disputes concerning the true nature and position of the coal, and so extensive are their operations—that I cannot, however, for the general interest of the Province, refrain from referring to the extensive operations now conducted on the spot, as illustrating what a fair amount of energy and perseverance may do in overcoming apparently insurmountable difficulties in mining operations." The discovery was made in 1849; but, from the conflicting accounts given by geologists of the geological relations and chemical character of the coal, the capitalists of New Brunswick held aloof from investing in what was pronounced an "uncertain and hazardous undertaking." Why it should have been so pronounced can be readily understood by reference to the trial, "Gesner *vs.* The Halifax Gas Co.," before Judge Wilmot, in 1852.

On referring to the Judge's minutes, it will be found that nearly the whole scientific world of America, and to some extent of England also, was employed in the determination of the vexed question. The witnesses for the Plaintiff swore:—That there was an anticlinal basis; that it was a vein, not a bed; an injected mass thrown up--strata distorted. No conglomerate above and below; no parallel strata of coal beds; no roof; no floor; no fire clay no coal fossils; *and lies beneath coal formation.* Amorphous; no vegetable structure; no cellular tissue; no lamination; and transmits light.

The Defendant's evidence was:—That there was *no* anticlinal axis; is a bed, not a vein; a deposit, and not an injected mass; strata parallel; has roof, fire clay, and coal fossils; and is just where it ought to be, in the coal series above the old red sandstone—and it would be a miracle if a coal bed were not there; has indications of vegetable structure; distinct laminations, &c., &c.

Then, as to its properties, the evidence of Plaintiff showed:—That it was fusible, melted by heat, and is the same after being melted as before; is soluble in coal-tar, in turpentine, in naphtha, and in other menstrua. The Defendant proved:—That it would not melt without changing its character, by throwing off gas. Every known variety of asphaltum melts at not exceeding 250, and, after cooling, can he melted again. Known asphaltum softens in the sun: sun has no effect on this. When apparently dissolved in coal-tar, it is not dissolved, but only held in mechanical suspension.

Hear, now, what Professor Bailley writes in 1863:—"I call the substance coal, although in the vicinity generally known by the name of shale . According to the statements of Dr. Robb, it is neither a shale nor a schist; but a true cannel coal, having all the characteristic properties of the substance to which that name is given in other localities. Openings have been made upon six different strata, and coal has been removed from them to the extent of 1,000 tons. I descended one of these openings, and found the coal to form a distinct stratum, about four feet in thickness, about ten feet from the surface. In descending, the bed rapidly increases in thickness and purity. The walls are composed of highly bituminous shale, emitting considerable odor. The shales and coal are perfectly conformable— the coal being a true *stratum*, and not a mere *deposit*, like some portions of the Albert coal."

"The unweathered coal is dark-black, and unlike the true Albertite, entirely lustreless. It admits, however, of a fine polish; and beautiful ornament objects might readily be cut or turned out of it, its color being little inferior to jet. It is not at all brittle, like Albert coal; but, on the contrary, rather tough, breaking with a large conchoidal fracture. It is nearly homogeneous in character; but occasionally contains irregular seams and masses of a brightly-shining and brilliant coal, apparently identical with true Albertite. Il is very hard and heavy, containing so much volatile matter as to allow of being readily ignited by the flame of a match or candle." Taking an average of the beds yet opened, their thickness would be from two to seven feet, and one of these beds is said to outcrop on the very summit of Baltimore mountain. These seams were at one time worked quite extensively, and distilled into oil, at the 'Caledonia works.' When Mr. Bailley visited them they were lying idle—probably from the same cause as led to the abandonment of the'Fraser mine,' near Albion mines, Pictou. "There can be no doubt," says Professor Bailley, "that the supply of coal in the vicinity of these oil works is very great, and its quality excellent." In a foot-note, the Professor says:—" At the time of the celebrated controversy upon the nature of the Albert coal, this fact was one of much importance. One party contended that the Albertite was a *mere deposit*— and hence not *coal*, but *asphalt*, the other, that it occurred in true strata of the coal measures, and was really a highly bituminous coal. The latter is undoubtedly the correct view; yet Mr. Byers informs me that, while in some portions of the mines the coal is in beds, *conformable with the natural stratification; in others it is directly at right angles with it.*"

Returning again to the 'Albert mine,' at Hillsborough —and which is not to be confounded with the Caledonia oil-coal mine, from which it is about eight miles distant—we find that this mine, pronounced at first utterly valueless, is every day becoming more extensive. "It was at one time thought that the supply of coal would soon become exhausted; and hesitation was evinced as to the propriety of erecting expensive machinery over a mine which might at any moment cease to be of value. This uncertainty arose from the fact, that the distribution of the coal does not seem to follow the same laws which are generally observed in coal-mining districts; and frequenly when a level is being worked in a particular direction, the supply is found suddenly to fail. This is, of course, partly due to *faults;* but not entirely so, as in many cases the coal shows no conformability with the inclosing rock. It has been found, however, that, in such cases, beds may be readily found after a little drifting; and the proprietors have now no hesitation in urging on other works. The coal is of a perfectly uniform character wherever found, there being no division possible into various qualities; and all commands the same commercial value." A valuable lesson may be drawn from this: twelve years ago, everybody seemed unwilling to engage in the enterprise; now steam-engines (one of 400 horse-power) are at work, and in 1863 above 16,000 chaldrons were raised; and, according to Professor Hind, since the opening of the mine 170,000 tons have been raised, of the value of $10 per ton.

Professor Hind visited the Albert mine in October, 1864. He descended the mine to the depth of 750 feet. He thinks the relation of the Albertite to the adjacent rock *absolutely undefined;* and says: *sometimes*, but rarely, the strata are parallel to the veins; sometimes, and generally, inclined to it, at a greater or less angle; and sometimes they butt end on; and not unfrequently, for some hundred feet, the strata are inclined, at different angles, to the vein at opposite sides. In fact, there are numerous dislocations,and in one dislocation the vein overlaps by many feet, and passes beyond the vein in another dislocation; and, from this fact alone, he believes that the *vein is not a bed*. He says, the evidence is now conclusive that the Albertite has been injected into an irregular fissure, in a liquid or soft state, under great pressure; so as not only to fill the fissure but to force itself into all the minor cracks in the rock subordinate to the main fissure. Professor Hind thinks that Professor Bailley, in asserting that it is coal, gives no reason for his opinion; and says;—"If it were coal, the mode of its occurence would be directly opposed to the views of geologists respecting the nature, origin and disposition of coal; and no sound advice could be given towards prosecuting a search for it in any direction." I may here remind you that, guided by the views of experienced geologists and practical miners, the agents of the General Mining Association selected their area south of the line of conglomerate, which was supposed to have cut off the coal seams to the north. The new adventurers, not having the fear of geologists before their eyes, discovered invaluable mines where geology had pronounced it was improbable they would be found.

Professor Hind believes Albertite to be an inspissated or hardened petroleum, and that its source lies below the Albert shales, among rocks of the Devonian age; though he admits that recent enquiries have established the fact that petroleum is not only very widely diffused, but is not, as was generally supposed, confined to rocks of a certain geological age—but that it occurs in rocks of all ages, and often in different mineral states or conditions. Naphtha, petroleum, rock oil, asphalt and mineral pitch, are all forms of bitumen.

In reference to the Albert or Baltimore shales, formerly worked by the 'Caledonia Oil Co.,' Professor Hind says, he counted, in an inch, upwards of a hundred of very thin alternate layers of stratified calcareous mud and bitumen, and that this bitumen differed from the Albertite; and that they appeared to be the uppermost beds of the formation, and to contain a much larger amount of bitumen—a ton yielding from sixty to ninety gallons of crude oil; and they seem to have been formed in a shallow, tranquil, tidal estuary, into which springs of petroleum were discharging themselves. They must not be mistaken for the 'oil shale,' or 'oil coal,' of the Fraser mine, in Nova Scotia, which lies geologically far above the Albert shales, and occupies a position within the true coal measures; nor with the earthy bitumens which are found within the same geological limits. These oil-coals and earthy bitumens of the coal measures are thought by Dr. Dawson (than whom a better authority on this subject does not exist) to be "a water-soaked vegetable soil, completely bitumenized and twisted and slickensided, owing to the giving way, under pressure, of the roots and trunks under which it was interlaced." Mr. Henry Poole describes it as 'a substance of shaly aspect, laminated and slickensided, and the laminae much twisted, causing it to be distinguished as *curly* oil-coal. This bed varies from two to twenty inches in thickness. Under it is a bed called 'oil shale,' about two feet thick, and containing ganoid scales, lepidodendron and cordaites. Below this are argillaceous shales, abounding in cypris and spirorbis ".

Professor Hind has no doubt that the Albertite is of Devonian or prior origin, and proceeds from rocks of the same age as those which yield the petroleum of Pennsyl vania, Ohio and Canada; and says:—"Recently some remarkable discoveries of bitumens in many different stages, from petroleum to Albertite, have been made in the West India Island;" and he quotes Dr. Sterry Hunt, as follows:—"We do not know the precise conditions which, in certain strata, favor the production of petroleum, rather than of lignite or coal; but in the fermentation of sugar—to which we may compare the transformations of woody fibre—we find that, under different conditions, it may yield either alcohol and carbonic acid, or butyric and carbonic acids, with hydrogen. These analogies furnish suggestions which may lead to a satisfactory explanation of the peculiar transformation by which, in certain sedimentary strata, organic matters have been converted into bitumen."

ProfessorHind also says:—"The altered character of the slates underlying the carboniferous system in the deep indent from Dorchester to Sussex, does not militate against the supposition, that the rocks to which these slates belong are the source of the petroleum; for it is well known that the metamorphosis produced by intrusive rock is generally confined to within a few yards of the intrusive mass". The petroleum springs in Albert and Westmoreland, which probably come from the underlying Devonian rocks, show that metamorphic action has not there changed in the least degree the character of the fluid; one of these springs being within five miles of the Albert mine, and within less than a mile of Albertite in place.

Albertite in position has been discovered in six different localities. Fifteen miles from Sussex Vale, in metamorphic slate. The Humboldt mine, in King's county, has a small vein running through metamorphic slate rocks In all other places, with this exception, the Albertite has been found in shales, sandstones, conglomerates, or limestones, of the lower carboniferous series. In the Humboldt mine no trace of shale is found; but the conglomerate and drift are impregnated and cemented together with bitumen.

British Columbia.

Coal crops out towards the coast of British Columbia, and has attracted some attention; and outcrops occur at several points of the eastern coast of Vancouver's Island; and the Hudson's Bay Company have made several attempts to turn this to profitable account. Works were commenced at Beaver Harbour in 1849; but were soon abandoned. Extensive seams of workable coal were subsequently discovered at Nanaimo, sixty miles north of Victoria, by Mr. Joseph McKay, in 1850. The same seam was found on Newscastle Island, and several other small islands in the channel; and the Indians got out 200 tons. At Nanaimo, a shaft to the depth of fifty feet was sunk by regular miners, and a vein to the depth of seven feet thick was found lying on conglomerate. Eight miners were able to raise 120 tons per week. The pit is within a few yards of the water, and vessels drawing sixteen feet can anchor close to it. It is believed that coal may be found anywhere within a circumference of two miles, at a depth not exceeding sixty feet. About 6,000 tons have been raised—one-half by Indians. The great importance of this mine will be understood, when it is stated that not less than 200,000 tons of coal are required for the consumption of the Pacific steamboats; all of which had to be carried from Europe, or from the Albion mines, at Pictou, Nova Scotia.

CANADA.

I now come to the consideration of the question:—Has coal been discovered, or is it likely to be discovered, in Canada? And as reference has been so frequently made to Sir William Logan's opinions, and as he is undoubtedly the highest authority to whom we can appeal, I shall at once give Sir William's own words, as we have them under the head "coal," in Geology of Canada:—"The black bituminous shales or pyroschists of the Portage and Chemung groups, contain the remains of terrestrial plants, including a species of calamites, the flattened stems of which are sometimes found to be converted into coal." The Portage and Chemung group are of the higher members of the Devonian series; and their shales contain so much organic matter, as to take fire and burn with flame, after which the color is changed to brick-red. The higher portions of the Devonian, at Gaspé, abound, in some portions, with similar remains of carbonized plants; and in the lower part of the Gaspé sandstones *there is a well-defined seam of coal*, with carbonaceous shale, measuring three inches, and *having beneath it a bed of clay holding the roots of plants*. The section of these sandstones, given on page 394, shews that a terrestrial vegetation prevailed throughout the whole series; yet in no other part of the thickness of 7,000 feet was there observed a distinct coal seam. The same upper Devonian strata, in the state of New York, contain in like manner thin seams of coal, which are of no economic importance. The rocks of the Bonaventure formation, in Gaspé—*the only representatives in Canada of the true coal-bearing series*—have afforded nothing but a few carbonized plants."

Under the head "Carbonaceous Minerals," viz, liquid and solid bitumen, carburetted hydrogen gas, bituminous shales, coal and graphite, Sir William says, that graphite is common to the Laurentian and the *altered* palaeozoic rocks; but the others are not met with in the unaltered palaeozoic strata alone. Bituminous matter in the form of petroleum, or mineral coal, appears in many places in the limestones of the Trenton group, from the extreme west to Gaspé Basin, where is found a layer of mineral pitch, or dried bitumen, an inch in thickness, lying beneath the surface of vegetable mould; while the soil from some distance to the east is saturated with petroleum. In other locaties is also found bitumen, in the form of asphalt; and at Petrolia, in Enniskillen, a bed, from four to two inches thick, was met with at the depth of ten feet in the clay, and reposing upon four feet of gravel. This bitumen is readily separable into thin layers, soft and flexible, and shewing on their surface remains of leaves and insects, which had become imbedded in the bitumen during its slow accumulation and solidification. Sir William likewise says, that at Kincardine and Bertie the soluble and liquid bitumen of the corals becomes replaced by an insoluble carbonaceous matter, infusible, the result of the slow oxidization of the petroleum. "These observations seem to throw light upon the origin of a black, combustible, coal-like matter, which occurs in many places in the Quebec group, and has in different localities been mistaken for coal. In the Quebec group, which is regarded as the equivalent of the calciferous formation, this substance has been observed at Quebec, Orleans Island, Pointe Levis, Sillery, St. Nicolas, Lotbinière, Drummondville, Acton, at Gaspé, and many other places.

The black shales at Bear Creek, near Kingston Mills, Warwick, are inflammable, as in the case of similar shales of the Utica formation, "and have suggested to many persons the probability of beds of coal in the vicinity. Between these highest shales, however, and the horizon of the true coal measures in the southern peninsula of Michigan, where these measures are nearest, *there is wanting in Western Canada the remaining portion of the Portage and Chemung group.*" The epithet bituminous shales, or pyroschists, is not only applied to such as contain ready-formed bitumen, but to coals, shales, &c., which closely resemble bitumen in composition and properties, and from which petroleum can be produced by destructive distillation, as from lignite, peat, and even from wood; "and it is probable that some of the strata of the Quebec group, as well *the black shales at its base,* are *pyroschists;* for the altered rocks of this series are, in many places, very carbonaceous, and contain an admixture of plumbago ".

Bitumens have been supposed to owe their origin to the action of heat on coal, and similiar organic matters, by slow distillation; but it is objected that they occur in rocks in which there is no evidence of the action of heat, as at Bertie, where bitumen has been generated in the porous rocks, where it is now found; and "in the palaeozoic rocks of North America, bitumen must be derived, either from a marine vegetation, or the remains of marine animals, the lower forms of which differ but little in elementary composition from plants, and may as readily yield bitumen; and the transformation, by which organic matters may be converted into bitumen, does not differ very greatly from that which produces the more bituminous coals, to some of which certain of the asphaltums approach very closely in composition."

The bitumen of Trinidad is in the tertiary system, and associated with beds of lignite, and confined to particular strata once containing vegetable remains, which, according to Mr. Wall, have undergone a *special mineralization,* producing bituminous matter, instead of coal or lignite. Vegetable matter, whether of marine or terrestrial origin, may be changed into petroleun, lignite, or coal; but it is very likely that an accumulation of molluscous animals, in certain strata, may from subaqueous decomposition, have given rise to the petroleum found in the coral rocks or palaeozoic limestones of Canada.

From these quotations, I do not think we would be justified in asserting that Sir William Logan has entertained the dogma that coal did not exist, and consequently could not be found, in Canada. True it is, he has said that the Bonaventure formation—which he considers the only representatives of the carboniferous systems in Canada—has only afforded a few carbonized plants; but discovery, even at Bonaventure, is not exhausted; and, from the facts which I have furnished in connexion with coal or coal-like substances in British North America, I do not think that Sir William would assert the impossibility of finding coal in Canada in quantity to be of economic value; though up to 1862—the date of the publication of the Geology of Canada—he might have thought it improbable.

I have now got pretty well through my subject; and trust I have arrived at the point from whence I can introduce, intelligently and intelligibly, the facts in connexion with the discovery of the coal-like substance at Pointe Levis, and which have led to the preparation of this paper.

On hearing that coal had been found at Fort No.3, Point Levis, I took the earliest opportunity of visiting the spot, as from the rumours that were abroad, I thought it not impossible that a discovery of some value had been made. I first went to the smithy, where I had been told it had been in use for the last few weeks. I saw in the coal bin about twelve bushels of what I at first thought was ordinary blacksmith's coal, but which the smith told me had been taken from the excavations for the fort. On a more close inspection I thought I had seen coal which really did not appear more genuine than that which I held in my hand, only it was much lighter than ordinary coal. The smith informed me that he had been using it, and nothing else, for the last twenty days, and that it answered equally as well as the Newcastle coal, which he had previously used, but that it burnt away more rapidly. It was easily lit, and when covered up at twelve o'clock, only required the blast of the bellows to bring it into a glow again, when work was resumed after dinner, at 1 p.m. It left little ash, and formed a light clinker.

I then visited the works, where I met Mr. Gunn, the overseer, who obligingly accompanied me to the vein or stratum, or I should rather say veins, for they were three in number, running parallel to each other, within a width of four feet, and being *conformable* with the strata of shale. The seams were of unequal width, the centre, being the largest was in some parts between ten and twelve inches thick, narrowing, both upwards and downwards, to a couple of inches; the two lateral seams in no part exceeded three inches in width. The dip of the slaty shale, with which they lie conformably, is to the south, at an angle not exceeding nine degrees. The seams have been met with, more or less regularly, running towards the east, about forty-five feet. On a subsequent visit, I inspected another small seam, about two inches in width, situated about ninety yards eastward of the first discovered seams. I looked upon this carbonaceous matter as nearly answering the description which Sir William Logan has given of the "altered bitumen formerly found in many places of the Quebec group, and which was first described by Vaunuxem, in the Geology of New York, under the name of *anthracite,* as occurring in the calciferous formation, with crystals of bitter spar and quartz (our Cape diamonds) having been introduced into the cavity, in a liquid state, and subsequently hardened, showing, by its having conformed, that it was once in a plastic state. Very pulverulent, brittle, of a shining black, and, according to Vaunuxem, yielding but a small amount of ash. The volatile matter given off from different specimens varied much; that from Mountain Hill, Quebec, equalled 19.5 per cent.; that from the Island of Orleans 21.0; that from StFlavien 15.8; and another 24.5. But then Sir William also had said: "It fills fissures several inches in diameter, so that it has been mistaken for coal, and attempts have been made to work it at Quebec and elsewhere. The mineral, however, is *never in true beds like coal,* but is always confined to veins and fissures, *which cut the strata,* shewing its deposition to have been posterior to the formation of the rocks."

Being anxious to have the opinion of Dr. Dawson, who, I was aware, was well acquainted with the Hillsborough mine, I forwarded him specimens, and gave expression to my opinion. Dr. Dawson very soon favoured me with a reply, which I was pleased to find accorded with my own expressed views. I give that portion of his letter bearing on the subject:—It is evidently the sort of altered bitumen which Sir William Logan refers to; and furnishes a curious illustration of the manner in which a substance resembling coal may originate in a quite different way from the ordinary one. It is likely that the deposit may be quite limited in extent; but this is not certain, and should not be taken for granted. The profitable working of the *Albertite* in New Brunswick, under circumstances very different from those of ordinary coal, shows that the most unlikely things are possible in such matters."

Analysis.—Two lumps of this coal, weighing 4 oz. 1 drm., taken indiscriminately from a keg, were put into a crucible, and placed in an open grate. When the crucible became red hot, one of the pieces softened, and swelled like a good bituminous coal; the other piece, which was harder and heavier, and evidently contained more earthy matter, swelled very little, but cracked and fell to pieces very slowly. The first piece gave out a large quantity of gas, the second less, which, mingling in the upper part of the crucible, broke into a flame, which burnt brilliantly for some minutes. The first piece left a small quantity of fine-ish cinericious ash; the second a large quantity of a brownish shaly matter. On weighing the solid product it was found to weigh 1 oz. and 15 drachms, having parted with 2½oz of gaseous matter, or nearly two-thirds of its original weight.

The crucible was then filled about one-third of its capacity with the finer part of the coal, which, when the crucible became red hot, swelled out, occupying another third, and for about half an hour yielding gas, which became ignited, and filled all the upper portion of the crucible. I here produce the cinder produced, which you will observe is light and porous, and has assumed the form of the interior of the crucible.

In conclusion, let me give the deductions which I have drawn from the various facts which I have submitted:—

First,—I think it has been proved that carboniferous matter pervades rocks not included in the carboniferous system of Geologists, and that, owing to special circumstances, the matter may be presented to us as Petroleum, Asphalt, Altered Bitumen, Lignite and Coal, varying from an earthy bituminous shale coal, to one so highly bituminous as to be with difficulty distinguished from pure asphalt.

Second,—That the productions of the mines of Europe, as well as Nova Scotia, which have generally been recognized as coals, owe their origin to the accumulation and decay, or change of *terrestrial* vegetable matter, from growth *in situ,* chiefly of sigillariae, calamites, poacites lepidodendron and ulodendron, as is so clearly illustrated in the section of the Joggins; or from drift formations, such as are now in progress, at the delta of the Mississippi, and other great rivers.

Third,—As a general rule, where coal owes its origin to terrestrial vegetable growth *in situ,* it is underlaid by a stigmaria clay; but that it may be generated without the stigmaria clay, as demonstrated by the two coal seams at the Joggins.

Fourth,—That oil coal, the production of terrestrial vegetation, may be generated in the true coal measures, as in the case of the "Fraser Oil Coal Mine," at Pictou, and the "Albert" deposit at Hillsborough, N.B., which Dr. Dawson pronounces "a fresh water formation of the *lower carboniferous period*", though Professor Hind views it as produced and injected from *beneath* the lower carboniferous series, from rocks of the Devonian, or prior origin.

Fifth,—That oil coal, the production of marine, vegetable, or animal organic remains, may occur in rocks of almost any geological age; and that it may present itself in fissures, *cutting* the strata below which it may have been generated, or that it may occur as a *horizontal* bed, originally poured out over the bottom of a lake, or of a shallow, tranquil, tidal, estuary, and hardened and covered up by sand and clay deposits of the carboniferous age.

Sixth,—That various instances cited show that petroleum generated from the destruction of marine, animal and vegetable life in the strata of the great palaeozic basin of British North America, at several different geological horizons, may, by oxidation and volatization, be slowly changed into asphalt, or mineral pitch, by a continuance of the same action, may be converted into a coal-like matter.*

Seventh,—That at the base of the lower silurian rocks in Canada (the Quebec group) a black, combustible, coal-like substance has been found in several places, and that comparing the conditions under which it has been discovered at Point Levis with those existing at Hillsborough, it is neither impossible nor improbable that *coal*, or a substance possessing many of its most valuable properties, may be yet found, in sufficient quantity to make it of great economic importance.

And Eighth,—That the facts cited in connection with the Hillsborough mine, in New Brunswick, and still more recently with the operations in the vicinity of the Albion mines, Pictou, N.S., show that the most eminent Geologists, and most experienced practical miners, may seriously err, and that it is not always safe to rely on their opinions and predictions in the prosecution of mining enterprise.

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*To enable us to form some idea of the enormous secretion of petroleum, it is only necessary to refer to the quantity yielded by the Oil Springs of North America, a discovery of yesterday. It is estimated that 500,000,000 gallons of crude oil have been produced, including 50,000,000 from the Springs of Canada.

NOTE.

SPECIMENS OF COAL EXHIBITED TO THE SOCIETY.

First:

1st. Brown.—Boghead; cannel coal.

2nd. Grey Black.—Lesmahago; cannel coal.

Qualities:—Hard, non-lustrous, highly bituminous, homogeneous, and admirable gas producers. They are found in the **Secondary** series, in the true coal measures, and their seams sometimes run into common bituminous coal; and fossils of sigillariae, and other plants of the true coal measures, are found in them. The "oil-coal" of the Fraser mine, at Pictou, Nova Scotia, and the "Albertite," at Hillsborough, New Brunswick, are similar to the lesmahago, and are situated in the true coal measures.

The Baron Von Buck considers the brown coals of Germany, of the miocene formation, to afford no intrinsic evidence of their age, as they are composed of fragments, or mere leaves, without flowers or fruit. The brown coal of Radabog, on the confines of Styria, is covered by strata containing **marine** shells, itself contains cones, leaves and wood of coniferous trees, and fragments of trees of the laurel and platainis tribes.

At Bonn and Cologne, the brown coal, or lignite, is of various ages—**eocene, miocene** and **pliocene**; and countains only one fossil, very like a cocoa-nut.

In 1851, the Duke of Argyle disscovered, in the Isle of Mull, in the **tertiary** strata, three leaf-beds, each from 1½ to 2½ feet thick, interstratified with volcanic tuff. The leaves belong to plants not now indigenous to the British Isles

Dr. Dawson discovered, at River Inhabitants, Nova Scotia, under the boulder clay, and superimposed on grey clay, a hardened peaty bed, nearly as hard as coal, but tougher and more earthy, containing many small roots and branches of coniferous trees, having a glossy appearance, approaching the brown coals in quality, and burning with a considerable flame.

Second:

1st. Dry cubical.

2nd. Fat cubical.

The ordinary domestic English and Scotch coals—composed of carbon, oxygen, and nitrogen, and the quality depending on their relative proportions.

Third:

Anthracites.—1st American Lehigh—black, hard and lustrous. In 1841, Sir C. Lyell saw at "Mauch Chunk." Lehigh, a seam between forty and fifty feet thick, from which coal was quarried in the open air—the overlying sandstone forty feet in thickness, having been removed bodily. This vast deposit, unmixed with earthy ingredients, Sir C. Lyell considers the result of the growth, during thousands of years, of trees and ferns after the manner of peat, subsequently condensed by pressure, and by the discharge of its hydrogen, oxygen, and other volatile ingredients.

2nd. Welch or steam anthracite—rather more bituminous than the Lehigh.

3rd. Scotch or blind anthracite—very similar to the Welch. The Scotch miners consider this coal to be bituminous coal, changed by the superimposition of **trap**; and in searching for anthracite always look first for the trap. The best anthracite has only from 6. to 11% ash; the less pure, as much as from 40. to 50. The characteristics of anthracite, whether splint, glance, hard, or culm, are great heat, little smoke, and little ash, on combustion.

Fourth:

Pyritous coal from Glace Bay, Cape Breton.

Fifth:

Coal or Altered Bitumen from the Palaeozoic rocks of Point Levi

N.B.—The Oolitic coal at Brora, Sutherlandshire, Scotland, affords the thickest stratum of pure vegetable matter hitherto discovered in any secondary rock in Britain. One seam of good quality, 3½ feet thick, has been worked, and there are resting upon it several feet more of pyritous coal, of which I have seen cart loads in square blocks, which shone in the sun like burnished coal. Sir C. Lyell points out that in this neighbourhood common hypogene granite, in contact with Oolitic strata, has been elevated bodily, at a period subsequent to the depositions of these strata. The pyritous coals are all liable to spontaneous combustion.

Sir C. Lyell also describes an Oolitic coal near Richmond, Virginia, which occurs in a depression of granites, extending twenty-six miles, north and south, and four to twelve, east and west. The measure is composed of grits, sandstones. and shales, exactly resembling those of primary date, in America and Europe, which they surpass in richness and thickness of coal seams. Sir C. descended a shaft 800 feet, entered a chamber 40 feet high, formed by the removal of pure bituminous coal, exactly similar to the finest Newcastle: and it is worthy of remark that it has been derived from pure, zanites, calamites and equisetums, very distinct specifically, and in part generically, from those which contributed to the ancient palaeozoic coal.

Flora of the coal period.—About 500 species have been discovered; among them 250 ferns—the larger portion of European existing ferns—only some sixty in number being represented; but some are decidedly arborescent. Of the lepidodendron—a coniferous tree from forty to fifty feet in height—there are many species. Of sigillariae, 350 species, some of which were seventy feet in height. Also, numerous calamites, poacites, astrophylites, and equisetums.

Shells, &c.—Cypris, modiola, spirorbis, of fresh water. And, in England, fresh and marine shells intermingled, limuli, cytheres, micoconchus; several fishes of genus megalocthys and holoptychlus. Ont or more species of scorpions; two beetles of the family cucurlionidae; an insect resembling the genus corydalis, and another the phasmrdae, in Coalbrookdale. Several specimens of cockroach, and the wing of a cricket, in the coal of Wetting, in Westphalia; and twelve species of insects— blattinas, neuroptera, scarabaeus, a grasshopper or locust, gryllacris, and several white ants or termites, in the nodular iron-clay of Soarbouck, near Treves. Lately, also, a spider has been found in the coal seams of the palaeozoic period.