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"Hew to the Line, Let the Chips fall where they May."

J. E. BIGNEY, Editor & Proprietor.

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Poetry.

IN HARVEST DAYS.

"I gather them in; I gather them in,"
Is the song to-day the harvesters sing,
And their sickles are glancing here and there,
While they bind the sheaves with an earnest care
And bear them away to the storehouse strong,
They sing over again the harvest song:—
"I gather them in; I gather them in."

"I gather them in; I gather them in,"
Is the song to-day the death angel sings,
And his sickle is glancing here and there,
While he gathers his grain with diligent care,
And bears our loves to his storehouse strong,
He sings them to sleep with his harvest song:—
"I gather them in; I gather them in,"

"I gather them in; I gather them in,"
Is the song to-day the old sexton sings,
And his pick-axe is glancing here and there,
While he turns o'er the sod with tender care,
And hides our dead in his storehouse strong,
He whispers o'er them in his harvest song:—
"I gather them in; I gather them in."

Praise God—a voice not thine, oh sexton gray,
Shall be heard o'er the earth in the last great day,
And the doors of the storehouse shall outward swing,
While the Lord his ransomed ones home shall bring,
And gather them into His storehouse strong,
He will cry aloud and this be His song:—
"I gather them in; I gather them in."

The Formation of Coal.

A PAPER READ BEFORE THE ACADIA MINES SCIENTIFIC AND LITERARY CLUB, SEPT. 25TH, 1886. BY MR. C. C. PRESTON.

Mr. President, ladies and gentlemen,—The subject which I have the privilege of introducing for your consideration and discussion this evening is one replete with interesting facts and startling revelations.

Coal is commonly said to be composed of vegetable matter, and although the statement is quite true, still it is well not to take it entirely upon trust, but reasoning from the known to the unknown, patiently follow our subject through every transformation from the growing plant, perfect in its vegetable organism, on the one hand, to the glowing, sparkling, scintillating diamond on the other. Strange the change from the decaying vegetable to the beautiful gem, but I would beg you to reflect that mixture provides us with illustrations of changes, quite as great if not greater. What could be more different than the rough mass of crude ore taken from any one of our levels in these hills, and the beautiful burnished steel which meets our gaze at every turn, or again, consider the field of green wheat, and the loaves of bread which are placed upon our tables? Can anything appear more different or unlike, yet no one doubts that the steel was once ore, or that the bread was once wheat. The difference lies in the fact that in the case of our illustrations the transformation is seen and noted at every stage, while in the case of our subject the change is and has taken place, *unseen* by mortal vision. Hence the necessity for reasoning from the known to the unknown.

The vast extents of known coal deposits, which, notwithstanding the fears of a few pessimist statisticians, are enough to supply the world for many thousands of years to come, were formed at a very remote geological period; scientific men differ as to the exact age, but their differences are trivial, being only a few million years (unfortunately I have forgotten the exact date myself), but it was during the carboniferous period of the worlds antiquity. In passing we may note that the carboniferous system is a name given to the strata which, in geological order, rest upon the Devonian measures, and are capped by the Permian series. They derive their designation from the amount of carbon contained in them, and to them the great coal fields in the world belong. From an economic point of view, they are the most valuable series of rocks in the earth's crust, forming the great storehouse from which is obtained the chief supply of coal, iron and lime. Leaving the iron and limestone, we will deal solely with the coal measures, consisting of shale (which was once a soft blue mud), and sandstone and grit (deposited by the action of water). For a few moments I invite your attention to a partial view of the geographical formation of the Northern Hemisphere, as it is supposed to have been situated in this remote period. North-Western France, Belgium, Holland and Germany were then under the sea, Denmark and Norway were joined to Scotland by a continent, a tongue of which ran across the centre of England and into Ireland, dividing the northern and southern coal fields, thence in process of ages, it joined Greenland, North America, with Scotland and Norway. This view of the position of the land has been founded on the fact, that all the coal deposits in these modern countries, although now separated, are of the same geological age. How far this supposition is beyond or short of the truth, there are no means of showing.

The records of that old land, save what these fragmentary coal measures can give, are buried in the vast abyss of countless ages. We look back with awe, but derive to ourselves comfort, from the thought that "Time is not eternity." The greater portion of this old country was covered with dense jungles and wide swamps, inhabited by cessile forms of animal life, some wholly aquatic in their habits, some were arboreal and others amphibious. Many of these are unknown at the present day, they performed their part in the economy of nature and disappeared. However, some of their remains are frequently met with in the coal measures and in the over and underlying rocks. Some of the reptiles were of an enormous size. Several years ago I saw in the British Museum the fossil remains of what was said to be a lizard, probably the Archæogosaurus or ancient land lizard. To a great length of body and tail was joined an extremely open countenance, so much so, that when its mouth was pushed back it could experience little difficulty in walking down its own throat. It is however with the vegetable life of this period that we have to deal, because to it we are indebted for our well-nigh inexhaustible coal supply.

But, though owing to the wonderful luxuriance of vegetation then prevailing, the greater portion of our coal beds seem to have been formed in the period we are now describing; we must remind you that they have also been found in other formations. In truth, coal is the result of every period, because it is simply the mineralized result of vegetable accumulation, which accumulation is due to immensity of time rather than to rapidity of growth. The teeming waters ripple on the low shores of many a pleasant island, most of them covered only with rank dwarf vegetation, but others and large ones (almost continents), with vast forests of fern trees and cycads, sigillania and others, deficient in bud and bloom, but richly adorned with light, symmetrical feathery fronds. "The trunks of a modern forest are rough and gnarled; but those of the carboniferous period spring up like the sculptured shafts of a medieval temple, graceful in proportion and rich in ornament through endless repetition of flutings, spirals, zig-zags, lozenges, ovals, and other geometrical designs—these designs being the persistent leaf-scars of a vegetation simpler in structure and more primitive in plan. Although some 300 distinct varieties of coal plants are known to Botanists, we will only notice a few of chief ones. The Lepidodendron were large trees, of from 40 to 50 feet long, and more than 4 feet in diameter. They taper upwards and branch in a dichotomous manner, *i. e.*, their branches were arranged in pairs. The surface is either covered with narrow, sharp-pointed scale-like leaves, or marked with oval-shaped spaces, the scars of the fallen leaves arranged in a spiral manner. The fruits are elongated, cylindrical bodies, composed of a conical axis, around which a great quantity of scales are compactly imbricated. Lindley sees in the Norfolk Island pines, the closest resemblances to this ancient class of plants.

Sigillaria.—To this order of ancient plant life we are indebted more than to any other, the roots are found well preserved in the shale, which forms the floor of all coal seams. The stems, which are found abundantly, are marked by parallel longitudinal flutings, and regular scars, formed by the base or leaf stalks which had fallen off. They rose tall and stately to a height of 70 feet, with a diameter of 5 feet, without branching until near the summit, when it branched several times dichotomously. The proportion of woody matter to cellular tissue in the stem was very small. Hitherto no foliage of any kind has been found connected with the trunks, and for this reason the restoration of the genus has been quite imaginary. Some have supposed that the trunk terminated in a crown of simple leaves, like that of many palms, while others considered that the fronds of "Pecopteris nervosa," which are very abundant in the coal measures, was its foliage, and they would restore it so as to have the appearance of a modern tree fern on an enlarged scale, and still others consider that its affinities are nearer to Lepidodendron, and that some of the numerous fragments which have been restored to this genus may be really the branches of the Segillaria. There are other opinions, but it is unnecessary to quote them here.

Ca'lamites are another genus of coal plants whose true position has not been satisfactorily ascertained. They have been regarded by many authorities as "huge horse-tails," but beyond the fact that 39 different species have been determined, little is known of them.

Trigonocarpon occur in all the coal measures, and are very common. From their shape, which varies in size from that of a pea to a walnut, and from their occurring in such quantities in some localities, to admit of their being gathered by the bushel, it has been thought that they were palm fruits, but recent investigations have shown them to be the fruit of a carboniferous tree, not unlike the drupe bearing *Salisburia*, a native of China and Japan. Dr. Dawson has suggested that that Triconocarpon is really the fruit of the Sigillaria, but the suggestion has met with little favor, as the latter is held to be a cryptogamus tree, and therefore had spores and not seeds for its fruit.

Ferns have been met with in infinite varieties, no less than 900 distinct varieties have been determined, ranging through every conceivable variety and size from the gigantic tree ferns, with its crown of feathery fronds, downwards.

Space forbids our noticing more of these interesting plants, but let us consider how and under what process they were converted into coal.

The generally accepted theory is that the rank and luxuriant vegetation, a very small portion of which we have noticed, grew and decayed upon land but slightly raised above the level of the sea. In process of time the land with its heavy burden of decaying vegetable matter sunk below the water line, the trees were killed, and the mud and sand which were brought down the streams enveloped their trunks, and formed the bed or bottom for the next layer. Perhaps the best evidence we have of such sinking of the earth, is that we have coal seam above coal seam, each with its under bed of clay, and that therefore the land must have sunk before the next bed of soil could have been deposited, and the next forest grown upon it. According to many geologists each coal seam represents a depressed swamp, while the intervening strata of sandstone, shale and clay mark the various sediments which were brought together by the action of the waters. The convulsions of nature, *i. e.*, earthquakes, have also performed their part in giving these valuable deposits to the world. The violent upheavals accompanying the earthquake shocks would raise these buried forests from under the sea level and make them dry land once more. Illustrations of this nature are many and widely separated. In 1819 an earthquake shock in Cutch, at the mouth of the river Indus, sunk a tract of land larger than Lake Geneva, in some places to a depth of eighteen feet, converting them into inland seas, while the same shock raised, a few miles off, a corresponding sheet of land 50 miles in length and 16 miles broad, ten feet above the level of the alluvial plain. Again, in the valley of the Mississippi, the earthquakes of 1811-12 caused large lakes to appear suddenly in many parts of the district amid the dense forests of cypresses. One of these, the "Sunk Country," is between 70 and 80 miles in length and 30 in breadth. Sir Charles Lyell says, "that as late as 1846 dead trees were conspicuous, some erect in the water, others fallen, and strewed in dense masses in the shallows and near the shore." In short we may easily picture to ourselves the process by which coal was laid down. Conceive wooded marshes, in any alluvial delta in a moist and warm climate, suitable or favorable to the rapid and luxuriant growth of vegetation, situate these at the mouth of great rivers, and imagine these marshes to be slowly sinking beneath the sea, the forests in them killed by the water, and then covered up by layers of sand, brought down from inland, until that new layer became dry land, to carry a fresh crop of vegetation. We have thus all that is needful to explain how coal measures were formed.

It may be of service if we here introduce an estimate of the area of the coal measures of the world:

	Sq. Miles
North America	310,500
Great Britain	6,200
France	1,500
Prussia	1,550
Belgium	775
Bohemia and Westphalia	1,210
Spain	310
Russia	150
Australia, South America, New Zealand and the Islands—unknown	
Total	322,255

In this connection (pardon the digression), we quote the following, taken from a descriptive catalogue of a collection of the economic minerals of Canada by the Geological Corps, Alfred R. C. Selwyn, C. M. G., L. L. D., F. R. S., etc., director Colonial and Indian Exhibition, London, 1886:

"The aggregate area of the coal bearing formations of the Dominion of Canada is very great, the fuels of economic importance occurring not only in the rocks of the carboniferous system, but also the cretaceous, the laramic, and in strata of Miocene age. The extent of the coal bearing rocks in the Northern and sparsely inhabited part of the Dominion, is scarcely known. For *that* portion of the country which has been more or less thoroughly explored geologically, the subjoined table gives an *approximate* estimate, which, though far from complete, may be accepted as a probable minimum statement:

	Square Miles.
Nova Scotia and New Brunswick, bituminous coals (carboniferous)	18,000
N. W. Territory, south of 56th parallel, area of coals and high class lignites (cretaceous and laramie)	50,000
N. W. Territory, Souris District, lignites (laramie)	15,000
Area in the Rocky Mountains, bituminous and anthracite (cretaceous)	500
Brit. Columbia, bituminous coals and anthracite	1,700
Brit. Columbia, lignite bearing rocks south of the 52nd parallel (tertiary)	12,000
Total	97,000

The coals of Nova Scotia and New Brunswick are bituminous in character, and referable to the carboniferous system, and it is possible that these measures may yet be found at a workable depth underlying P. E. I.

In the provinces of Ontario and Quebec coal is *not* found, although an anthracite mineral is occasionally found in small quantities in the vicinity of Quebec, on the Island of Orleans, and elsewhere in this province, and has given rise to considerable expenditure in fruitless search for workable coal in these localities, in all of which only rocks of Lower Palæozoic age occur. In the North-West Territory, the coals and lignites are of cretaceous and laramic age. In British Columbia the bituminous coal and anthracite of the coast region is of cretaceous age, while both on the coast and in the interior of the province, wide-spread tertiary deposits occur, yielding lignites which, in some cases, approach coals in composition."

As mentioned in our opening remarks, coal is said to be composed of vegetable matter. We will now consider the transformations in their several stages. As we have already shown, each layer was compressed beneath the enormous weight of the overlying strata and while undergoing this compression, was compelled to part with some of its oxygen, in the shape of carbonic acid gas, or choke damp, until the first stage was reached. A better understanding of this part of our subject may be had by giving the following approximate table of the composition of wood, and as each stage is reached we will notice its composition:

Wood.	
Carbon	50.0
Hydrogen	6.2
Oxygen	43.8
	100.0

The first stage is Peat, which is composed of carbon, and is vegetable matter more or less decomposed.

Carbon	60.0
Hydrogen	6.5
Oxygen	33.5
	100.0

The third stage is Lignite, which is fossil wood imperfectly mineralized, and therefore not improperly described as intermediate between peat and coal. Its composition is:

Carbon	65.7
Hydrogen	5.3
Oxygen	29.0
	100.0

A fourth stage is common or bituminous coal, formed by parting with much of its hydrogen, chiefly in the form of carboretted hydrogen, the common gas used in cities for lighting purposes. It is composed of:

Carbon	70.9
Hydrogen	4.3
Oxygen	24.8
	100.0

A fifth stage is cannel coal, which in color is greyish black, kindles like pitch, and burns with a bright white flame. This coal is very clean, and scarcely soils the fingers when rubbed. It is chiefly found in Ohio and Missouri.

Before proceeding to another stage, we wish to make this general statement, *that* wood can become lignite, or wood coal, by parting with some of its oxygen, in the shape of (carbonic acid gas or choke damp), the common coal by parting with much of its hydrogen, and it is a fresh corroboration of the theory that coal has once been vegetable fibre, for it shows how vegetable fibre can, by the law of nature, become coal. And again, if we know this, does it not help us in reasoning from the known to the unknown. Further, this fact explains why in mines of the later coal measures, much choke-damp is given off, while in mines of older coal, not only choke-damp, but fire-damp (which is carburetted hydrogen and olefiant gasses) is set free. And does it not

(*Continued on fourth page.*)