

The Knowledge Bank at The Ohio State University
Ohio Mining Journal

Title: Origin of Coal and Early Mining

Creators: [Roy, Andrew, 1834-](#)

Issue Date: 15-Aug-1883

Citation: Ohio Mining Journal, vol. 1, no. 4 (August 15, 1883), 147-157.

URI: <http://hdl.handle.net/1811/32331>

Appears in Collections: [Ohio Mining Journal: Volume 1, no. 4 \(August 15, 1883\)](#)

THE OHIO MINING JOURNAL.

AUGUST 15, 1883.

ORIGIN OF COAL AND EARLY MINING.

BY ANDREW ROY.

THE rocks of the earth, known as the "Coal Measures," consist of a series of beds of sandstones, shales, limestones, fireclays, iron-ores, and coals, in manifold alternations. The beds of coal are now universally held by men of science to have been formed from the decomposition of vegetable matter—the leaves and stems of ancient plants and trees which grew, and died, and became decomposed and mineralized on the spot where the coal is now found; and the associated beds of rocky strata to have been derived from the sediments of the water which flowed over the carbonaceous accumulations during the subsidence of the land. Several other theories have been advanced, accounting for the origin of coal—as that it is of animal origin, or that it was formed from petroleum. Bischoff, and other eminent geologists, held that the carbonaceous matter was an accumulation of vegetable detritus, which had been drifted by rivers into bays and estuaries, as the vast rafts of dead floating trees now accumulate in the Lower Mississippi; but careful examinations of the original coal plants found in the floor of the coal, first brought to notice by Sir William Logan, in 1840, during a survey of the South Wales coal field, have confirmed the theory that the vegetation grew on the spot where the coal is now buried.

During the coal formation period, in the history of the earth, vast marshes or swampy plains skirted the ocean, or perhaps formed low islands near the shore. Upon these marshes there grew a profuse and luxuriant vegetation, consisting of numerous beautiful and various plants, differing in size from small mosses to stately trees, which, year after year, dropped their leaves and fruit, and in time died themselves. New forests arose and died in succes-

sion, growth and decay going on through many slowly moving centuries, until a mingled mass of vegetable tissue was accumulated, like pulpy mass of a peat bog of the present day. At length, through the agency of subterranean movements, the area of the coal marsh became depressed with much uniformity, the land slowly and gradually sank, and the water of the ocean flowed in over the carbonaceous accumulation, bringing along mud and sand and other sedimentary materials, which settled at the bottom. As the sinking process continued, the ocean currents brought in more detritus, covering the older decompositions, which, becoming compressed by the accumulating weight, solidified, forming in to sandstones, shales, etc., according to the nature of the materials. The buried peat bog became greatly compressed by the accumulated weight of this detritus, the original plants and peaty tissue matting together and becoming hard and compact, while a portion of the gases escaped in the forms of carbureted hydrogen and carbonic acid by slow distillation and putrefactive fermentation.

The subsidence period was in time arrested, and was followed by a long period of rest, when the waters of the ocean becoming filled up, there was formed a new subaereal surface. A growth of vegetation covered this new plain, as in the former case. Generations of forests again succeeded each other, and again the vast marsh accumulated matter capable of forming a second seam of coal. Then followed another downward movement of the land, and another burial of the coal vegetation by the detritus of the water. The set of processes thus described was repeated in the formation of every seam of coal and its associated beds of strata; the periods of elevation were longer or shorter according to the amount of vegetable matter which accumulated on the marsh; and the periods of subsidence were longer or shorter according to the amount of strata which accumulated between the different beds of coal.

Many geological writers maintain that during the Carboniferous era, the atmosphere of the earth was intensely hot, and was also saturated with vapor, and charged with undue proportions of carbonic acid gas which had been liberated from the interior of the earth through the agency of volcanic eruptions; the conditions being claimed as essential to the production of the coal vegetation. But as coal is found in newer formations than the Carboniferous

era—the coal of China belonging to the Triassic, and that of the Pacific Coast to the Cretaceous formations—and as coal is doubtless forming now in many places of the earth, it may be fairly assumed that the climate of the Carboniferous age was not unlike the climate of the present age, although, perhaps, more mild and equable; only the plants and animals were different. Instead of one peculiar coal-bearing age, all ages, perhaps, as well deserve to be called carboniferous. Sir Charles Lyell, in his "Principles of Geology," writing of the formations of the Delta of the Mississippi, mentions instances of whole forests of strata sunk as they grew, and covered, to a depth of several hundred feet, with an accumulation of mud and sand and vegetable soil in alternating beds, in the same manner as the coal marshes were covered up in the primeval ages. The sunken country of New Madrid a water space of nearly 80 miles long and 30 miles wide, caused by the earthquake of 1811–12, was filled, as late as the year 1846, with dead trees, some standing erect in the water, as they grew, others fallen down, and lying in dense masses over the bottom, and along the shore. He mentions another case of a tract of land, at the mouth of the river Indus, larger than the Lake of Geneva, which was converted into an inland sea in the year 1819, by an earthquake shock, while an adjoining tract, 50 miles in length, and nearly 16 miles wide, was raised by the same shock, ten feet above the level of the alluvial plain.

The coal strata are full of the remains of animal and vegetable life. Nearly a thousand different coal plants have been described by the geologists. Beneath every seam of coal there is generally a stratum of fire-clay—the original land surface upon which the coal plants grew, in which rootlets, stumps of trees, stems and dark filaments are found. Sometimes the remains of trees, embedded as they grew in the underclay, and standing up through the coal and the roof above, and then abruptly stopping—the upper part having rotted and fallen off—are met with. In the year 1844, at the Parkfield colliery, near Wolverhampton, in England, the workmen mined into a quarter of an acre of coal, which was filled with stumps of trees, standing as they grew; the trunks, flattened by the pressure of the superincumbent strata, were converted into coal, but were identified. The trees were found scattered in all directions, having evidently been snapped off by a storm or an in

flow of the water, during the sinking of the land, or by an earthquake shock. The roof above the coal is often charged with the remains of ferns, flattened trunks of trees, pieces of bark, branches and leaves, crossing each other in promiscuous profusion.

Of the numerous forms of vegetable matter, from which coal is derived, a great bulk of the coal appears to have been formed from trees allied to the club mosses, ferns and rushes of the present day—more particularly in the lower beds or coal. The casts of the sigillariæ, known by their fluted and symmetrically scarred bark, often lie full length, as they fell in the mud, immediately above the coal, and can be traced for fifty and sixty feet along the working places of the miners. The gigantic lepidodendrons, allied to our modern club mosses, which in the coal era attained the height of forty feet, lie stretched full length, alongside of the sigillariæ. Calamities (the representatives of our rushes) with jointed or straited stems, meet the eye in nearly every mine, and often measured thirty feet in length. The fossil remains of fishes, marine shells and amphibian reptiles are also found interspersed in the roof shales. One hundred and fifty species of fishes, many of them of immense size as compared with the fishes of the present day, have been discovered in the coal and its associated strata, and the teeth, scales and spines of fishes are frequently found imbedded in the same manner. The tracks of the reptiles, formed as they walked along the soft and muddy sediment of the ancient shore, ripple marks, and the impression of rain drops, have also been seen in the roof shales of some mines.

Some of the coal fields of the world contain strata of immense thickness. At Lundy, in Wales, the coal measures are known to be fully ten thousand feet thick, and to contain forty-two different seams of coal, the total thickness of which measures one hundred and fifty feet. The coal strata of Nova Scotia, at the Joggins, are fifteen thousand feet thick, and include seventy-six different seams of coal, one of which measures thirty-seven feet in thickness, and another twenty two feet. The coal field of Saarbrucken, on the left bank of the Rhine, in Prussia, has the enormous depth of twenty thousand feet.

It has been estimated by eminent geologists that it would require a period of 150,000 years to accumulate matter to form sixty feet of thickness of coal, an amount far exceeded in many coal

fields of the world. In this calculation, no account is taken of the different periods of subsidence of the land, when the associated strata were deposited. As the sinking process was slow and gradual, and as fifty feet of strata intervene, on an average between the different seams of coal, it may be reasonably assumed that an equal period of time was required in building up these strata as occurred in the formation of the carbonaceous matter which formed the coal.

Beroldingen first suggested the theory that the coal beds of the present age, were the peat bogs of the primeval ages, converted from peat into brown coal, and then into true coal; and this view is now accepted by every intelligent geologist. The progressive steps from peat to anthracite, are thus described by Dr. Newberry, the eminent geologist of Ohio:

“Coal is now considered, by all good chemists and geologists, as of organic origin, and it may be easily demonstrated that it has been derived from the decomposition of vegetable tissue. As we find it in the earth, it forms one of a series of carbonaceous minerals which represent the different stages in a progressive change from vegetable tissue as found in the living plant. In peat and lignite, we witness the first step in the formation of coal. Peat is bituminized vegetation, generally mosses and other herbaceous plants, which, under favorable circumstances, accumulate in marshes, hence called peat bogs. Lignite is the product of a similar change effected in woody tissue; and because it retains in a greater or less degree the form and structure of wood, it has received the name it bears. Peat is the product of the present period, and lignites are found in deposits of recent geological age. In the older formations, these carbonaceous accumulations, still further changed, are bituminous coal.

“The changes which vegetable tissue has suffered in passing through these various stages, are not only physical but chemical. They have been carefully studied by several eminent chemists, and have been so fully explained that they may be comprehended by any intelligent person. The rationale of this process may be seen at a glance, by reference to the following formula, taken from Bischoff's Chemical Geology:

	WOOD.	LOSS.	PEAT.
Carbon	49.1	21.50	27.6
Hydrogen	6.3	3.50	2.8
Oxygen.....	44.6	29.10	15.5
	WOOD.	LOSS.	LIGNITE.
Carbon	49.1	18.65	30.45
Hydrogen	6.3	3.25	3.05
Oxygen.....	44.6	24.40	20.20
	LIGNITE.	LOSS.	BITUMIN'S COAL.
Carbon.....	30.45	12.35	18.10
Hydrogen	3.05	1.85	1.20
Oxygen.....	20.20	18.13	2.07

“This is the condition in which we find most of the beds of peat and lignite that accumulated in the Carboniferous age, millions of years ago, and which, deeply buried, have been subjected to slow and general distillation, resulting in the different varieties of bituminous coal. Where exposed to peculiar influences, as to heat from volcanic eruptions, or from the elevation of mountain chains where all the strata are metamorphosed, the volatile constituents of bituminous coal are partially or perfectly driven off, giving us, first, semi-bituminous coal, then anthracite, and finally graphite. The process by which graphite and anthracite are formed from ordinary bituminous coal, is indicated in the succeeding formula:

	BITUMINOUS COAL.	LOSS.	ANTHRACITE.
Carbon	18.10	3.57	14.55
Hydrogen	1.20	0.93	0.27
Oxygen.....	2.07	1.32	0.65
	ANTHRACITE.	LOSS.	GRAPHITE.
Carbon	14.53	1.42	13.11
Hydrogen	0.27	0.14	0.13
Oxygen.....	0.65	0.65	0.00

From the above tables it will be seen that the change from wood tissue to peat or lignite, and from these to bituminous, thence to anthracite coal and plumbago, consists in the evolution of a portion of the carbon, hydrogen and oxygen, leaving a constantly increasing percentage of carbon behind, until, ultimately, the resulting mineral consists of a portion of the original carbon of the plant, with all its earthly matter. That portion of the original substance which is lost in the progressive change escapes in the form of some hydro-carbon, as water, carbureted hydrogen, car-

bonic acid, petroleum, etc. The escape of these volatile compounds we see in the gases bubbling up in marshes where vegetable matter is undergoing decomposition, in the gases generated in our coal mines, and in the oil springs, which always flow from strata charged with bituminous matter. By the application of heat, and with proper management, we can manufacture any of these mineral fuels from vegetable fibre, at will. This has been done repeatedly, and although we cannot accurately reproduce the conditions under which these changes are effected in nature's laboratory, we can so closely imitate them as to demonstrate their character.

It would require from eight to ten feet of thickness of the loosely matted peatty tissue of the coal marshes to form one foot of coal; and as some coal seams are thirty and forty feet thick, in several of the coal fields of the world, an enormous bulk of vegetable matter must have accumulated for the production of these thick seams. The thickest peat bogs of the present day seldom exceed thirty or forty feet.

The coal marshes of the primeval world, on being opened up to serve the purpose of man, present several distinct varieties of coal. The coals of the Carboniferous age, called true coals, in contradistinction to the lignites or brown coals of more recent geological ages, are classed under the general heads of bituminous and anthracite. The bituminous coals are divided into different species, and show great diversity, both in their physical and chemical properties, and they are known by different names, according to their qualities and chief properties, such as "dry-burning coals," "caking coals," "gas coals," "cannel coals," etc. Bituminous coals are of all shades of color, from deep black to greyish-black, and they exhibit in their structure some well marked peculiarities.

The dry-burning variety usually possesses a laminated structure, the fracture or cleavage of the coal being horizontal, and the seam is often intersected with partings or cutters, which cross each other every foot or two, like latitude and longitude lines, giving the masses, as they come from the miner's pick, the appearance of squares, or blocks, hence they are called block coals. Such coals do not cake nor swell when burning, and for this reason they are especially adapted for smelting iron in a raw state. In the blast furnace they retain their shape until they fall to ashes. They are

generally very hard and compact, and bear transportation better than any caking species of bituminous coals.

Caking coals melt and fuse to together in the act of combustion. This property forbids their use in the furnace, as they form a hollow fire, and they require to be converted into coke before being applied to the reduction of ores. The slack or small coal is of nearly equal value, when in a pure state, with the round coal, the abundance of bituminous matter in the coal causing the whole to agglutinate in masses when exposed to moderate heat.

Cannel coal is nearly always formed in thin seams, and the deposits generally occupy but limited areas. It contains a large percentage of hydrogen, and burns with a bright, clear flame, making a very pleasant parlor fire. Cannel is the richest gas coal obtainable, the gas possessing brighter illuminating powers than that of the more common varieties. This coal has a dull lustre and is in color between a velvet and a greyish-black; it breaks with a flat, conchoidal fracture, and is very compact and fine in the grain. It will scarcely soil the fingers in handling it, and it makes very little dust in the mine. The remains of shells, fishes, and amphibious animals are often found imbedded in the beds of cannel coal, whence it is thought that the carbonaceous matter from which it is derived was deposited in lagoons of open water in the condition of muck or mud, similar to the muck swamps of the present day.

The specific gravity of bituminous coals is from 1.25 to 1.4. They generally contain from 55 to 80 per cent. of carbon, and from 8 to 22 per cent. of oxygen, hydrogen and nitrogen, with variable proportions of earthy matter.

Anthracite is a black, heavy coal, having a conchoidal fracture, and containing from 80 to 95 per cent. of carbon, and a small per cent. of hydrogen, oxygen and nitrogen. This coal kindles with difficulty, but when once fairly ignited, it burns with an intense heat, emitting neither smoke nor flame. It occupies much less extensive areas than the bituminous species.

Anthracite coal was originally bituminous, the change having been effected through the agency of heat, which drove off the bituminous matter, as the gases are now driven off from bituminous coal in the production of common street gas.

The anthracite coal fields of Pennsylvania form part of the great Allegheny coal field. During the upheaval of the Allegheny

Mountains, which occurred after the close of Carboniferous age, the heat which attended the elevation of the mountains, acted on the coal and drove out the gaseous matters. Anthracite exists in South Wales, and in France, Russia, and Saxony, and everywhere it is found occupying abrupt flexures of the strata, the result of gradual and irresistible forces. So abrupt are these flexures in the anthracite region of Pennsylvania, that the coal strata are found occupying in many places, nearly perpendicular positions, and in some cases reverse dips. The specific gravity of anthracite is from 1.3 to 1.75.

Semi-bituminous coal is as its name implies, intermediate between bituminous and anthracite. It contains little bituminous matter and a large percentage of carbon, and is highly prized for the generation of steam and the manufacture of iron. This coal burns freely, producing an intense heat when exposed to the action of a strong blast. Like anthracite some bituminous coal has been subjected to the action of heat, though in a less degree, during the folding of the strata. The coal is less bituminized, because during the metamorphic process, the gaseous materials had not the same opportunity to escape; the strata, though folded, are nowhere fractured.

The lignites, or brown coals, belong to geological formations of more recent age than the true coals of the Carboniferous period. They exhibit in their structure, plain and unmistakable traces of their vegetable origin. These coals burn with a clear flame, but give off a highly bituminous smell. They decompose very rapidly when exposed to the action of the atmosphere, and for this reason are unfitted for distant transportation. The coals of China and of our Pacific Coast belong to this class; and they exist over large areas on the Continent of Europe. Some of the better sorts approach the true coals in character.

The coal fields of the world generally exist in the shape of elliptical basins. Some of the basins are nearly round; but in most cases they possess greater length than breadth. The greatest thickness of strata, and, consequently, the greatest number of beds of a field, exist at the centre or trough. From this point the strata are inclined, or pitch upward in all directions, the upper coals cropping out first, and the lower ones stretching across the whole surface of the coal marsh. The original shape of many fields has been

greatly changed by faults in the form of "slip dikes" and "dislocations" of the strata. These faults traverse the coal field for miles, and are the result of violent mechanical convulsions, by which the strata in one part of a field are thrown up on one side of the dislocation. The change of level caused by such faults ranges from a few inches to hundreds of feet; and it frequently happens in the operation of sinking for coal, that a seam is reached by a shaft at a depth of three hundred feet, while on the opposite side of the fault the same seam is found a thousand or twelve hundred feet deep.

These dislocations are very common in the British coal fields. They sometimes divide the basin into subordinate basins, presenting great barriers to the successful prosecution of underground operations. But they come as friends as well as enemies, for they are true flood-gates, damming back the waters of the mine. The line of direction of these slip-dikes is not always the same, and they sometimes cross each other.

The change of level caused by a slip dike in one of the Scottish coal fields, is stated by Mr. Robert Bald, the eminent coal viewer of Scotland, to be no less than 1,230 feet, and the coal field is divided by this and by another slip, on the north side of the basin, into three subordinate basins. The great dislocation throws out the whole of the coal strata for nearly a mile, when, by reason of the natural inclination of the rocks, the missing materials again appear as the outcrop of one of the subordinate fields.

Another dike in Lanarkshire causes a change of level of the coal rocks, of the enormous distance of 2,700 feet.

The change of level caused by slip-dikes is upward or downward, according to the side from which they are approached by the miner; and when forming an acute angle with the floor of the mine the coal strata are thrown down; when the angle is obtuse, they are thrown up. Sometimes, however, the face of the dike is perfectly vertical, forming a right angle with the pavement, in which case it is very difficult to determine whether it is an upthrow or a downthrow. These dikes are not always upthrows or downthrows, for the strata are sometimes only pierced by them without change of level. In these examples they are known as trap-dikes, the intrusive matter being lava which flowed in during the rents of the strata. In approaching such faults the coal is frequently found burnt like coke.

Besides dikes of the character noticed above, there are a number of other faults encountered in mining, which are known by various names, such as "troubles," "horsebacks," "nips," "clay-veins," "wants," etc. Troubles are generally meant to denote irregularities in the coal, as where a seam has an irregular floor, and is subject to sudden thinning, or where part of the coal is so soft as to resemble the gob waste of the mine. Horseback is an Americanism, and in this country, is now very generally applied to every trouble of the mine, though originally meant to designate a fault in the floor of the coal, which resembles the shape of a horse's back. Sometimes irregular layers of sandstone or shale appear in the body of the coal; and it also frequently happens that a foreign mass of sandstone will be found usurping the place of the coal. This latter fault is very common in some mines, and is, doubtless, due to currents of water, in rapid motion, having carried sand across the old coal bog, which, by constant friction, has removed the coal, and finally settled down in its place.

In the coal fields of the United States, although there are an abundance of faults of a local character, there is seldom met any slip dike; and such dislocations of the strata, whenever encountered, seldom exceed a few feet of upthrow or downthrow; though in the coal strata of North Carolina, which are subject to many troubles, some of the dikes are known to cause twenty or thirty feet change of level.

The various beds of coal in the coal fields of the world generally bear a parallel relation to each other. This fact, though general, is by no means universal, for there are some well known cases where the beds diverge or approximate each other, according to the line of direction in which they are followed; and sometimes, also, the seams split up into two or more parts, by the introduction of shale bands, which though thin at first, continue to increase in thickness until two or more independent seams are formed. The great thick coal of Billston, Dudley and Wolverhampton, in England, which forms a mass of solid coal, from twenty-four to thirty-six feet in thickness, splits up in one part of the coal field into nine different beds; and the mammoth vein of the anthracite region, also splits up into several seams. Some well marked cases of the splitting of the seams also occur in the coal strata of Ohio.