Story

of the

Richmond Coal Field or Basin

by

F.R. Wedleigh

Bound in: Excerpts from the press
about Carbonite

related in the pages following, is based upon a study of available sources of information, all of which are listed in the Bibliography.

I have endeavored to give, as far as possible, a continuous history of the field and its development, as told in the exact words of the various writers, whose published papers, reports, letters, etc. have been consulted; included also a summary and certain conclusions and suggestions of my own regarding the future development of the fields.

Much of the data given have been taken from the various publications of the United States Bureau of Mines, the United States Geological Survey, and the Virginia Geological Survey, and from the Transactions of the American Institute of Mining Engineers.

Appendix "A" consists of an interesting document which gives much information regarding mines and mining conditions in the Richmond field, being a statement of Mr. A. G. Lucas, State Mine Inspector, who worked in the mines for a number of years.

Appendix "B" contains reports made in 1912, on explosions at the Carbon Hill Mines, in the Richmond field.

Appendix "C" consists of data taken from the files of the Southern Railway, regarding the mines of the Murphy Coal Corporation, at Midlothian, operated 1921-1923.

Appendix "D" contains information furnished by the Richmond, Fredericksburg and Potomac Railway Company, regarding Richmond field coal and its use on locomotives.

Appendix "E" contains a private report made by E. V. D'Invilliers on the Midlothian Property" dated January 1904, and given in full.

F. R. Wadleigh.

INTRODUCTION

As a fitting introduction to the story of the Richmond Coal

Field, there are given the following brief descriptions of the recorded discoveries and use of coal in North America previous to and shortly after its discovery in the Richmond Area of Virginia.

The first recorded discovery of coal in North (or South) America seems to have been made on Cape Breton Island (and Nova Scotia). In 1654 a concession was granted one Nicholas Denys to mine gold, silver, copper and other minerals on the whole of the island. In 1672, a prospectus was published in Paris by M. Denys, in which it was stated that coal was to be found near the sea-coast of the Island, and in 1677 the Intendant of "New France," M. Duchesneau, issued a proclamation placing a royalty of 20 sous per ton on all coal mined in Cape Breton.

In 1690-95, French ships were taking "cargoes of pit-coal from Cape Breton to Martinico and Guadalupe" (Baron Lahentan's Memoirs and Travels, London, 1735.)

In 1711, according to Admiral Walker's Journal, a supply of coal was obtained for his ships from the cliffs on Cape Breton Island, and in 1720, Cape Breton coal was used by the men constructing the fortress of Louisburg. In 1724 some of the Cape Breton coal was shipped to Boston (Mass.)

The earliest discovery of coal in the United States, of which there is record, was made in 1673. In that year, Louis Joliet, a native of Quebec, accompanied by Father Jacques Marquette, a French Jesuit Missionary, started on a "voyage" of exploration to find the Mississippi River, during the course of which they went up the Illinois River Valley. Coal was found on the River, at a point somewhere between the sites of the present cities of Utica and Ottowa; the approxiate location is marked, on Joliet's Map of 1674, "Charbon" de terre" and a similar notation is found on Marquette's Map of 1681.

The next recorded discovery of coal in the United States occurred in 1679, often, but wrongly, given as the first. In 1679 Father Louis Hennepin accompanied the Sieur de la Salle on his famous expedition, the main objective of which was to find the mouth of the Mississippi (or Meschasipi) River. Father Hennepin reported the finding of coal along the Illinois River, near Fort Crevecour; on his map (later published) a "cole mine" is shown above the Fort, near the site of the Peoria of today.

Father Heppepin's Journal was published in 1689 at Brussels under the title of "Map and Description of a large Country newly Discovered in the Northern America, between New Mexico and the Frozen Sea - together with the Course of the Great River Meschasipi. By Father Louis Hennepin, Missionary Recollet and Apostolic Notary."

Following these discoveries in Illinois came its discovery in the Colony of Virginia, in the Richmond coal field, in 1700-1701.

THE RICHMOND, VIRGINIA, COAL FIELD.

Summary - Historical:

The story of the discovery and mining of coal in the Richmond field, or basin, as it is sometimes called, covers the entire period of coal mining and production in the United States, from 1701 to date, although there have been some years when no production from the Richmond field was recorded.

While the first discovery of coal in the United States has been traced back to 1673, in what is now Illinois, there has been found no record of actual mining of coal previous to 1766 (at Fort Pitt, Penna.) except in the Richmond field, and no recorded annual production tonnages in the United States are available previous to 1807, according to the statements of the U. S. Bureau of Mines and U. S. Geological Survey, which give the first annual recorded production of bituminous coal as being for the year 1822; production recorded from 1807 to 1822 having been all anthracite.

production in the Richmond field, in its earlier After the first report of coal having been found in 1701, no written record of any further discovery or development has be found until 1730, in 1759, and again, previous to and during Revolution; there are no records of the actual annual tonnage produced, however, until 1822.

During the first half of the 19th Century and until 186. there was considerable activity in the Richmond field and production of coal until that year averaged well over 100,000 tons per year. After 1865, production fell off and there was less activity until in 1905, production had almost ceased. Between 1910 and 1913 (inclusive) there was a small output and again in 1921-1923, production was resumed; since 1923 there has been no production recorded, although a small quantity has been mined each winter for local use.

According to Mr. J. K. Roberts in Bulletin #29, Virginia Geological Survey (1828), coal mining activity in the Richmond field is divided into three distinct periods, 1701 to 1840, 184. to 1880, and 1885 to the present. But, there were several years, it should be noted, during which there was no production of record - 1905 to 1909, inclusive, 1914 to 1920, and 1924 to date

In the year, October 1, 1790 to September 30, 1791, the first recorded export shipments of coal from the United States were made, amounting to 3,788 bushels, of which 1,470 bushels came from Virginia; the balance was shipped from Massachusetts, Rhode Isl nd, New York, and Pennsylvania, and consisted of British Nova Scotia and probably some Virginia coal.

The destinations of the shipments referred to were as follow

To Dutch West Indies	144	bushels
British West Indies	570	"
French West Indies	1,526	"
East Indies, generally	828	"
Africa	780	"

THE RICHMOND COAL FIELD OF VIRGINIA

Its Location and Area: The Richmond coal area, known generally as the Richmond basin or coal field, lies in Eastern Virginia, within but near the margin of the Piedmont Plateau, on either side of the James River, and extends through five counties. About one-fifth of the area lies to the north of the James River and includes parts of Henrico and Goochland Counties; the portion south of the James River includes parts of Chesterfield and Amelia Counties. It is not a large area, its length north and south being approximately 33 miles and its widest portion about 9.5 miles in breadth.

The total area is estimated to contain from 150 to 189 miles, not including the small outlying basins.

Discovery and Early History: The first known, written mention of the discovery of coal in the Colony of Virginia is contained in a letter written by Col. William Byrd, F.R.S. of Westover, the most prominent man of his day in Virginia, to the Colonial Council of Virginia; under date of May 11, 1701, Colonel Byrd wrote:

> "Went up to the Newsettlements of ye French refugees at ye Manakan town. Wee went up to ye cole, which is not above a mile and a half from their settlement on the Great Upper Creek, which riseing fery high in great raines, hath so washed away the banks that the cole lyes bare, otherwise it is very deep in the earth."

"Manakan Town," now Manakin, is on the north side of the James River and on the northwestern edge of the coal fields, about 14 miles from Richmond. In this vicinity there are known to have been at least eight mines opened between 1842 and 1880.

It seems highly probable that the actual first discovery of "ye cole" was made before 1701, as the French Hugenot refugees (whose name of Hugenots still persists in the towns of Hugenot,

Huguenot Bridge, and Huguenot Springs) came to the vicinity in 1699. It is also entirely probable that the refugees mined, or at least dug, some of the "cole" for their own use, although Colonel Byrd makes no mention of it, and Colonel Wooldridge, writing in 1841, states that the mining of coal in Virginia began in 1700. The date usually given when the mining of coal in Virginia was first started is the year 1750.

In "The production of Coal in 1914" U. S. Geological Survey publication, by C. E. Lester, it is stated: "The Richmond Coal Basin is the only area of free burning coal located immediately adjacent to the Atlantic Seaboard. The first coal mined in the United States was from this area, mines having been opened and worked as early as 1750." In "The Story of American Coals," by W. J. Nocolls (written in 1896) it is stated that "In 1750 the Virginia bituminous mines were opened and worked on the James River, near Richmond." No authority is given for the foregoing statements or no evidence as to their correctness.

In the 1901-02 Annual Report of the U. S. Geological Survey, it is stated that the occurrence of coal in this area was known as early as 1700 and the coal was used as early as 1755.

Bulletin 29, Virginia Geological Survey, 1928, gives a brief historical account of coal mining in the Richmond basin, in which Mr. J. K. Roberts, the author, says that "The most dependable records show that the first continuous mining was somewhere between 1770 and 1780, with no complete figures of production. "An old arsenal (Bellona Arsenal) on the James River, 14 miles west of Richmond and another arsenal west of Huguenot Springs, date back to Revolutionary times and Trassic coal (from the Richmond basin) was used in both."

It may be safely assumed, therefore, that coal was first discovered, and probably used, in the Richmond basin as early as 1700-01.

After 1701 the next documentary evidence of coal in the Richmond basin is found on an old historical map of Virginia, on which is marked "Midlothian, probably oldest coal mines in the United States, 1730." We have no means of ascertaining the correctness of the notation but there must have been some ground for it.

The next evidence found of the actual mining of coal in the Richmond basin, seems entirely trustworthy. The writer has a copy of Archdeacon Burnaby's "Travels through the Middle Settlements in North America," 1759 to 1760, in which the definite statement is made that "Some coal mines have been opened upon James River near the falls which are likely to answer very well."

How long these coal mines had been open, the Archdeacon does not say, nor give any intimation.

NOTE: The Rev. Andrew Burnaby, Archdeacon of Leicester and Vicar of Greenwich, was in Virginia from July 3, 1759 till June 11, 1760, and journeyed as far west as Winchester and the Shenandoah Valley; he spent some time with Colonel Byrd at Belvedere and with Colonel Washington at Mount Vernon.

We have further and reliable evidence that coal pits had been opened and were producing coal in the Richmond Coal field previous to the Revolution; also that a small amount of Virginia coal was exported previous to that time.

Thomas Jefferson, in his "Notes on the State of Virginia" (written in 1781, corrected and revised in 1782 and first published in 1787, in London) wrote as follows:

> "The country on James River, from fifteen to twenty miles above Richmond, and for several miles southward and northward, is replete with mineral coal of a very excellent quality. Being in the hands of many proprietors, pits have been opened, and before the interruption of our commerce, have worked to an extent equal to the demand."

A table showing the "average export trade" of the State previous to the Revolution, is also given by Mr. Jefferson ("taking

one year with another") in which there is included, among other commodities, an item of "6,666-2/3 American dollars" worth of "pit-coal and pig iron."

In 1776 "The Committee of Safety" authorized the "employing of proper persons" to bring coal from the mines in Virginia to Philadelphia, which was evidently a movement of coal that had been customary, and which was resumed definitely in 1779, the coal being for "domestic and blacksmith use."

An advertisement which appeared in "The Virginia Gazette" in 1776, given an indication of the good quality of the Richmond coal; the advertisement stated that "Samuel Duval has coal for sale at 12¢ per bushel, equal to the Newcastle coal."

MINES AND MINING -1790-1842.

The only available written records or descriptions of coal mining in the Richmond field between 1790 and 1842, are contained in the following papers:

1. A letter from Mr. John Grammar, dated January 28, 1818, Petersburg, Va., published in the American Journal of Science, Vol. 7, 1818.

2. A letter from Mr. James Pierce, published in the American Journal of Science, Vol. 2, 1826.

3. A paper by Col. A. S. Wooldridge, the President of the Midlothian Mining Co., dated September 1, 1841, Richmond, Va.; published in the American Journal of Science, Vol. 43, 1842, and entitled "Geological and Statistical Notes of the Coal Mines in the Vicinity of Richmond, Virginia."

4. Mr. G. J. Heinrich, in his paper on "The Mesozoic Formation of Virginia" quotes from a letter of Col. Wooldridge, dated 1841, as given elsewhere in these pages.

5. "Statistics of Coal," by R. C. Taylor, 1848.

6. Reports and Papers of W. B. Rogers, First Director, Virginia Geological Survey, 1835-1842.

(1) Mr. Grammar wrote (1818) as follows:

"The pits visited are situated in the County of Chesterfield about 14 miles distant, west-southwest from Richmond and three

miles South of James River.

"The coal is now procured from at least 25 different pits, opened at convenient distances through an extent of from 50 to 70 miles.

"At Heth's pits, the coal is 50 feet thick. At some of the pits between Heth's and James River, it is 30 feet thick and at the River, not more than 25 feet. The thickness of the coal on the north side of the James River, at the pits in Henrico and Hanover Counties is variable, but at no place greater than 25 feet.

"Heth's pits were first opened about 30 years ago and worked to some considerable extent, but abandoned on account of near approach to a part of the coal which was on fire. Some few years ago, Mr. Heth again commenced work in the coal and now has three shafts open, one at a depth of 350 feet, and the other two 300 feet about.

"In sinking shafts, they cut in the first place perpendicularly through the coal to its lower surface and then turning westwardly they opened a horizontal gallery through the inclination of the vein to its upper surface. Length of the gallery which passes (in the direction of the vein) by the mouth of each shaft, is 1350 feet and is terminated by a dyke of hard sandstone, they were preparing to blast through this rock. At right angles, shorter galleries have been opened, connected by passages parallel to the first or principal gallery.

"The fire in the old deserted workings is used to ventilate the mines."

(2) Mr. Pierce's letter of 1826 contains the following:

"The bituminous coal region of Virginia continues to be profitably explored; new shafts are sinking and coal of an improved quality and in increased quantity raised.

"From the pits south of James River a million of bushels (about 35,700 tons) have been conveyed to Richmond during the past

year - a distance of 14 miles, at an expense of nine cents the bushel - the cost of raising is about four cents.

"The coal is raised by machinery propelled by mules. A steam engine was erected at one of the pits, but abandoned as the sulphuric acid of the water raised from the mine and used in the boiler, corroded and soon destroyed the iron.

"The coal in a few places approached the surface, and quantities were formerly obtained with little labor, but it is now generally procured by sinking shafts from 50 to 400 feet, at an expense of from seven thousand to twenty thousand dollars.

" A considerable proprietor is said to have realized the past year, a profit of forty thousand dollars from his coal pits.

"The coal beds are from thirty to fifty feet in thickness and appear in exhaustible.

"Some instances of conbustion and explosion of gas at the Richmond pits were mentioned. Safety lamps have not been used and a large proprietor of coal beds had not heard of the invention.

"Several old pits adjacent to beds now worked have been on fire many years; hot air and smoke incessantly issue from the shafts, from the crevices in the rocks, and from those in the earth.

"The extent of the coal region has not been ascertained. A bed of superior coal was lately disclosed, twenty miles west of Richmond, on the James River.

"North of that stream, about 400,000 bushels (about 14,290 tons) of coal were raised last year, and conveyed to Richmond through the medium of the canal; the expense of freight and toll being but three cents the bushel; but the coal is generally inferior to that raised south of the James River."

(3) In Mr. Wooldridge's paper there is given an interesting and somewhat detailed account of the development of the coal mine "in

the vicinity of Richmond" in previous years and descriptions of the mines then in operation. This paper is given in full, as it presents much practical information regarding the early days of operations in the field, which is not found elsewhere.

"The coal field of this vicinity lies about thirteen miles west of Richmond. It is known to extend from about 15 miles north of James River, south beyond the Appomattox; is said to be some 50 miles in length and in width about twelve miles; its bearing is some 13 degrees west of south; it lies upon granite and is supposed to be in form of an ellipse; it outcrops to the East and West. The coal lies in six counties, Henrico, Hanover, Goochland, Chesterfield, Powhatan and Amelia.

"The mines in Chesterfield County may be said to occupy the center of the field on the Eastern outcrop and it is in this vicinity that the coal appears in its greatest thickness and purity; it varies from fifty feet to some four or five feet in thickness. It may be well, perhaps, to remark that all the explorations and workings in this coal field have been confined chiefly to the outcrop or sides of the basin, and that there is nothing yet developed indicating with any degree of certainty how thick or deep the coal will be found embedded in the center of the field.

"The first mines discovered in this vicinity were the old Black Heath pits, Buck & Cunliffe's, Ross & Craig's, Wooldridge's, Bailey's and the Green Hole, and on James River, in Chesterfield County, also Trabue's & Sallee's pits. These have all been discontinued or worked out.

"The mines now in operation are the Maidenhead pits, known as the mines of the Black Heath Co. of Colliers, discovered in 1821. There are at these mines several shafts, varying from 150

to 700 feet deep; during the year before the last, Colonel Heth, originally a large shareholder, purchased these mines with all their real estate and other property; he bought also Sallee's pits, with a large adjoining tract- intending to combine all these various tracts so as to form a new company and with this object went to England. While there, an explosion from inflammable gas occurred in his mines in which 53 out of 56 were killed. He brought out from England suitable men to reclaim his mines, which was done, and with him came agents, sent out to examine and report on the value of this property. He is now in England closing a sale of the whole of this property and the agents of the English Company are expected to put these mines under work.

"On the Maindenhead tract are two deep shafts, the one in which the explosion took place, about 700 feet in depth, and the other about 600 feet deep. The coal from these mines is a good quality, averaging 36 feet in thickness and the two shafts can produce two million bushels of coal per annum. On this estate are all the buildings, engines and other machinery necessary for a large business, with a railroad, the property of the Company, leading from the pits to the James River and passing through the tract of land owned by said company, called Sallee's containing a valuable deposit of iron ore (which, it is expected will be worked.)

"Explosions occurred several times in the Maidenhead pits prior to the great explosion. On these occasions several men were killed or burned. At that time the art of ventilating coal mines was imperfectly understood here. Since that period, much greater, if not entire security exists under the ventilation by Newcastle gas-men. On the north of these works lies the mines owned by Thompson Blunt, now under a lease to Colonel Heth, and best known as the pits of Wills, Brown & Co., of whom Colonel Heth purchased

the lease; but one shaft, and that 400 feet deep to the coal, is in operation at the mines; at the bottom of the shaft there are two inclined planes, one worked by mule-power and the other by steam. These slopes increase the depth about 300 feet more. A force of about 90 hands is employed; these pits being about two miles from the coal railroad leading from Manchester, which is the shipping point on tidewater to most of the mines in the vicinity. The coal, which is about 30 feet thick, is of superior quality for smitheries and the product about 400,000 bushels per annum. Several accidents by explosive gas occurred in these mines during the last year and preceding years. These mines were opened about 25 years ago; during the first year's operation when the miners were out for their dinner, about one o'clock in the day and within an hour from the time they ascended, the pit fired and the flames instantly rushed from the shaft to the heights of 200 feet about the surface; whether this was caused by an explosion of gas is uncertain. (?)

"Immediately adjoining these mines on the north, are those called the Gowrie pits, owned by Murchie, Moseley and Brander, and now worked under a lease by George E. Swann. There are two shafts on this property, one about 160 feet deep, and the other about 460; about 80,000 bushels of coal will be hoisted this year. The coal is about six feet deep; the present prospect is not promising and it is probable that these mines will not be worked the ensuing year.

"Next on the northeast are the old pits of Buck and Cunliffe worked out; and in the northeast of these are the old Black Heath mines in like condition. About two miles north are Sallee's pits named before and owned by the English company; in which company Colonel Heth retains a royalty upon one-half of the minerals owned by it, as well as on the coal property.

"On the north lie Trabue's old pits extending to James River, now owned by Thomas M. Burfoot and under a lease to Stanford, Duval & Co., who have sunk some shallow shafts south of the former workings, 50 to 250 feet deep. A new shaft is now sinking on the land - about 125,000 bushels will be produced this year.

"On the southeast of these mines, on the lands of Major Clarks, some years ago, coal was mined to a small extent.

"Returning to the Maidenhead pits, which lie on both sides of the Buckingham Road from Richmond to Lynchburg, Wooldridge's old pits and Baileys, the property of Nicholas Mills are directly east and adjoining.

"East of these mines are the old Union pits worked out, not having been wrought more than some fifteen years after being discovered. South of these are the exhausted Mill Creek pits, and south of these are the old Green Hole pits, one of the oldest and exhausted by working.

"Next and immediately south lie the Creek Company's mines, discovered about four years ago. They were valued and sold to an incorporated company at $96,000.00. They have but one shaft in operation and the present year's product will be, as for the two preceding years, about 250 to 300,000 bushels of coal. The coal is of good quality, but difficult to mine in consequence of the field being somewhat troubled. They have two cooking ovens and a branch railroad connecting with the main railroad to Manchester.

"On the south of these works and immediately adjoining are the Stonehenge pits, now unwrought; owned by the heirs of Martin Riley. The old shafts at these mines are very numerous varying from 50 to 400 feet deep. It is supposed new shafts will be sunk and operations carried on in the future. The coal from these pits ignites easily and burns freely, being very suitable for grates, locomotives, etc. but not for smith's use.

"There are several seams of these coals; the first from 12 to 16 feet in thickness, the next 28 inches, the thir four and one half feet.

"These coals were discovered about 30 years ago by a crew-fish bringing up coals to the surface above his hole. Wooldridge's old pits were discovered by the wheels of wagons on the Buckingham road turning up coal in the ruts; and the coal at the old Creek Hold pits was said to be discovered by a deer jumping across the creek and throwing up coal on the snow.

"The Midlothian Coal Mining Company's pits lie immediately south of the Maidenhead mines, southwest of Railey's pits, west of the Creek Company's mines, west and south of Stonehenge and adjoins all these mines. This Company was chartered in 1833 and organized in 1836. The tracts of land containing 404-1/2 acres, in two tracts, were valued at $300,000 and owned by Wm. Wooldridge's heirs - to-wit, Dr. A. S. Wooldridge, Jane A. Elam, Charlotte Wooldridge, and myself (A. S. Wooldridge). $100,000 cash was raised in and around Richmond and given to the Company as capital for sinking, etc. Four shafts were commenced extending six miles or more on the run of the coal and in 1839, coal was found in one shaft at 722 feet to the coal and others temporarily suspended at 625 feet, 300 feet and 85 feet.

"The coal at 722-1/2 feet was 36 feet thick.

"While the coal basin extends south to the Appomattox River and perhaps beyond, no coal of sufficient thickness has been found nearer the river than Rowlett's old pits one mile to the north. Between these and Hills old pits, five miles still further to the north is supposed to be the only part of this section that will be found valuable from a mineral standpoint.

"Rowlett's pits were some 20 years since leased by a company

of gentlemen in Petersburg; after a trial of two years, search for coal was abandoned.

"About 20 years ago Hills pits were put in operation, worked for 5 or 6 years and abandoned.

"These are the only workings that had been attempted on the south side of the basin until 2 years ago since when coal was accidentally discovered upon the lands of James H. Coxe, 3/4 mile south of Hills pits on the side of a hill where it had been uncovered by washings from heavy rains.

"The thickness of the seam varies from seven to fifteen feet and the coal is of superior quality, but wants proper facilities for transportation, which are to be furnished by the construction of a railroad to the Appomattox, a distance of 5 miles or one to intersect with the Richmond and Petersburg railroad and reach James River about Osborne's or Bermuda Hundred.

"These mines have recently been sold to the Clover Hill Company now working them. Moody and Johnson have a lease of Anderson's land adjoining, and the two operations produced last year 200,000 bushels of coarse, grate coal; the fine coal not being able to bear the cost of transportation, is still remaining in the pits.

"Several mines were worked by three incorporated companies, on James River, on the western outcrop, in Powhatan County, but have all failed as the coal both in quantity and quality was not equal to the coal of Chesterfield.

"In Goochland County, on the western outcrop, coal of good quality was formerly worked and known as the Dover pits, owned by Anderson and Moody, and conveyed to the Dover Coal Mining Company. These mines are not now worked, the company having failed and the mines reverted to the former owners.

"On the east side of the outcrop, on the Goochland and Henrico side of the James River, are several mines, some now in operation and some not.

"The largest operators in that neighborhood are the Messrs. Crouche and Sneed, the owners of extensive mines in good working condition employing about 150 hands and raising 400,000 bushels of coal the present year. Near these mines, on James River, are those of the Tuckahoe Coal Company. The old mines are out, but a shaft is sinking.

"Near those are Woodward's and Cottrell's mines, both now unwrought. Northeast of Crouche's and Sneed's mines, lie the Edge Hill pits, now worked by Richardson. On the north part of Crouche's and Sneed's property, Townes and Powell are hoisting Coal. There may be some other mines not remembered. There is a railroad connecting these mines with the James River canal, down which the coal passes to Richmond.

"The coal on the north side of James River sells for a less price than that on the south side, being considered not as good.

"Some four or five miles north of these mines lie those called the Deep Run pits, worked by John Parr, who raises over 250,000 bushels and employs 40 hands. This coal is of fair quality as is that from Burton's pits, now mined by Grabs and Co., who will raise about the same quantity. The coal from these mines is transported to Richmond over the Fredericksburg & Richmond Railroad Company, a branch of their road having been extended to the pits.

"The charge for coal on the road is four cents from mines to Richmond. The charge for boating coal down the James River is about three cents from the mines; that on coal passing the coal railroad in Chesterfield from the mines to tidewater is five and a half cents. (Presumably per bushel.)

"There is found in connection with the coal at Sallee's and Surfoot's pits in Chesterfield on the north side of James River at the mines generally, a substance formerly called "dead coal," recently called natural coke, that has lately been used and very much appreciated as grate fuel."

(4) See quotations from Colonel Wooldridge's letter in Mr. Heinrich's paper, given elsewhere.

(5) Mr. R. C. Taylor, who was called the foremost economic geologist and Mining Engineer of his day (he died in 1851, at Philadelphia) has given a brief description of the Richmond coal field in his book "Statistics of Coal" (623 pages, published in 1848, 2nd Edition 1854.)

The following quotations are taken from the 1848 Edition:

"Before quitting the Atlantic slope, we have to notice a bituminous coal field, small in area, yet rich in the abundance of its coal, and most favorably situated in regard to facility of transportation. Almost in the center of Eastern Virginia, between N. latitude 37° and 38°, lies the little basin of Richmond, or Chesterfield. This field contains the oldest worked collieries in America.

"The geological map of McClure - the father of American geology was prepared to illustrate his memoir in 1817. In position and form, as there represented, this coal-field differs in no material respect from the maps of the present day - and thirty years of operations there have not greatly enlightened us as to details."

Regarding the probable depth of coal beds in the center of basin, Mr. Taylor wrote:

"There exist, probably, no date by which the depth to which the coal descends in this trough, can at present be ascertained. The outcrop on the eastern margin, rises at a much greater angle

than that on the western. In the former, the shafts are far deeper than in any others in America. Reid's deep pit at Chesterfield measures 412 feet from the surface to the granite floor. The following summary shows the number of seams of rock, sandstone, shale and coal which were penetrated by this shaft. It is to be observed, however, that as the strata were not intersected at right angles, but at the inclination at which they were cropping out to the surface, they are proportionately and individually of greater thickness, as represented in the table, and traversed by the pit, than in strict accuracy ought to be assigned to them.

"The entire series, so far intersected, comprises 94 beds. Forty of these, consisting of varieties of carboniferous, micaceous and argillaceous shales, occupy an aggregate of 134 feet. Fifty-one other strata consist of granitoid psammites, carbonaceous sandstones, white or gray micaceous grits of various degrees of texture, ranging from conglomerates up to schistose sandstone, and comprise a thickness of 167 feet.

"At the base of the group are two or three coal beds with intermediate shales; the whole embracing a thickness of from eleven to forty feet of coal, and even fifty feet, according to the irregularities in the granite floor.

"As before stated, there are other shafts which reach the coal at a deeper part of the basin than at this point; and as the operations are carried down the slope of the main seam, the works are necessarily becoming deeper, and the coal is excavated and brought to the surface at a corresponding increase of expense. Up to the present time, we believe, the eastern outcrop alone is that which is almost exclusively wrought, and owing to the steep inclination of the coal measures not to a greater breadth than from

one-half to three-quarters of a mile.

"The general course of this eastern boundary is S. 24° W. or thereabouts, and every investigation shows the arrangement to be that of an extremely elongated trough, occupying a hollow in the primary rocks.

"Some of these deep mines contain a good deal of water, and are consequently attended with expense to keep dry; for, as the structure of this trough precludes the possibility of draining and working by the economical system of adit levels or tunnels, all the water, as well as the coal, has to be elevated to the surface by machinery.

"Other mines are comparatively dry, even in the vicinity of the wet shafts. This fact speaks conclusively as to the dislocated nature of the coal basin, near the eastern margin.

"The Maidenhead or Heath's mines are remarkable for their dryness, and no water occurs in any of the workings; such at least was the case in 1835. Some portion of this freedom from water is perhaps attributable to the subsidence of old works.

"The Black Heath mines were then on fire and could not be worked.

"The Bell workings had been on fire for 25 years, and the fire had advanced to the workings of the Rise Shaft.

"The Bell and Rise workings, of about 400 feet depth, gave way on the Christmas eve of 1833 (fire-damp explosion). Being a holiday not a single life was lost. On the succeeding morning, the course of all the underground workings could be traced on the surface by the lines of fissure extending along the ground.

Clover Hill Coal Mines.

Mr. Taylor gives also the following data regarding the Clover Hill mines, in the vicinity of Winterpock:

"In 1845, the Clover Hill Railroad Company constructed a road from a shipping point on the Appomattox River, near Petersburg, to what was then a new coal region, but is ascertained to be an extension of that which had been long known and worked, in a north-east direction. These mines are about 14 miles south of the most southerly previously wrought, and there is a space of ten to twelve miles between the two regions, in which no mines are yet opened, but in which the coal measures, and in fact coal is known to exist, although it has never been explored.

"The Clover Hill portion of the field has been practically open to commerce only during 1846 and 1847."

Mr. Taylor reported also that since the completion of the Clover Hill Railroad to October 1, 1847, there had been shipped from the mines 2,187,000 bushels (78,107 tons) of coal, of which 1,592,830 bushels (56,880 tons) were shipped to northern and southern ports, the remainder was consumed in Richmond and Petersburg.

Statistics: Mr. Taylor gives the following statistical data regarding the Richmond field coal:

"In 1840, the Congressional return of the annual production of this coal-field was 80,671 tons. By a subsequent return to the Virginia legislature, it appears that the quantity of bituminous coal raised here, between the years 1822 and 1841, inclusive, was 49 millions of bushels, 1,750,000 tons, being at the average rate of 87,500 tons per annum, for twenty years. The expense of raising the coal was stated to be $1.12 per ton."

The following statistical data are also given by Mr. Taylor:

"Shipments of Virginia coal into Boston, Massachusetts, were as follows:

Year	Bushels	Tons
1835	212,106	7,575
1839	144,475	5,159
1846	183,052	6,537
1850	63,415	2,265
1853	4,600	165

VIRGINIA DIVISION OF MINERAL RESOURCES LIBRARY

In a document submitted at Richmond, dated February 6, 1838, it is stated that "every cannon foundry in the U. S. is furnished with coal from the Black Heath pits," and that "other pits supply large quantities to the northern iron factories."

"In 1846 Richmond coal sold for 20-22 cents per bushel in Philadelphia.

In the period 1835-1841, Richmond coal received in Boston was sold at an average price of $5.805 per ton.

In 1848, the price of Chesterfield County coal at Richmond was $5.04 per long ton - best Clover Hill coal $5.60.

(6) Prof. William Barton Rogers, First Director, Virginia Geological Survey, in his report of 1835, wrote of the Richmond field:

"The very fine qualities of the coal in this field, both for domestic use and manufacturing purposes, together with the very enormous thickness of the deposit in many of the mines, holds out an ample guarantee that, if prosecuted upon a correct conception of its internal structure, it must always form a profitable region to the quarter of the State in which it lies.

"We regard it (the Richmond field) as one of the most valuable deposits of mineral wealth within the area of Virginia."

Professor Rogers also remarks:

"The longitudinal direction of the coal field, or what is the same thing, the line of bearing of the outcrop of coal, is nearly north-northeast and south-southwest. The internal structure of the field is one of excessive intricacy and, with the changing thickness of the coal, shows the necessity of boring."

In 1840 Professor Rogers listed the mines then in operation as follows:

<u>South of James River:</u>

Heath, owned by Potts & Co.,
Engine Shaft
Maidenhead Shaft, 412 feet.

Mills & Reid's Creek Pit, 420 feet
Mills & Michaels Pit, 570 feet.
Greenhole Shaft, 100 feet.
Colonel Heth's Deept Shaft.
Powhatan Pits (Capt. Finney)
Cox's Mine, Winterpock Creek.
Coalbrook Dale.
Andersons Pits.
Barr's Pits.
Crouche's Lower Shaft.
Scott's Pitt, formerly Woodwards.
Waterloo Shaft.
Deep Run Pits.
River Pit, 130 foot depth.
coal 20 foot thick when abandoned.
Midlothian Pit, 500 feet depth and working to 700 feet, coal variable in thickness, worked at more than 30 feet and in small basins 40 to 50 feet.
Mills Mines, East side of basin, coal variable from almost nothing to upwards of 40 feet.
Black Heath, new shaft, 380 feet. Union.

The greatest number of pits is upon the Eastern border of the field.

Daddow and Bannon - 1866:

Messrs. S. H. Daddow and B. Bannon, in their book "Coal, Iron and Oil, or the Practical Miner," (Pottsville, Pa. 1866) discuss conditions in the Richmond coal field as follows:

"The Methods of mining pursued are exceedingly primitive and the cost of producing coal at least double that of our anthracite or western coal fields."

"Experience and capital would undoubtedly remove some of the expense and render mining more profitable, but the formations of this coal field are so peculiar and uncertain that no man, however, experienced in other coal fields, should feel confident in this without much study and investigation ..... It is true that most of the blunders and failures made in the Richmond coal field are the results of ignorance - but rather a want of local information than general mining experience. No judgment, however practical can be depended on without actual testing by proof-shafts.

"We think there are few coal fields more inviting to the

miner than the Richmond basin, but there are none where skill and engineering are more needed to insure success. Success, however, is certain to those who go prudently to work and develop with sound judgment.

"The Midlothian and Clover Hill mines are the principal works on the South side at present, or which were in operation at close of the Civil War. The celebrated Black Heath had been worked out and abandoned some years previous. Though these mines have been worked more or less for a period of 50 years, but a small portion of the coal field has been exhausted,

North Side:

"The fifth seam on the north side is a bed of natural coke ranging from 5 to 6 feet in thickness. In appearance it is much like artificial coke but with less lustre and fracture more like bituminous coal. There are two varieties of this natural coke in the same seam. The most valuable is denoted at "Soft, or free-burning," and the less valuable as "hard, or popping coke" from its tendency to fly and split. The soft coke burns beautificully, but the hard coke ignited with difficulty and burns less slowly.

"The only operations of note in the Richmond Coal field before the War were the Midlothian and Clover Hill mines on the South side, and the Carbon Hill and Dover Mines on the North side. There were also several very small operations in several other localities - on the south bank of the James River near the Danville Railroad in the vicinity of Black Heath - but the total amount mined in the Richmond coal field did not exceed 100,000 tons per year at the commencement of the War. We think this amount per year will cover the entire production of the field for the last 50 years.

"No regular record has been preserved, but the amount raised between 1822 and 1841 amounted to 1,750,000 tons or 87,500 per year;

and we do not think the entire amount raised to be over 5,000,000 tons in the aggregate.

"The cost of raising this coal has not been less than $2.50 per ton or $3.50 delivered in Richmond. The prices there from 1850 to 1860 ranged for run-of-mine $4.50 to $5.00 per ton, and for best household coal $6.00 to $7.00.

"The Midlothian pit is over 750 feet to the sump, or 722 to the coal, which was 36 feet thick when struck - this is the deepest pit in the field and including the dip workings to the basin, 150 feet by slope, the total depth from surface is 900 feet.

"The Black Heath and Clover Hill pits are from 500 to 700 feet deep, the Carbon Hill 150 to 400, and the Dover from 100 to 400 feet.

"There is one slope at Trent's mines, near Carbon Hill, which is about 1800 feet in length and 700 feet perpendicular; abandoned sometime ago on account of difficulties with air and water.

"The mining operations in the Richmond field have been generally of the most primitive character. Instead of progressing, they have gone backward for the last 10 years and are now less able to mine coal with economy than they were 20 years ago.

"Great and permanent injury has been done to a large portion of this field by the numerous and small pits sunk along the outcrop to the depth of 100 to 200 feet.

"These mines have been long abandoned and the excavations filled with water; and as no records are kept of the direction and extent of these old workings, it becomes dangerous now to approach them from the deeper pits."

The following paragraphs are taken from Leslie's "U. S. Mining and Railroad Register," as quoted in Macfarlane's "Coal Regions of America" (New York 1873).

"The geological difficulty will not, however, stand in the way of the proper development of the Richmond coal basin, when those into whose hands its property tracts fall, learn that before a shaft is sunk the whole of the ground of any proposed colliery must be carefully studied with the diamond drill.

"We have often turned with a sort of wonder to regard the Richmond coal basin. Its history is very strange. It was one of the earliest opened by the miner. It is the solitary one at tide-water and near a State capitol, for the Rhode Island coal basin does not deserve the name.

"It contains several beds of coal, and one of these sometimes at the great thickness of 60 feet. It is mined on the English plan and affords a variety of fuel from gas coal to natural coke. One would have expected its complete development long ere this. A little reflection, however, will serve to explain the phenomenon. The Richmond coal field is in Virginia and Virginia has been in a profound sleep for a hundred years, a sleep undisturbed by dreams of any other than a political complexion.

"Industry was always ignoble in Virginia; interests in unwieldly breadth of soil was the only vogue. Wood was always plenty for the hearth and the forge, and why raise stone coal, when there were neither steam mills, cotton mills nor woolen mills, coke stacks nor puddling furnaced in the region.

"The Tredegar Iron Works (at Richmond) could supply itself from Baltimore or raise enough from a single shaft with 50 black miners to supply all its needs.

"From the Blue Ridge to the seashore and from the Potomac to the Savannah, no one thought of using stone coal for any purpose whatsoever. If they had, the capacity of the Richmond field would have been developed; for it stands alone, or stood alone, the

solitary source of mineral fuel for a region 500 miles long and 250 miles broad. The Deep River (N.C.) basin was almost, and the Dan River basin was wholly unknown.

"Even now the latter remains practically untouched and the former is not to be compared with the Richmond field for size of its bed nor quality and variety of its coals."

Mr. Macfarlane (1873) gives also the following brief description of some of the mines, their location, thickness of seam, etc.

"The Deep Run (Springfield) basin is opposite the extreme northern part (of the field) from which it is three miles distant, with primary rocks between; it is two miles long and 1/4 mile wide.

"On the northeast side of the field there are two seams in Andersons pits, 30 feet asunder, the highest six to sixteen feet, the lower from four to eight feet thick.

"At the River pits on the south side of James River, in old workings at the depth of 130 feet, was a twenty foot seam. Crossing to the east side of the coal field, we find some extraordinary sections of this mineral. Hill's pit contains three seams of five, six and 25 feet.

"In the Maidenhead, or Heath's mine, Professor Taylor examined a gallery cut in a solid seam of splendid coal not less than 25 feet thick. The Black Heath Coal, which is reported the finest in the district, is 40 feet thick. The Creek pit has a bed of six feet, separated from the main body of the coal, which is here 48 feet, including two feet of shale."

In the Transactions of the American Institute of Mining Engineers, Vol. 3, 1875, there is included a paper with discussions presented by Mr. Martin Coryell, M. E. (of Wilkinsburg, Pa.) on "The East Virginia Coal Field" from which the following quotations are taken:

"The object in presenting this subject is to call attention to the fact that for want of scientific knowledge in mining, mine surveying, and the careful recording of notes, a large amount of capital has been expended in producing a small amount of coal. We have here, within a few miles of navigable tidewater, an area of ninety-six thousand acre of coal measures, having upon it seams or pockets of coal from five to sixty feet in thickness as proved by workings in various places, which is left unimproved, unproductive and almost unknown at this day.

"There are several collieries opened and producing coal to a very limited extent, the principal ones being Clover Hill, on the southeastern side of the basin and Midlothian on the eastern side, near the middle of the field, on the Richmond and Danville Railroad and only 12 miles from the City of Richmond. In this vicinity are, further, three or four individual operations.

"The James River Coal Company, occupying and operating the property of the Carbon Hill Coal Company, is on the north side of the James River and the coal is here loaded into canal boats from a railroad four miles in length.

"Messrs. Wilkinson and Duval and the Old Dominion Coal Company, on the south side of the James River, are on the westerly rim of the basin and load their coal into canal boats on the James River.

"South of the James River it is generally believed that there is but one seam and that very thick, from 20 to 60 feet.

"On the north side of the James River four seams are represented at the mines now worked by the James River Coal Company. They were reported as follows, beginning at the bottom:

1.	Seam of Coal, unknown	00
	Rock	40 to 60 feet.
2.	Seam of Coal	6 feet
	Rock	12 feet

3.	Seam of coal	5 feet
	Rock	50 "
4.	Seam of coal	6 "

Mr. Oswald J. Heinrich, who was "Superintending Engineer" at the Midlothian Mines from 1869 to 1874, when the mines were closed down, has written five papers on conditions in the Richmond coal field, all but one of which were published in the Transactions of the American Institute of Mining Engineers, 1873-1878, under the following titles:

"The Midlothian Colliery, Virginia, 1875.

"Remarks on Trap Dykes and on Natural Coke in the Richmond Coal Field; Engineering and Mining Journal, Vol. 19, 1875.

"An Account of an Explosion of Fire-damp at the Midlothian Colliery, Chesterfield County, Virginia," American Institute of Mining Engineers, Transactions, 1876.

"The Midlothian Colliery, Virginia," American Institute of Mining Engineers, Transactions, 1876.

"The Mesozoic Formation of Virginia," American Institute of Mining Engineers, Transactions, 1878.

Much valuable information regarding the Richmond field and its coals is given in Mr. Heinrich's papers, from which quotations are given below:

Mr. Heinrich was the outstanding Mining Engineer of his day in the Richmond field, and the following brief sketch of his life is of interest; the information it contains was furnished by his grand-nephew, Mr. R. H. Rudlich, U. S. Bureau of Mines.

Mr. Heinrich was born in Germany and was graduated from the Freiburg (Germany) School of Mines. He came to Richmond, Virginia in 1850 - practiced as Civil Engineer and Architect, and taught drawing in Richmond schools 1863-1866. Went to Buchanan (Virginia) in connection with laying out town, designing buildings, shops, etc.

In 1869 he went to Midlothian where new Richmond interests

acquired the coal mines; as Superintending Engineer, he sank a new shaft and operated the mines successfully until fire broke through from an old mine and the expense of fighting fire becoming too great, the Company failed, most of the officials and miners moving to Powhatan where a new operation was being started.

Mr. Heinrich returned to Richmond in 1874 and for two years, 1875-1877, operated a salt mine at Goderidge, Canada; he came to Drifton (Pennsylvania) in 1877 to conduct the mining and Mechanical Institute, organized by Eckley B. Coxe, a prominent anthracite operator and owner, to educate sons of employees in mining and mechanical engineering. Mr. Heinrich died at Drifton in 1886, and is buried in Hollywood Cemetery, Richmond, Virginia.

In his 1873 paper, Mr. Heinrich mentions the fact that he came to the Midlothian mines just after the property had been sold at public auction for $189,000, and described the dilapidated condition of the buildings and equipment, and the difficulties and methods used in fighting an underground fire in "Bailey's Hill," where the coal was said to have been on fire for some 50 years.

"The Midlothian Colliery, Virginia," 1873, by O. J. Heinrich.

The following quotations have been taken from Mr. Heinrich's paper of 1873.

The section of the formation on the "Bailey Hill" property of the Midlothian Company, near Midlothian, Chesterfield, is given by Mr. Heinrich, as follows:

		Feet	Inches
1.	Hard dark-gray sandstone	3	7
2.	Hard Bluish-gray sandstone	4	0
3.	Bluish-gray clay slate	2	3
4.	Black slate	2	0
5.	Gray argillaceous sandstone (jointed)	6	2
6.	Gray slate and indurated shale	4	10
7.	Top seam of coal	5-6	4
8.	Top seam of slate, often interstratified with inferior bony coal	5-6	4
9.	Clean good coal	3-4-	0

10.	Dark Slate		0	1-2
11.	Rich coal, highly bituminous		9.8-12	0
12.	Sulphur Band		0	1-7
13.	Coal		2	7
14.	Dark Slate		0	1½
15.	Good clean coal (bottom of main seam)		5	7
16.	Light gray slate		0	9
17.	Coal			
18.	Gray slate band		0	2
19.	Coal		6	0
20.	Slate (gray)		1	6
21.	Coal	5 inches		
22.	Gray Slate	4 "		
23.	Hard gray sandstone (floor)	3 "	1	0

"The pitch of the coal varies from 25 degrees to even 75 and even real faults dislocating the coal vertically, are met with at disturbed points." (This section shows a total minimum thickness of coal amounting to 33.8 feet.)

Mr. Heinrich wrote in 1873 -

"The Richmond coal field has a well-founded bad reputation, arising from the fact that many of its collieries have had to be abandoned from time to time, on account of fires, caused by spontaneous combustion, to which the character of the coal in this field renders them peculiarly liable; but many lamentable disasters could have been avoided if a suitable system of mining had been pursued in all the collieries.

"This, and a series of other errors, too numerous to be recounted here, but all due to ignorance, want of system and false economy, have concentrated all the worst elements imaginable to prevent the continuous prosperity of these mines. Otherwise, under good management and improved system of mining, the superiority of the coal, the large yield per acre and the close proximity to home and foreign markets, ought to have placed them amongst the most prosperous and remunerative mines in the United States.

"Although the existence of irregularities in the seams may be freely admitted, it could have been made comparatively harmless by proper records, surveys, maps and timely exploration; by taking up new ground, free from the curse of former bad management.

"The origin of spontaneous combustion in collieries is chiefly due to bad systems in laying out the pits, unclean workings, insufficient ventilation and neglect in damming off works after they are exhausted of the main coal. This is particularly so in the Richmond field, because it is difficult and dangerous to remove the last vestiges of coal on account of inferior roof and the necessity of retaining all slates and bands to fill up, although such material is liable to fire."

Mr. Heinrich's second paper on "The Midlothian Colliery," appeared in the Transactions of the American Institute of Mining Engineers for 1876, quotations from which are given below.

Thhe following paragraph regarding the Richmond coal basin

taken from the Engineering and Mining Journal of January 1, 1876, was quoted by Mr. Heinrich:

"It has contributed but little to the supply of fuel during the year past, notwithstanding the fact that it is the most favorably situated of all our coal fields and possesses a fuel of good quality, well adapted to many important uses. An unaccountable lethargy seems to have fallen on all who have touched this field, and yet, in the future, it can scarcely fail to become one of the great sources of coal supply."

Midlothian Mines:

In a report of Colonel Wooldridge, dated 1841, the following occurs, as reported by Mr. Heinrich in his paper:

"Coal was mined in this neighborhood as early as 1700 and used in the vicinity of 1775.

"The oldest mines - in the neighborhood were the old Black Heath pits, Buck and Cunliffe's; Ross and Currey's lying northeast of Midlothian, Wooldridge's, Bailey's and the Greenhold pits, now owned by the Midlothian Mines; also nearer the James River, Trabue's and Sallee's pits, all in Chesterfield County.

"In 1841 the Maidenhead pits (Black Heath Co.), discovered in 1821, were the principal openings. Formerly worked by Colonel Heath, they were sold in 1840 to English capitalists, under the name of the Chesterfield Coal and Iron Mining Company. Considerable work was done and a good deal of coal mined until 1852 when mining was stopped. The ground was afterwards leased to the Midlothian Company and adjoins the Midlothian mines and is in the same basin.

"Previous to 1841, a number of old pits, the Union, Mills, Greenhold and Creek Company pits, were worked but abandoned after 12 to 15 years.

"The Midlothian Company was organized in 1836. Four shafts were sunk -

Old Pump shaft -	777 ft.	716 ft.	to	coal	
Middle "	625 "	612 "	"	"	
Wood "	625 "	300 "	"	"	
Grove "	622 "	485 "	"	"	

"Later another shaft was down 1,015 feet and bored 312 feet below shaft bottom, but no coal was found.

"In the fall of 1839, coal was struck in the Pump shaft at 716 feet, 36 feet thick, and others abandoned. In 1840, 300,000 bushes of coal were raised from Pump shaft, with 150 men and 25 mules."

Mr. Heinrich goes on to say that "In 1855 a serious explosion occurred, killing 35 men. In 1867, the company failed owing $180,000 and in 1869, the property was sold at public auction to present owners.

"In 1873, boring was started and clearing out of the old Grove Shaft. Afterwards, coal was found by two holes, 477 and

598-608 feet deep, in three seams, 14-1/2, 12 and 3-1/2 to 4 feet thick. Shipments from the new pit started in January, 1876."

Mr. O. J. Heinrich's paper, "The Mesozoic Formation in Virginia" (published in the Transactions of the American Institute of Mining Engineers, Vol. 6, 1878) gives much interesting and practical information regarding the Richmond coal field. The following quotations are from the paper in question:

"The Richmond coal Basin (coal-field) extends from the northern county lines of Goochland and Henrico Counties across the James River to the Appomattox River, lying in Powhatan but mainly in Chesterfield County, about eleven miles from Richmond. It extends upon both sides of the James River, but mainly upon the south. The Deep Run (Springfield) area is a small isolated basin, near Hungary station of the Richmond, Fredericksburg and Potomac Railroad, and about 1.6 square miles in extent.

"Its existence was known in 1700 and the coal was used as early as that date in the neighborhood. At least two workable seams of coal are known to exist in that basin; the lowest seam from three to five feet and the big, or upper seam, from twenty to forty feet or more in thickness and occasionally developed in two seams, divided by a series of slates and sandstones from five to ten feet thick.

"There is no doubt whatever that these carboniferous deposits, geologically speaking, are continuous. But, like many other formations of the kind, they have their deteriorated localities and pinched places which may, and often have deceived the inexperienced.

"The coal, although in various instances reaching almost to the surface, has its outcrop hidden by a covering of alluvium, and also probably to a small extent, by tertiary strata, ranging from ten to forty feet.

"The seams pitch variously from 20 degrees upwards. Nearly flat depositions exist in the bottom of the subordinate troughs, or synclinal basins, and heavy pitches to 60 to 70 degrees near the anticlinal rollsor saddles; on the average, a pitch of 25 to 30 degrees may be assumed. The course of the coal is about north 12 degrees to 15 degrees East. The main dip in the Richmond basin upon the Eastern side is northwest, upon the western, southeast.....

"With such precautions, the yield of these seams is most favorable and it is astonishing that so little attention has yet been paid to this section of the country. According to former statements, the Mesozoic rocks cover an area of 189 square miles, in the Richmond coal basin, equal to 120,960 square miles. Not over 500 acres of this area has actually been worked, but what is still more important, these 500 acres are principally divided into about six localities, namely, the mines about Carbon Hill, National, Midlothian and vicinity of Clover Hill, upon the line of eastern outcrop, at the extreme northern and southern points and about in the middle of the border line of twenty-eight miles extent; also for about ten to twelve miles upon the extreme northern point of the western outcrop, in the vicinity of Dover, and the mines south of James River; in all, say 35 to 40 miles of outcrop, the circumferential line of the basin being about 75 miles.....

"The total production from 18.2 to 1877 of the Richmond coal-field amounted to 5,647,620,61 tons or without any allowance for years previous to 1872, it would average a yield of 102,684 tons per annum, and 11,295 tons per acre of ground worked. That this is by no means an unreasonable calculation has been practically proved at the Midlothian Colliery, where, in 1873, from one acre of ground 19,057 tons of coal were raised from a twenty-foot seam, averaging from twelve to fifteen feet of coal.....

"I mention this simply to show what may be accomplished in this coal-field by taking up new ground, free from the curse of former bad managements. There is no shadow of doubt that under skilful management, and by introducing late improvements in mining, even the deep mines in this coal-field would pay handsomely, the advantage of freight to the market giving them constantly an advantage in the competition with other coals.....

"Most of the labor is colored, although we have a few good white miners.....

"This field yielding an excellent gas coal, as well as coking coal, steam coal and blacksmith coal, its revival in the United States markets which it commanded before the Civil war, will only be a matter of time, because its accessibility to sea-going vessels of 500 to 1,000 tons capacity, will fairly counterbalance the moderate cost encountered by deep mining.....

"Therefore, this oldest of our coal-fields is yet to see its best day."

"THE VIRGINIAS"

Mr. Jed Hotchkiss, in his publication "The Virginias," July 1882 issue, makes the following comments regarding the Midlothian mines and the Richmond field, by inference. Mr. Hotchkiss' strictures on the field may have been somewhat colored by the fact that he was actively engaged at that time in furthering the development of the new Flat Top Pocahontas field in Tazewell County, Virginia, where mining was first started in 1882.

"The Grove Shaft of the Midlothian coal mines, Chesterfield County, Virginia, that has now been closed for several months since the dreadful accident that occurred there (an explosion of gas and dust, February 3, 1882, in which 32 were killed. F.R.W.) is to be opened again and the bodies of the victims of that disaster recovered and work resumed by order of A. S. Warner, one of the executives of the Burroughs Estate.

"There has been a great deal of controversy in the mining journals of the country over the unfortunate explosion in these mines that resulted in such a large loss of life and led to closing them to extinguish the fire lighted by that explosion.

"Now that it has been decided to reopen this shaft and resume work in it, we would say that in our opinion, there exists no necessity for working these dangerous mines, since we have so much coal of the same general character that can be mined with perfect safety (vide the explosion at Pocahontas in 1884, in which 112 were killed. F.R.W.) and put in the markets with that coal at about the same price; but if the owners persist in working it, the public has a right to demand that neither care nor expense be spared to make this mine as safe as possible, that another chapter of horrors may not be added to the wretched history of this mine." "Virginias" December 1880.

In December, 1880, it was stated in the "Virginias" that J. T. Jones & Company are now opening a new mine near Coalfield station of the Richmond and Danville Railroad (now Southern Railway), in the Midlothian basin, going down 210 feet to reach coal.

"Virginias, The," October 1881.

"At the Fair of the Virginia State Agricultural Society, the Brighthope Railway Company has a fine exhibit of bituminous coal from its mines at Winterpock, Chesterfield County, Virginia, 32 miles by rail from Richmond. The samples were mined 700 feet below the surface from a bed 4 feet thick."

According to the Mining Directory of the Tenth Census, the following mines were working in Chesterfield County, in 1880:

1. Brighthope, at Clover Hill, operated by Brighthope Railroad Company; top, middle and bottom seams, 27 to 30 feet thick; Product, 19040 net tons. Markets, Richmond, Petersburg, Norfolk, Virginia, and the tidewater cities on the Atlantic Coast.

2. Cunliffe Mine at Coalfield, operated in Geo. H. and John Jewett; product 6,720 tons; thickness of seams 25 feet; Market Richmond, Virginia.

3. Union mine, at Midlothian. Operator, Jacob Beach; product 1,638 tons; thickness of coal 8 feet. Market, Richmond.

4. Midlothian Mine, at Midlothian, Operator R. S. Burrows; product 13,122 tons; thickness of coal 4-2/3 feet. Market, Richmond and Manchester, Virginia.

In "The Virginias," Vol. 1, February 1880, appeared the following item regarding the Brighthope mines, near Winterpock, in the southern part of the field.

"In the Chesterfield coal basin near Richmond, Virginia, after two years of constant labor, the water from the Raccoon pits has been drained into the Brighthope pits and so brought under control, so the Brighthope mines will be able to again do a successful business."

William Clifford, a well known English Mining Engineer, visited the Richmond coal field and published the results of his investigation in the transactions of the Manchester (England) Geological Society, Vol. 19, 1887, and Vol. 20, 1889, from which the following quotations have been taken.

"Richmond Coal Fields, Virginia:"

"From the swamps at the head waters of the Chickahominy River, northwest of Richmond, Virginia, there extends for a distance of over 30 miles a coal field which has been known and worked since the commencement of the 18th Century. It supplied fuel for the smith at the time Cornwallis' Army lay in its camp at Genito on the Appomattox. It is also said to have supplied fuel to a cannon foundry in Richmond during the American Revolution.

"Long before the log foundations of Fort Pitt - where Pittsburgh now stands - were laid, or the hunter, Phillip Ginter, discovered Anthracite on Bear Mountain, coal mining was actively - and then so termed - extensively carried on at Midlothian, Virginia,

13 miles from Richmond.

"The only trace that now remains of the celebrated Black Heath pits is a large pond or swamp.

"It was here that Sir Charles Lyell mentions descending (1884) a shaft 800 feet deep and having seen coal taken out 40 feet thick, and "like the finest quality shipped at Newcastle."

"At Midlothian three years ago, two feeble affairs were still in operation, one working natural coke, and the other working coal from the old Etna Shafts. Deep Run was closed - fully worked; and the Tuckahoe basin was dead and the railway to Carbon Hill, pulled up; two little places were working on the south side of the James River, near Sabot's Island.

"Clover Hill, in the southern part of the coal-field, was working with a promise of increased capacity and apparent success.

"The appearances, with these exceptions, every where were of a coal-field worked out. "Yet so far from this being the case, only the most sketchy outline of the field had been touched. Of the 180 square miles contained within its boundaries, less than two square miles have been worked and probably less than half the coal got out of that area.

"The northern end of the coal field is tapped by a branch of the R. F. & P. RR. from Hungary station, the R. & D. strikes the field on its eastern boundary near Midlothian, about 13 miles from Richmond.

"Formerly there was a coal railway worked by mules from the collieries at Midlothian to the James River opposite Richmond. It was over this railway that the gas coal was carried for shipment to New York and Philadelphia, as mentioned by Sir C. Lyell on his 1844 visit.

"The Clover Hill Railway, in 1887 now called the Brighthope Railway

has been extended to Eppes Falls on the Appomattox River, three miles south of the collieries, on the one hand, and on the other from Chester to their shipping staiths at Bermuda Hundred.

"Natural Coke was principally found in that part of the field lying to the north of the James River, but in 1882 it was found near Midlothian, at old Black Heath.

"Mr. J. H. Nort, then Managing Director of the Brighthope Railway and Clover Hill Collieries, wrote, "as quoted by Mr. Clifford,

"The rank of the colliers are for the most part negroes, but there is a good sprinkling of whites.

"The negro slave formerly had the field to himself, the overseers only, being white until 1842 or 1843. It was the slave collier who first worked the coal and many of these now employed were slaves before the Civil War.

"These Virginia collieries were the penal settlements in the days of slavery.

"Refractory slaves were sent to the pits and hired by colliery owners at $30.00 per year, with two suits of clothes and a month's holiday at Christmas. Colliery owners had to deliver back slaves under conditions, but were not responsible for his value if killed, so the slaves were insured by the owners."

Mr. Clifford further states, in conclusion, "Speaking generally of the (Richmond) coal-field, there has been no lack of interest by outsiders. The old Virginians did what they thought was their duty; they got overseers and advice from the best men of the day in England.

"The general apology for failure is to blame nature for the somewhat erratic ways she has exhibited in this part of the world of rocks, but the bounteful compensations she has given are entirely overlooked. She has placed within the reach of the enterprising and persistent a possible degree of success not elsewhere attainable in America, but it must be won by patience, by judicious and even liberal expense of capital, by waiting for harvest time before reaping.

"The history of this coal-field is a record of failure, disaster and death." But "the writer believes that some day this field will be successfully and profitably worked, but not until someone who can and will afford to make a really fresh start, clear of old workings, and develop the field in accordance with sound mining knowledge."

In "Mineral Resources of the United States" 1887, the following brief statement regarding the Richmond coal basin is given:

"For a number of years prior to 1887, but one mine operated in this basin, that of the Brighthope Railway Company. This mine produced 30,000 tons during the year 1887.

"Toward the close of 1887, a number of new companies were organized to develop the coal lands in the Richmond basin; the most important of these are the Virginia Tidewater Coal Company, S. S. Murphy and the Richmond Coal Mining and Transportation Company. The two former are opening mines near Midlothian. The Carbon Hill mine of the Richmond Coal & Transportation Company is working the Natural Coke and semi-anthracite in the vicinity of Carbon Hill, but expects to sink shafts to the bituminous coal beds below."

In Bulletin 85, U. S. Geological Survey, published in 1892 (now out of print), entitled "Correlation Papers - The Newark System," Mr. I. C. Russell, the author, gives the results of his personal observations on the Richmond area, made in 1885.

Mr. Russell's observations, made, as they were, by a well-known economic geologist, have a direct bearing on the mining conditions, especially in that part of the area near the James River and are, therefore, given here, as far as they refer to conditions affecting the coal beds and mining.

After discussing previous studies by others, Mr. Russell goes on to say:

"The observations of the present winter made in 1885 seem to warrant the conclusion that the Richmond area has been greatly disturbed by fracturing, especially along its eastern and western margins, and that as a whole it owes its preservation to faulting.... The faulting that has taken place along the margins of the area indicates that the strata were formerly more extended than now.

"West border of the area. The Dover mines, on the north side of the James, and the Powhatan, Norwood and Old Dominion mines, on the south side of the river, are ranged in line along the west border of the area, and may be considered as constituting a single district. In this district, as has been demonstrated by mining operations, the inclinations of the rocks change abruptly from northwest at some localities to southeast at others near at hand, the inclinations varying from 15 to 20 degrees. This diversity is explained by the fact that the district has been broken by approximately north and south faults, and that the included beds have been variously tilted.

"The structure is especially well illustrated in the Norwood mine, in which the coal in certain of the fault basins has been worked out and the forms of the troughs demonstrated. These mines are located on the low bluff bordering the flood plain of the James, and the coal comes to the surface, although the lines of outcrop are concealed by superficial clays and gravels. The coal is worked by means of slopes following the dip of the seams. In the workings which were open in 1885 the dip is westward at an angle of from 20 to 25 degrees. The main slope has been excavated, following the inclination of the strata, for about 300 feet, and exposed sections of two coal seams, both of which are irregular in thickness. Three principal faults were exposed, all remarkably uniform in strike and hade.

"The displacement amounted to 5 or 6 feet in each instance, and the fault planes are inclined eastward at angles of from 50 to 70 degrees with a horizontal plane.

"At the bottom of the slope another fault of greater magnitude was encountered....."Along each line of faulting the coal had been pinched out to a mere "Stringer" of comminuted and slickensided fragments - Near the lines of disturbance the fragments of coal and shale are intimately mingled, much to the detriment of the former."...

"These displacements are accompanied by a thinning of the coal adjacent to the planes of fracture and a thickening in the central portion of the fault blocks. "This phenomenon has been observed in many other mines in the Richmond area and is probably the explanation of the great thickness reported in some of the coal seams along the eastern margin of the area.

<u>"East border of the area."</u> "In the neighborhood of Midlothian there is a double line of coal outcrops separated by a strip of crystalline rocks, having a breadth of about 2,000 feet.

"The western line of outcrop marks approximately the boundary of the main coal field, while the eastern line is formed by coal seams in detached basins. "Mining in this region has demonstrated that there are at least two separate basins in the outlying strip of coal-bearing rocks.

"These are the <u>Black Heath</u> and <u>Green Hole</u> areas widely known during early mining operations in Virginia.".....

"In the eastern border of the main area at Midlothian the strata, although disturbed by many faults, are inclined westward at an angle of between 15 and 20 degrees. "In the outlying local basins the strata are reported to be inclined from each side toward

the center, with two parallel lines of outcrop. "It is also reported that the coal seams are thin along their outcrops and thicker in the central part of the basins.".....

"At Clover Hill, in the southern part of the eastern border of the Richmond Coal field, coal has been mined for a long series of years. In 1885, this was the only point at which active mining operations were being carried on. "The incline which was being worked followed the slope of the coal seams for about 250 yards. "The dip of the strata is northwest 20 to 35 degrees, and the strike S. 10° 30' W., agreeing very nearly with similar measurements at Midlothian. At the date mentioned (1885), mining operations were united on the west by a fault, striking about north and south - "In the mines there are several minor faults, parallel to the one on the west, some of which have a displacement of 40 to 50 feet.

FAILURES IN MINING DUE TO GEOLOGICAL STRUCTURE. - It is safe to say that a large part of the failure which have attended the working of the coal in the Richmond coal field are due to the faulting and crushing that the rocks have suffered.

"Mining has been attempted only along the immediate borders of the main area and in the small secondary basins, that is, in localities where the greatest amount of disturbance has occurred. "The central and undisturbed portion has never been explored. "A few drill holes midway between Midlothian and the Old Dominion mines would demonstrate whether the coal in the central portion of the field is sufficiently thick and of such a quality that it would repay mining at the considerable depth at which it occurs. While the central portion of the field is practically without faults, it is possible that it is traversed by sheets and dikes of trap, the effect of which on the coal, whether to decrease or increase its value, can not be predicted."

Mr. Russell gives also some value general information regarding the Richmond field, as follows:

"Richmond Area."

"The eastern border is eleven miles west of Richmond. It is crossed from east to west by the James River, and thus divided into two unequal parts, the larger of which is to the south.

"Its extreme length from north to south is 31-1/2 miles. "The main field, as determined by Heinrich, is 24 miles long from north to south, and 7-1/2 to 10 miles broad. "Its area is about 189 square miles.

"Included are several small detached basins along the eastern border of the main area. "The most distant of these is the one in which the Deep Run mines are located, about 6 miles east of the northern end of the main area.

"The deposit at Deep Run is designated as the Springfield deposit, by Heinrich, and is stated to have an area of about 1.6 square miles."

"The coal seams of the Richmond field are irregular in thickness, and have been greatly disturbed by faulting.....

"The seams are not continuous throughout the field, although they occur at approximately the same horizon. "There is no assurance that the seams worked on one side of the basin are individually the same as those explored on the opposite side, or even in adjacent mines. "Seemingly the coal occurs in lenticular beds, the outlines of which have not been determined. "The edges of these beds overlap, so that while the series as a whole may be continuous over comparatively large areas, individual beds die out and are replaced by others. "What is a thin seam in one mine may thicken and become the most important bed in an adjacent mine.

"In the Norwood mine on the west side of the area the coal is worked by means of "inclines" on which the following section was exposed in 1885.

Sandstone and shale dipping W. 20 to 25 - - -	10 to 200 feet.
Coal, with medial partings of shale - - - - -	5 to 7 " .
Shales -	10 to 1[illegible] " .
Coal, with medial parting of shale - - - - -	6 " .

"In the neighboring Powhatan mine there are five coal seams, the most important having a thickness locally of 7 feet.

"The Old Dominion mines, a mile or two south of the Norwood mines, were worked several years ago by means of a shaft, but are now abandoned. "At this locality the strata were penetrated to the depth of 125 feet and found to contain three coal seams. "The upper one, where it outcropped at the surface, was about 4 feet 6 inches thick, but increased to 12 feet when followed down the dip. "The second was from 18 to 24 inches near the surface, and increased to 4 feet in the lower part of the mine. "The third was struck 4 feet below the second and contained 3 feet of coal of inferior quality.

"The mine of Manakin (Dover) on the west side of the Richmond area, north of the James, were worked for more than 50 years and a large quantity of coal obtained. "They are now abandoned and the shafts are in ruins.....

"The section of Carbon Hill, north of the James, is as follows:

Section at Carbon Hill, Virginia	Feet
Recent formation, soil	20
Alternation shales and sandstones	450
Cinders, so-called fire clay	195
Nodula Pyrites	15
Shales and sandstones	60
Coke seam (coke 2'4" - Coal 3' 8")	6
Shale and sandstone	50
Coal seam	3
Shale, third seam	17
Coal	.5
Shale and sandstone, containing 6 inch coal seam, second seam	40
Coal seam, slope seam 8 to 10 feet, first seam	9
Sandstone and slate to supposed granite base	160
	1032.6

"An extremely detailed record of the strata passed through in exploring for coal with a diamond drill at Midlothian, in the central portion of the east border of the field, has been published by Heinrich, "There explorations passed through 1518 feet of Newark rocks and reached the underlying granite. "Four coal seams were penetrated, the lowest of which is 570 feet above the granite. The record of the coal-bearing section is here copied, with slight verbal changes:

SECTION OF MIDLOTHIAN - VIRGINIA.

Stratum	Thickness Feet	Thickness Inches	Distance above Granite Feet	Distance above Granite Inches
Sandstone, arkose	34	9	566	4
First coal seam, 3' 6" coal 1' 6" slate	5	0	571	4
Slate, sandstone, dark gray	6	2	577	6
Sandstone, light gray	4	3	581	9
Slate, dark gray	3	0	589	0
Sandstone, arkose, gray	9	10	599	7
Second coal seam	1	0	600	7
Slate, gray	9	0	609	7
Sandstone, gray, hard	9	0	61[illegible]	7
Third coal seam divided by slaty bands from 2 to 24"	12	0	-	-
Sandstone and slate, gray-	10	3	655	4
Fourth coal seam, divided by slaty-bands	14	0	-	-
Slate, black, and sandstone	4	9	659	4

"At Clover Hill on the southern part of the eastern border of the Richmond area, the character of the coal-bearing strata has been recorded, (Fontaine, 1883).

"There are three main coal seams and four others of less thickness designated as local. The strata between the lowest seam and the granite floor on which the system rests, has not been penetrated. The dip is to the westward and the coal beds outcrop at the surface.

Section at Clover Hill.

	Feet	Inches
Coal seam, local, 12 inches to	4	0
Sandstone and shale	14	0
Coal seam, local	0	12
Sandstone and shale	11	0
Coal seam, local	0	14
Sandstone and shale	25	0
Coal seam, local	0	18
Sandstone and shale	40	0
Upper bed of main coal	5	0
Shale, varying thickness	5	0
Main coal, lower bed	13-16	0
Sandstone and shale	40	0
Lower persistent coal bed	4	9
Sandstone and shale, about	250	0
Gneissic floor		

Mr. Russell then discusses the general conditions in the Richmond field as follows:

"The section here given indicates the character of the coal seam about the border of the Richmond coal field. In the isolated secondary areas along its eastern border the rocks have been so greatly disturbed that it is difficult to obtain reliable record of the strata. It has been stated that the coal seams in these basins were from 10 to 60 feet thick. The high inclination of the beds, however, and such descriptions of the mines as can be found in books or obtained from men who worked in the mines, render it evident that the thickness of the seams has been exaggerated.

"The presence of workable beds in the central portion of the Richmond area seems probable. The nearly horizontal position of the rocks over the central area is a promise that the coal, when reached

will be found in a much less disturbed condition that in the borders of the field. "The depth at which coal will have to be looked for in the central area is in the neighborhood of 2,500 feet."

The Transactions of the American Institute of Mining Engineers for 1901-02 contain a paper presented by Mr. J. B. Woodworth (U.S. Geological Survey) on the "History and Conditions of Mining in the Richmond Coal Basin of Virginia." The following quotation is taken from Mr. Woodworth's paper;

"The basin on the north side of the river is narrower and apparently less deep than on the south side.

"The chief need of borings on the south side is to establish beyond doubt the existence of workable beds of coal in the great south central tract and to determine the depth at which they must be worked, if they can be worked at all."

In a discussion of Mr. Woodworth's paper on the Richmond Coal Basin, Mr. Ware B. May of Richmond, made the following statements:

"It is now about 17 years since I first became interested in the Richmond coal field and until about six years ago I passed much time in investigation and spent thousands of dollars in development. "Six years ago the properties in which I was interested were leased to others.

"The result of my investigation, after considering all the theories, expert reports, legends and other information I could obtain, was the opinion, which I still hold, that the most practical and the most economic way for proving the extent and value of the field is by sinking slopes from the eastern outcrop, and by prosecuting such slopes in the vein and following the coal to the western outcrop, thus obtain an actual cross-section in fact and not in theory.

"Proceeding upon this hypothesis, I sought for the position where this could probably be accomplished most quickly and develop a marketable coal area as the work thus progressed.

"The outcrops on the north side being nearer each other, and both eastern and western having been proved and worked for many years, I concluded that to afford the best point, especially as a slope 1,656 feet long then existed at the old Trent mine at Goyton. "The unwatering of that old slope was proceeded with, and when this was being done, a slope was also projected at the Dover mine, upon the western outcrop and driven far enough to determine the character and continuity of the vein and its pitch eastward, which is about 30° the pitch on the eastern outcrop being much less, about 20°.

"The bottom of this 1,656 foot slope is in good coal and continues on about the same pitch. "Overlying the vein in which this slope has been driven are two more veins of bituminous coal and one of the natural coke.

"Upon the south side of the James River, similar opportunities exist for the extension of slopes, and I firmly believe it to be the best way to open the Richmond coal field and less expensive in time and money than by deep and expensive drilling, affording a means of continual output."

The following quotation is taken from J. B. Woodworth's paper "The Atlantic Coast Triassic Coal Field" given in the 22nd Annual Report of the U. S. Geological Survey, 1900-1901.

"The occurrence of coal in the area was known as early as 1700. "In 1789, shipments were made to Northern Cities." According to Meade, "A Geological Account of the United States, 1807, the general use of the coals in Richmond was credited with lessening the febrile ailments of the inhabitants." The unusually thick beds of coal in the small detached basins on the eastern margin were early and quickly won and during the thirties and forties the mining operations here were the most extensive in the United States.

"Three fields on the eastern outcrop of the main basin have been long worked in a small and intermittent way, north of the James at Carbon Hill, the vicinity of Midlothian and at Winterpock (Clover Hill). On the western margin, the Norwood, Old Dominion and Scott's pits, on the south side of the James and the Manakin mine, on the north bank of the river, were worked to a small extent, but have for many years been abandoned.

"An attempt was made in 1874 to reach the coals near Midlothian by the "sinking shaft" which was abandoned before the horizon at which the coal occurs was reached. "At present the deeper lying coals are reached at Gayton and Winterpock by slopes driven down from the Eastern outcrop or driven from the feet of shafts sunk near that outcrop.

"The larger mines in the best days of this field were worked on the English plan by means of shafts and slopes. "Water has been raised largely by means of buckets, and in many ways, the methods employed have been rather those of the early part of the Century than those now most approved. "The shafts are sunk to depths determined by the distance from the outcrop. "North of the James there were at one time as many as twelve of these shafts within a mile. "Graham's or Anderson's Shaft was 450 feet deep. "On the south side of the James the shafts were from 400 to 500 feet deep. "The Midlothian Company's shaft reached the coal at a depth of 72[illegible]-5 feet and went through 36 feet of coal, with a sump 16.5 feet deep. "The Gowrie Shaft was 46[illegible] feet deep.

"The present operators hold to the policy of reaching the central portion of the basin by means of existing slopes and shafts sunk on the eastern outcrop, and are thus following the coal without testing the ground in advance of their workings by means of the drill. "While this policy obviates the expense of drilling and the initial cost of deep shafts in the middle of the basin, its continuance must leave for several years the actual occurrence of workable beds of coal

in the central portion of the basin a matter of inference, with the prospect that the lengthening of existing slopes must ever increase the cost of bringing the output to the surface. "None of the borings so far made at a distance from the margin have penetrated to the crystalline basement, so as to reveal the number, thickness, or extent of the coal beds which may underlie the area."

In "Mineral Resources of the United States" 1911, it is stated that "During the last two years, through the efforts of the Old Dominion Development Company, the old mines at Gayton, in Henrico County (VA.) have been reopened with modern mechanical equipment, including a coal washery, and mining was resumed in 1910 by a New York Corporation."

Note: - These mines were operated in 1910-11-12-13 and closed in 1914.

The following data are taken from "Mineral Resources" 1886-1888-1890-1891-1892:

Richmond Field

1886 - The Brightrope Railway Co. produced 28,000 net tons and shipped 26,200 tons.

1887 - Brighthope Co. produced 30,000 tons.
1888 - Total production 33,000 tons, all from Raccoon pits, valued at mine, $1.60 long ton.
1889 - Total production 49,411 tons, men employed 257.
1890 - Production, Henrico County, 19,346 tons.
1891 - Production 17,190 net tons
1892 - Production 37,219 net tons.

The following description of mining methods and mines is taken from Bulletin 29, Virginia Geological Survey, submitted for publication in February 1927, and published in 1928.

"The method of mining in the Eastern Virginia coal fields has progressed from the most primitive kind through the more improved stages. "Even today at points along the eastern border of the Richmond area small local or "wagon mines" may be found, such as around Winterpock north of Midlothian and south of the James River. "The early method on the eastern margin, as typified by the workings around Midlothian,

was to begin removing the coal at the outcrop and follow the bed, the incline having the same slope as the dip of the coal layer.

"Shafts were used later to reach the deeper coals and also because of the frequent pinching or thinning of the beds on account of the rolls or buckling in the strata.

"During the third period of mining activity in the first decade of this century a branch line was build from the Chesapeake and Ohio Railway northward from Gayton Junction to Gayton and extensive preparations were made to mine coal. "An incline was constructed dipping at approximately 35°, and extended to a distance of 1,650 feet, and on the 1,350 foot level a tunnel 930 feet long extended in an eastward direction. "The incline was extended 750 feet further, thus making a total distance of 2,400 feet, "A very large breaker was constructed and the mine was supplied with a fairly good ventilating system. "At the present time the Gayton Coalbrook mines give the impression of the most elaborate preparation of any of the mines in the entire area. These mines were closed in 1912. "At the old Midlothian main colliery one mile south of Midlothian the Grove Shaft was sunk during the sixties and its depth is 618 feet. "An incline was put down 200 yards south of the old Grove Shaft late in the final decade of the last Century, and recently this incline has been extended by the Murphy Coal Corporation. "In July 1923, it measured 2,330 feet in length, starting on the surface at an angle of 19° W., and ~~the~~ following the dip of the Triassic beds, which at times becomes 70° due to rolls or buckling of the strata. "The direction of the incline is N. 64.5° W. and the vertical distance from the deepest working to the surface in July 1923, was 1,240 feet or 900 feet below sea-level.

"The zenith of activity around Winterpock was from 1905 to 1907 and since that time the shafts have been abandoned.

"When the several mining localities are studied it is an outstanding fact that the point of maximum and continued interest cen-

ters around Midlothian. "The production of the Midlothian mines has in the main furnished the great bulk of coal."

Although there was no mining development in the Richmond field or no recorded production after 1923, purchases of land were made by certain individuals beginning about that year, looking to the acquisition and future development of some 4,500 acres of coal lands lying between the James River on the north and the Southern Railway on the south.

In 1930 a syndicate was formed to prove and develop the property and between April 1, 1930, and August 1, 1931, five diamond drill holes were put down. Under date of July 15, 1931, the following was submitted to the syndicate on the results of drilling:

> Diamond Drill Holes: At the direction and under the supervision of Manager Lusk, five diamond drill holes were made. This work was done between April 1, 1930 and August 1, 1931, a period of sixteen months. These holes are designated as Holes #3, 4, 5, 7 and 8.
>
> Exceptional difficulties are encountered in hole #7. Practically a year was devoted to the drilling of this hole. It was necessary to redrill 400 ft. of this hole, (from a depth of 1667 ft. to a depth of 2064 ft.). This redrilling alone required six months.
>
> The total footage of drilling done to date is as follows:

Hole #3	487.0 feet		(Complete)
#4	583.5 feet		"
#5	487.0 "	(a)	"
#7	2345.0 "		"
#7	396.5 "	(b)	"
#8	1072.0 "		(Incomplete)
Total	5371.0 "		

> A - Hole #5 - Abandoned by Contractor
> B - Hole #7 - Redrilling.

The drilling contract called for a major program of eight holes with the price per foot ranging to a depth of 2000 ft. The price over 2000 feet was made by subsequent arrangement with Mr. Lusk. The contract time or the major program was five and one half months.

Detailed data in regard to each hole is as follows:

Hole No. 3.

Location - 700 ft. west of Eastern outcrop.
Total Depth - - 487 feet.
Seams - Coke 14'8" thick at 290 ft. depth.
Good coal 1'8" thick at 338½ ft. depth.
Good coal 1'4" thick at 369 ft. depth.
Good coal 0'6" thick at 452 ft. depth.

Remarks: Granite located at 487 ft.

Hole No. 4.

Location - 1200 ft. West of Eastern outcrop.
Total Depth - - - 583.5 ft.
Seam - Coke 14'10" thick at 492 ft. depth.
No coal seams.

Remarks: Granite located at 584 ft. ←
Hole #7 "probably on a roll".

Hole No. 5:

Location - 1700 ft. North of Hole No. 4.
800 ft. West of Dickinson Pit.
where 9' to 12' seam of good
coal was found.
(See paragragraph later on Dickinson Pit.)
Total Depth - - - 487 ft.
Seams - None.

Remarks: Abandoned by Contractor on account of starting with too small a casing.

Notes: The above three holes and 634 feet of Hole No. 7 were completed by June 24, 1930, or within the first three months of drilling.

"The data from the above holes indicates the disturbed condition of the outer edge of the basin."

Hole No. 7:

Location - 4000 ft. West of Eastern Outcrop.
Total Depth - - 2345 feet.
Seams - Pony Coal - 0'7" thick at 362 ft. depth.
Good Coal - 0'7" thick at 419 ft. depth.
Other Materials: Oozing petroleum at eleven places
between 1200 and 1725 ft. depths.
"On Sunday, Oct. 26th, the drillers noted gas
issuing from the drill rods. This was lit
and burned about 12" high (See Report #2 & 3.)

Remarks: Casing shifted at depth of 1780 ft. Necessary to redrill 397 ft. Discontinued on account of encountering same arkose formation as found at base of Hole #3.
Expected to find coke seam at depth of 1500 ft. This hole was an attempt at exploring the "Center of the basin.
Now appears that this hole may be at the Western edge of the disturbed Eastern margin.
Basal formation checked by Phila. geologist.

Questions: #1. The importance of confirming the fact that this hole was carried to the basal formation is self evident. It is understood that this fact was checked by a Philadelphia geologist. Suggest that same and any other supporting data be submitted herewith.

#2. Suggest that some explanation be made about the destruction of Hole #7. Some understanding that this hole could be left in such condition as to permit further work in same at a minimum expense of a few hundred dollars. Appears that the Hole is entirely destroyed.

Hole No. 8:

Location - 5800 ft. West of Eastern outcrop.
2000 ft. North of Salisbury diamond drill Hole - 1893.

Remarks: Stopped at 1072 ft. depth pending further arrangements. Drilling of this 1072 ft. was accomplished in practically four weeks after setting up of drill.

Hole No. 8 was further attempt to explore the center of the field.

The following "Conclusions on results to date" are given in a report by A. H. Lusk, dated August 15, 1931, to the Syndicate mentioned.

From General Sources of Information:

There are at least three seams of coal along the margin of this Basin. Some places along the eastern margin of the coal is in one thick bed, 29 ft. in one location, 95 ft. in another. The top and bottom seams are from 3 ft. to 5 ft. and the middle seam 7 ft. to 12 ft. as reported at the Midlothian Colliery on the east. On the western side, some five miles distant, there were three seams, top being 12 ft. second 8 ft. and no thickness given for the lower seams. These seams are all supposed to be below the coke seam and are contained within 60 ft. of strata including the coke seam.

FROM THE PRESENT DRILLING:

The territory from the outcrop and for about 4000 ft. to the west is in a disturbed condition as now seems evident from our drilling. This condition may account for the many failures in mining during the past. As the coal is found below the coke-seam on this eastern margin as has been proved and the coke-seam has been found inside at a distrance of 5800 ft. from the outcrop in the aforementioned old hole, it would appear certain that the inside of the Basin contains the coke-seam and no reason why we should not find the coal seams below. There is some four miles of an un-explored territory to the west which should contain coal in a like measure to that now determined at 5800 ft. from the eastern side. The hole now under way is to prove the coke-seam to the north of where it has been found and determine the coal-seams below.

DICKINSON PIT:

Preliminary to starting the diamond drilling, a small amount of exploration work was done under this project at what is known as the"Dickinson Coke Pit." This is an old pit immediately adjacent to the Eastern outcrop. A seam of good coal 9 to 12 feet thick was found here just below the ground surface. In view of the objective of the present project it was not regarded as necessary to continue operations at this pit. Hole No. 5 was located 800 ft. West of this pit and was started as a check on this seam. This hole was abandoned by the Contractor, however, as stated above.

OPTIONS:

Attention should be called to the fact that of the 4400 acres covered by the contract between the Land Owners and the Management Organization, 1287 acres of the total was under option. I understand that this option has subsequently expired. The question of renewing this option and taking up any new options should have full consideration in any future plans.

RECOMMENDATIONS AS TO FUTURE PLANS:

Mr. Lusk advises the completion of Hole #8 and "If results are satisfactory the adoption of one of the Geophysical methods of exploration with the idea of checking the territory to the West for faults, etc. This method will save a large part of the cost of future drilling that might otherwise be necessary and will serve to make the location of future coal borings to secure samples and thickness of seams as nearly sure as can be done."

Some of Mr. Lusk's conclusions and recommendations seem hardly warranted by the information, available; it is certain that additional prospecting will be required before conditions can be definitely determined and future development of the property in question planned.

In "Information Circular 6766," issued by the United States bureau of Mines, April 1934, there is given a brief "Historical Summary" regarding Virginia's coal mines, from which the following quotation regarding the Richmond field has been taken:

"The first coal mined in the United States is said to have been along the James River in the Richmond Basin, near Richmond, Virginia. "The date usually given is 1750, although some accounts state that this coal was used as early as 1700." "The first record of production is for 1820, when 54,000 tons were mined in one year, but after the "War of the 60's" mining declined in this field, although some revival was attempted after 1900, coal production was discontinued in a few years, although great coal reserves remain."

TONNAGE OF COAL, ESTIMATE OF,

IN THE

"RICHMOND AREA"

The only known estimate of the tonnage of coal in the Richmond field is contained in the Nineteenth Annual Report of the U. S. Geological Survey for 1897-98, as reported by Professors Shaler and Woodworth, in the following quotation from their paper on the Richmond area.

"When all the evidence is weighed it leads to the conclusion that the central portion of the area most likely contains coal beds in something like the measure that they are exhibited in the margin. "The measure of the probability of such occurrence is rather greater, as regards that portion of the field which lies to the east of a line drawn from the Clover Hill pits, near the southern end of the basin to the Old Dominion Mines on the western margin about two miles south of the James River, than it is concerning the field west of that line. This is for the reason that outcrops have not been found along the western margin south of the Old Dominion property, though, as before noted, the failure to occur may be accounted for by accidents of faulting. Leaving out of the reckoning the southwestern portion as possibly lacking the coal bearing beds, there remains an area of about 150 square miles where the deposits may reasonably be expected to occur.

"Although the information obtained from the existing and the old workings show the coal to vary greatly in thickness, it is not an unreasonable estimate that the average thickness of the workable material is 12 feet. "Allowing for occasional strips of coal, which have been crushed by faulting and for loss in treatment in the breaker, the yield per acre may be roughly estimated at 1,000 tons per foot in depth, or a total of 12,000 tons.

"The total area which is reckoned as most probably coal-bearing (150 square miles on 640 acres) equals 96,000 acres, which on the basis of yield above adopted, would give a total content of 1,132,000,000 tons. "This reckoning, it should be said, rests altogether on probabilities.

"In none of these mines does it appear that less than two beds of workable thickness (of coal) are encountered. "In other instances there is reason to believe that three, four and at Clover Hill even five beds of economic value were found. "Although all these beds thicken here and thin there and probably at points units or separate, the coal-bearing character of the section in which they lie is probably maintained in a tolerably continuous manner."

It will be noted that in the foregoing estimate of the total tonnage of coal in the Richmond area field, 1,152,000,000 tons, no allowance is apparently made for losses in mining, which may run anywhere from 10 to 35 percent or even more, depending upon underground conditions and the efficiency of mining methods and management. Even if the estimated total is reduced by 35 percent there is still left an original 748,800,000 tons of mineable coal of which not to exceed 8,000,000 tons has been mined out to date, as partly estimated, leaving a total of 740,800,000 tons in the ground today.

Mr. O. J. Heinrich, while making no estimate of the total amount of mineable coal in the Richmond basin, states that the total production from 1832 to 1877 would "Average a yield of 11,295 tons per acre of ground worked" and that, in 1873, at Midlothian Colliery, from one acre of ground, 19,057 tons of coal were raised from a twenty-foot seam, averaging from twelve to fifteen feet of coal.

If the yield per acre of 11,295 tons is applied to the 95,[illegible]30 acres in the area, as estimated by Shaler and Woodworth, a total of 1,084,320,000 tons of recoverable coal originally or, deducting an estimated 8,000,000 tons produced to date, there remains 1,076,320,000 tons as of today.

Both of these estimates of the amount of recoverable coal in the Richmond field are based on probabilities and take no account of variations in thickness of beds or of other possible conditions.

Both estimates are probably too large, but we have no actual data with which to check their accuracy, or which would enable us to make other estimates that could be proved to be more nearly correct.

DEPTH OF COAL IN THE CENTRAL AREA OF THE RICHMOND BASIN

Regarding the depth of the coal in the central parts of the Richmond basin, Professors Shaler and Woodworth (U. S. Geological Survey Annual Report, 1897-98) have given the following views:

"The questions as to the depth at which the coals lie in the central parts of the basin or were at the existence of a mile from the margin cannot, for lack of information, as yet be satisfactorily dealt with.....

"In the present condition of our knowledge of the basin it will be safe to assume that at the distance of a mile from the eastern outcrop the coal-bearing section lies at a depth of about 2,500 feet below the surface. "Farther toward the interior of the field the depth at which it will be found will probably be somewhat greater. "It is not impossible that at some points the faulting has carried these deposits more than 4,000 (but less than 5,000) feet below the present surface.

"In the present condition of the art of mining the cost of working coal seams at the greatest depth above mentioned would not be prohibitive, provided there were no elements of expense than those due to the construction of the shafts and the charges of hoisting."

After pointing out the possible underground conditions that might add to the difficulties and expense of mining the coal, the authors go on to say:

"All of the above noted difficulties can probably be met by a proper system of mining."....."There appears to be no evident

reason why the coals of this basin may not be won at depths as great as they are likely to be found. "The cost of the mining and the relative advantage of the fuel, as compared with that of other districts needs be the matter of special reckoning. "All that can be said on those points in this report is that hitherto there has been no well-devised mining work on a large scale done in this field. "The coal has been often marketed without due attention to its condition, or to processes of bettering its quality so that the commercial results thus far attained afford no fair measure of the possible value of the fuel resources of this field."

"There can be no question that the conclusions just stated explain, to some extent, the failure of this field to live up to its possibilities as a producing district."

NAMES OF MINES THAT HAVE BEEN OPENED

IN THE

RICHMOND FIELD

The names and location of the mines of "pits" that have been worked during the development of the Richmond field are given in the following list, and have been taken from various sources of record beginning with 1818. It is probable that there have been other small openings for local supply of which there is no known record.

The principal mines are distributed around Gayton and Manakin, north of the James River, and Midlothian and Winterpock south of the James. Most of these mines have passed through several different hands, some of them under different names.

LIST OF MINES OR PITS IN THE RICHMOND COAL FIELD

(Taken from Bulletin 29, Virginia Geological Survey and other sources)

(2) Grayson [illegible] Vicinity:

Carbon Hill (Edge Hill) (Old Dominion Co.)
Edge Hill Shaft, 400 feet
Dale Shaft, 500 feet
Eureka, 406 feet
Sanders Shaft, 250 feet
Grayton Coke Shaft, 600 feet
Coke Shaft, 600 feet
Coalbrook Slope
Coke Pit #1
Coke Pit #2
Cook, H. J., Mine
Maggie Pits

(3) Manskin Vicinity (Dover):

Andersons Pit
Aspin Hall (Shaft 904 feet)
Coalbrookdale
Crouche's and Tneed's (S. side)
Deep Run, Barr's (Springfield Pits)
Dover Mines (West side of basin)
Jones Pits (Shaft 500-600 feet)
Manskin (West side of basin)
Randolph's (Shaft)
Tuckahoe (Shaft)
Trent's Pits
Townes & Powell Mine
Waterloo
Woodward Pits
Wills Pit (Wills, Brown & Co.)

(3) Hugenot Springs Vicinity:

Pinney (Powhatan) (Shaft, west side of basin)
Harwood " " " " "
Old Dominion Pits " " " " "
Scott's " " " " "
Spencer
Trabue
Belfona Arsenal Pits (Shafts)

(4) Midlothian Vicinity:

Aetna
Black Heath (Shaft)
Blunt's, Thompson
Bolling
Buck & Cunliffe's Pits (Shafts)
Burfoot
Creek Company's Mines
Diamond Hill
Forbes
Cowrie Shaft (Murchie, Moseley & Brander)
Green Hole (Shaft 400 feet)
Groves (Shaft 600 feet)
Murphy's (Slope)
Jewett's (Coke)
Maidenhead Pit

Midlothian
Mills & Reed, Creek (Shaft)
Bailey's
Ross & Curry Pits
Tallec's Pits (Shaft)
Stonehange (Shaft)
Union
Coolidge (Shaft)

(5). Winterpock and Vicinity:

Brighthope Shaft
Coxe (Clover Hill) (Shaft)
Retreat (Slope)
Hall (Slope)
Mills Pits (Shaft)
Jew Done (Shaft)
Park Hill
Racoon (Slope)
Powlett's Mines
Tippecanoe
Vaden (Shaft, North of Brighthope)

Numbers (1) and (2) North of James River; Numbers (3) and (4) and (5) South of James River. All mines on the East side of the basin, except those marked as on West side.

Bulletin No. 29, Virginia Geological Survey, gives also the following "openings which were producing during the summer of 1923".

(1) Forbes Mine, 3 miles south of Midlothian - coal mined during summer and fall for local use.

(2) Mennon (Scott) Mine, 1-1/2 mile northeast of Huguenot Springs - coal mined during fall - 150 tons annually.

From the foregoing lists, it will be seen that there have been at least 60 mines opened in the Richmond field, of which there is record: besides the probability of other small openings, for local supply, of which no record has been found.

PRODUCTION - SHIPMENTS

No record of the amount of coal produced in the Richmond field previous to 1822 has been found, except estimates for a few years. The following table given the annual production in 1822 and succeeding years, as obtained from the sources noted.

Year	Net tons produced	Authority
1822	54,000	(1)
	54,000	(2)
1823	60,000	(1)
1824	67,040	(1)
	66,960	(2)
1825	75,[illegible]00	(1)
1826	88,720	(1)
	88,720	(2)
1827	94,000	(1)
1828	100,080	(1)
	100,080	( )
1829	100,000	(1)
1830	102,800	(1)
	102,800	(2)
1831	118,000	(1)
1832	132,000	(1)
	132,000	(2)
1833	125,000	(1)
1834	124,000	(1)
	124,000	(2)
1835	120,000	(1)
1836	124,000	(1)
	124,000	(2)
1837	?	
1838	108,000	(2)
1839	96,000	(2)

Notes: (1) U. S. Bureau of Mines
(2) R. C. Taylor, "shipped from Richmond."

Year	Net tons produced	Authority
1840	90,350	(3)
1841	79,600	(3)
1842	73,600	(3)
1843	93,606	(4)
1844	115,313	(4)
1845	134,603	(4)
1846	124,669	(4)
1847	136,422	(4)
1848	120,747	(4)
1849	138,801	(4)
1850	138,017	(4)
1851	136,523	(4)
1852	106,087	(4)
1853	101,726	(4)
1854	132,554	(4)
1855	125,977	(4)
1856	106,150	(4)
1857	114,826	(4)
1858	113,734	(4)
1859	106,338	(4)
1860	112,473	(4)
1861	94,697	(4)
1862	115,495	(4)
1863	112,068	(4)
1864	111,742	(4)
1865	73,730	(4)

Year	Net tons produced	Authority
1866	70,912	(4)
1867	90,810	(4)
1868	96,184	(4)
1869	115,564	(4)
1870	90,200	(4)
1871	101,932	(4)
1872	95,973	(4)
1873	101,504	(4)
1874	81,851	(4)
1875	88,706	(4)
1876	57,182	(4)
1877	67,907	(4)

Notes: (2) R. C. Taylor, "Shipped from Richmond."
(3) R. C. Taylor, Production "Congressional returns."
(4) O. J. Heinrich, American Institute of Mining Engineers, Transactions, 1877-78.

Year	Net tons produced	Authority
1878	50,000	(5)
1879	45,000	(5)
1880	43,079	(6)
1881	50,00	(5)
1882	(7)	
1883	(7)	
1884	(7)	
1885	50,000	(8)
1886	28,000	(9)
1887	50,000	(10)
1888	33,000	(11)
1889	49,411	(11)
1890	19,346	(11)
1891	17,190	(11)
1892	33,000	(11)
1893	(7)	
1894	(7)	
1895	1,076	(11)
1896	(7)	
1897	(7)	
1898	(7)	
1899	(7)	
1900	40,173	(5)
1901	11,760	(5)
1902	16,906	(5)
1903	18,084	(5)
1904	2,100	(5)
1905	(7)	
1906	(7)	
1907	(7)	
1908	(7)	
1909	(7)	

Notes: (5) Mineral Resources of Virginia
(6) Mineral Resources of the United States, 1883-1884 (4 mines in operation)
(7) No data available
(8) Mineral Resources of the United States, 1885
(9) Mineral Resources of the United States, 1886
(10) Mineral Resources of the United States, 1887
(11) Mineral Resources of the United States

Year	Net tons produced	Authority
1910	(12)	
1911	(12)	
1912	(12)	
1913	(12)	
1914	(7)	
1915	(7)	
1916	(7)	
1917	(7)	
1918	(7)	
1919	(7)	
1920	(7)	
1921	(12)	
1922	(12)	
1923	50,000	(13)
1924-1934	(14)	

Notes: (7) data available.
(12) Production reported, but no tonnage, U. S. Bureau of Mines.
(13) Bulletin 29, Virginia Geological Survey.
(14) To date, production small, if any.

SHIPMENTS OF COAL FROM THE RICHMOND FIELD

IN NET TONS

(As given by O. J. Heinrich.)

Year	By Richmond Fredericksburg and Potomac Railroad	By James River and Kanawha Canal	By Richmond and Danville Railroad	By Clover Hill and Richmond and Petersburg Railroad
1822 to 1842	-	-	-	-
1843	18,000	-	-	14,300
1844	18,000	18,418	-	14,300
1845	18,000	36,446	-	14,300
1846	18,000	23,462	-	18,000
1847	18,000	27,446	-	25,000
1848	-	30,797	-	25,000
1849	-	27,997	-	30,000
1850	-	35,937	-	36,000
1851	-	27,531	17,432	43,000
1852	-	21,752	34,955	43,000
1853	-	21,098	15,620	58,352
1854	-	20,533	43,454	59,895
1855	-	21,152	35,621	60,951
1856	-	19,084	38,842	41,280
1857	4,000	28,824	24,274	50,216
1858	4,000	17,477	29,918	54,905
1859	4,000	14,156	30,834	50,391
1860	3,495	21,305	32,315	48,000
1861	500	20,146	18,363	49,503
1862	-	20,612	29,146	56,681
1863	-	19,608	42,000	41,628
1864	-	20,000	42,190	40,751
1865	-	20,000	42,000	5,313
1866	-	19,842	25,918	20,513
1867	6,289	41,159	19,700	18,384
1868	7,605	45,380	14,782	27,224
1869	9,179	38,682	20,433	39,709
1870	2,904	31,100	26,734	23,560
1871	9,078	11,860	34,288	47,337
1872	57	13,167	29,175	47,295
1873	3,027	13,792	38,025	40,019
1874	824	20,440	18,690	36,542
1875	5,404	19,301	14,453	43,745
1876	-	8,682	16,322	28,366
1877	-	6,841	14,741	34,197
Total	138,363	793,918	750,218	1,287,369

Misc. by wagon	Consumed at Mined	Total Amount Shipped	Total Amount Produced	1822 to
-	-	1,925,000	1,925,000	1842
57,051	6,254	89,351	95,605	1843
57,051	7,543	107,769	115,312	1844
57,051	8,805	125,797	134,602	1845
57,051	8,155	116,513	124,668	1846
57,051	8,924	127,497	136,421	1847
57,051	7,899	112,848	120,747	1848
57,051	8,753	125,048	133,801	1849
57,051	9,029	128,988	138,017	1850
39,619	8,940	127,582	136,523	1851
-	5,979	99,787	106,686	1852
-	8,184	95,071	101,725	1853
-	8,672	123,882	132,554	1854
-	8,241	117,736	125,777	1855
-	6,944	99,206	106,150	1856
-	7,511	107,314	114,826	1857
-	7,435	106,299	113,734	1858
-	6,957	99,381	106,338	1859
-	7,358	105,115	112,473	1860
-	8,195	68,502	97,697	1861
1,500	7,556	107,939	115,495	1862
1,500	7,332	106,736	112,068	1863
1,500	7,301	104,441	111,742	1864
1,500	4,917	68,813	73,730	1865
-	4,639	66,273	70,912	1866
-	5,287	85,524	90,810	1867
-	6,292	89,891	96,184	1868
-	7,560	108,003	115,564	1869
-	5,901	84,298	90,199	1870
-	6,668	96,263	101,932	1871
-	6,279	89,694	95,973	1872
-	6,640	94,864	101,504	1873
-	5,355	76,496	81,852	1874
-	5,803	82,903	88,706	1875
-	3,812	53,369	57,182	1876
-	12,138	55,779	67,907	1877
502,027	250,727	5,396,795	5,647,621	TOTAL

The following notes are appended to the table by Mr. Heinrich. Richmond, Fredericksburg and Potomac Railroad: Previous to 1841 Deep Run produced about 18,000 tons taken as an average until 1847, when the mines stopped working.

Chesterfield Coal, Iron & Mining Company raised 213,303 tons from 1841 to 1851, or 21,331 tons as an average.

Midlothian Company estimated 35,700 tons as an average from 1843 to 1852. Books burned on the evacuation of Richmond. Transportation on old Richmond Horse railway up to 1851 from Midlothian district. Clover Hill Railroad, books burned at the evacuation of Richmond. 1862-3 Miscellaneous transportation estimated by wagons during war. Richmond and Danville Railroad: No reports kept in consequence of depreciation of currency during War.

1864, James River and Kanawha Canal estimated. Books burned on evacuation of Richmond.

1865, Richmond and Danville Railroad, same as 1863.

Richmond, Fredericks & Potomac Railroad: No coal shipped during War, the Deep Run mines belonging to a northern company.

Table of Annual Shipments of Virginia Coal
(A. C. Taylor, "Statistics of Coal")

Year	Tons	Year	Tons	Year	Tons
1822	48,214	1830	91,786	1838	96,429
1824	59,857	1832	117,857	1839	85,714
1826	79,214	1834	110,714	1840	78,571
1828	89,357	1836	110,714	1841	71,071
				1842	65,759

In 1847, 96,000 tons of coal were shipped from Richmond to Philadelphia.

Average annual receipts of coal from Virginia (Richmond fields) in Boston and Philadelphia were:

Year	To	Tons
1824-1829	Philadelphia	4,143
1835-1841	Boston	5,805

EXPLOSIONS AND ACCIDENTS

No record is available of explosions or fatal accidents in the Richmond coal field previous to 1839. The U. S. Bureau of Mines has published (I. C. 6166, 1934) a report on "Explosions in Virginian Coal Mines, 1839 to 1933", from which the data in the following table have been taken, which show the explosions recorded in the Richmond coal field during the period named.

Date	Mine	County	Type of Mine	Daily Tonnage	Average No. men Employed
1839 March 18	Black Heath	Chesterfield	Slope Gassy	85	60
1841	Wills	"	-	-	-
1844	Black Heath	"	Shaft	-	-
1850	Cox's Pit	"	Slope	-	-
	Clover Hill	"	Gassy		
1854 May 15	Chesterfield	"	Gassy Slope	-	20 in mine
1854 March 19	Midlothian	"	Gassy Slope	-	-
1859 April 13	Brighthope	"	Gassy Slope	-	-
1863	Raccoon	"	Gassy Slope	-	-
1867	Brighthope	"	Shaft Gassy	-	69 in mine
1875	Raccoon Pit	"	Slope Gassy	-	3 in mine
1876 May 20	Midlothian	"	Shaft Gassy	-	10 in mine
1882 Feb. 3	Midlothian	"	Shaft Gassy	-	32 in mine
1909 Jan.	Carbon Hill	"	Slope Gassy	-	-
1911 Jan. 1	Carbon Hill	"	Slope Gassy	150	90
1912 Jan.	Carbon Hill	"	Slope Gassy	-	-
1912 June 19	Carbon Hill	"	Slope Gassy	-	-
1912 July 16	Carbon Hill	"	Slope Gassy	150	90

Explosion Type	Extent	Lighted By	Cause of Accumulation	Source of Ignition	Other Factors	Killed	Injured	Yearly Total Killed
Gas	Violent	Going to surface	Door left open over Sunday	Open light	No inspection before Sunday	40	3	40
Gas	Violent	-	-	-	-	several	-	-
Gas	Violent	-	-	-	-	11	-	-
Gas	-	Open light	-	-	-	7	-	11
Gas	-	-	Unventilated old workings	Open light	-	20	-	20
Gas dust	Violent	Expansion	Blast released gas from old workings	Blasting	-	55	5	-
Gas	Local but strong	-	Open door gas gathered in heading	Open light	Kegs of Powder	9	1	9
Gas	-	Soldiers stripping wire	-	Open light	-	17	-	17
Gas dust	Violent	-	Door removed	Open light	Neglect of gas men	69	-	69
Gas	Local	Small amount	Unventilated working place	Open light	Used both Bary & Open	3	-	3
Gas	Violent	Expansion	Inadequate ventilation	Open light	Gas reported with open light	8	2	8
Gas dust	Violent	-	Sealed fire area	Open light	-	32	-	32
Dust	-	-	Solid shooting black powder	Blasting	Tamping with coal dust	6	5	6
Gas dust	Strong	Expansion water	Miner passed danger board	Open light	-	7	6	6
Dust	-	-	-	Shot firing	-	5	2	
Gas	-	-	-	Open light	-	2	8	0
Gas	Small	Gathering	-	Open light	Inadequate ventilation supervision	8	1	1

It will be noted that the foregoing table does not include fatalities caused by falls of roof or coal, of which no reports have been found covering the Richmond field. Yet falls of roof form the principal cause of fatal accidents in coal mines in this country.

For instance the percentages of the total coal mines fatalities that occurred in the principal coal producing states during various periods (all previous to 1914), caused by falls of roof were as follows:

Number of Years	State	[illegible] from [illegible] of [illegible] and [illegible]
29	Illinois	47.40
19	Indiana	45.37
26	Kentucky	49.76
30	Ohio	65.34
36	Pennsylvania (bituminous)	56.93
5	Virginia	52.19
29	West Virginia	51.64
	United States	47.49

Notwithstanding the large number of explosions that have taken place in the Richmond field mines, there seems to be an entire lack of any detailed accounts of the actual causes and conditions that led to the explosions, with one exception, the explosion at the Carbon Hill mine, one mile from Gayton, on the north side of the James River and on the eastern side of the basin, about 16 miles from Richmond. This explosion, following five others at the same mines in the three previous years, occurred on July 16, 1912.

A detailed confidential report on conditions at this mine at the time of the explosion, its cause and comments and suggestions, is given in an appendix. The investigation of the conditions (made on the ground) and the report were both made by a well known and competent Mining Engineer, whose name cannot be used, for obvious reasons, but who was not connected in any way with the mining company or its organization.

The following comments on the report in question were made by another well known Mining Engineer, of national reputation, and are given here in his own words; they do not exaggerate the almost unbelievable conditions disclosed by the investigation, and perhaps explain the bad reputation of the Richmond field for disastrous explosions and accidents.

"Mr. _____ investigations disclose a very remarkable state of affairs in this mine. "Apparently from the beginning there has been entire absence of knowledge on the part of successive owners of this property, in dealing with dangerous conditions, such as they have in this mine, spontaneous fires, fire-damp and coal dust. "Apparently the present operators, since that last explosion, have tried to remedy conditions, but it would not appear that

they have realized the full dangers, since standing gas is allowed to remain in the mines; or, in other words, the mine is worked while there is standing gas in same; and entirely inadequate provision is being made for the future in ventilation through failure to provide air courses parallel with the entries or levels. "Break-throughs between rooms, will not take the place of an air course. "Further, the absence of barrier pillars between the different levels or between the level and the rooms on the next level below, makes ventilation uncertain and there is no opportunity to fight fires that may be come started.

"Supporting Mr. _____ suggestions, my recommendations would be that a local management should be obtained which is thoroughly familiar with a gaseous mine: (2) that air courses should be driven and maintained; (3) that locked safety lamps or electric lamps of an approved type shall be used to the exclusion of open lights or other dangerous lights.

"Mr. _____ informs me that he understands that the relations between the stockholders and directors are not harmonious. "Nevertheless, I think that they should be informed of the dangerous conditions that prevail, and the terrible conditions that have existed in the past. "In fact, it seems incredible that such mining conditions should have been permitted in any state. "Apparently the operations might be made profitable, as a good price is obtained for the coal, but the operators should learn that it is to their interest in the long run to proceed with the utmost care, and spend money in the development underground."

Strong words, these, but they were apparently justified. It should be pointed out that there was no state mine inspector or mines department in Virginia until after the Carbon Hill explosion; although an act creating the office of State Mine Inspector in Virginia had been passed on March 1912, no money was appropriated until afterwards for the purpose.

THE NATURAL COKE (NATURE'S COKE)

OF THE RICHMOND FIELD

The occurrence of Natural Coke (carbonite, mineral charcoal,

semi-bituminous coal) in the Richmond area has been known for many years. It was subject of a paper presented in 1842 by Dr. W. B. Rogers, but had been known to exist for some time previous. It may be described as a "modification of the normal coal due to the heat of intruded localized masses of igneous rocks (diabase)." It is porous and much like oven coke, medium gray to grayish black in color, and with a specific gravity of 1.320 to 1.345.

According to some reports Natural Coke varies considerably in both quality and texture and also in its burning characteristics; some of it burns slowly, "snaps" when burning, and is known as hard, or "popping" coke, while the best variety, known as soft or free-burning, occurs in rather dense blue black masses suitable for household use.

Analyses of the Natural Coke are given in the following table, as taken from all available sources. Most of the analyses are old; the exception being one made in 1912 by the U. S. Bureau of Mines and given in its Bulletin 85 as follows:

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U. not determined
Sample as received	2.5	16.3	70.3	10.9	1.3	-
Dry basis	-	16.7	72.1	11.2	1.3	-
New Mexico Natural coke has the following analysis:						
	-	16.87	74.18	8.95	-	-

Analyses of Natural Coke from the Richmond Basin.

Location of Mine	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.
Midlothian (1887)	1.66	18.35	67.13	12.86	4.70	-
Chesterfield County	-	17.00	68.00	15.00	-	-
Chesterfield County	-	10.70	83.30	6.00	-	-
Carbon Hill	1.57	9.64	79.93	8.86	-	-
Carbon Hill	1.12	11.98	75.08	11.83	-	-
Chesterfield County	-	9.98	80.30	9.72	-	-
Chesterfield County	-	16.00	70.00	14.00	-	-
Carbon Hill	1.56	14.26	81.61	2.24	.33	-
Richmond Basin	0.44	14.08	77.17	8.31	-	-
Carbon Hill (1912)	2.54	16.28	70.24	10.94	1.31	Ash fusing temp 2250° F.
Average of five analyses by different chemists reported by Russel	-	12.50	79.93	6.53	0.26	-

The Natural Coke in this field varies much in quality and texture, ranging from a dense, amorphous, graphitic-looking material to that which in general aspect, especially in the prismatic form of the masses, resembles the non-compact varieties produced in modern ovens." "Much variation in the amount of ash is to be expected." - (Chaler & Woodworth).

Dr. R. W. Raymond, in Transactions American Institute of Mining Engineers, 1883, presented a paper on the Natural Coke of Chesterfield County, Virginia, from which the following has been taken:

"In 1882, a mine was opened upon a "Carbonite" seam, near Midlothian, Chesterfield County, by Messrs. Jewett and Brother, "The seam, which dips westerly at an angle of about 30° was struck at a depth of about 137 feet, with a vertical shaft, and followed on the dip 325 feet, at which gangways were opened north and south.

"The section following was taken on the face of gangway, February 17, 1885."

Thin rock	2'6"
Hard Shale	6'0"
Shale, dark	1'0"
Carbonite	2'0"
Shale	1'0"
Carbonite	2'8"
Shale	1'3"
Carbonite	1'9"
Shale	0'1"
Carbonite	9'0"
Fire clay bottom	

Samples of the "carbonite from the Jewett Brothers mine mentioned were separated into two portions, a "dull" and a "lustrous" portion, and analysed separately by Doctor Brown with the following results:

	Dull Portion per cent	Lustrous Portion per cent
Carbon	70.33	81.52
Volatile Matter	15.47	11.10
Ash	3.20	6.68
Moisture (loss at 100° C.)	2.00	0.69
Sulphur	4.08	1.60
Specific gravity	1.375	1.350

Professor Rogers (Proceedings Boston Society of Natural History, 1854) gives the following description of the Natural Coke and its occurrence.

"In the district on the north side of the James River, where the most valuable seam of coke has been explored, it is at present wrought by two vertical shafts. "In that nearest the outcrop, the coke is reached at 112 feet from the surface; in the other at 207 feet, the dip of the coal being nearly west and at a low angle. "A third shaft recently sunk, which lies nearer the margin of the basin than either of the preceeding, cuts the stratum of coke at 90 feet.

"A bed of coarse, gray trap is intercalated in the coal measures of this part of the basin, intersecting the two first-mentioned shafts, but cropping out a little west of the third.

Nest beneath lies a stratum of carbonaceous fire-clay and a depth of about 70 feet below the trap occurs a bed of Natural Coke, for the mining of which chiefly these openings have been made.

"The Coke, when successfully mined, forms a bed about five feet thick, including but little slate and presenting a nearly homogenous mass, of a bluish-black color, uniformly vesicular, and light enough to float in water - it ignites freely and burns like ordinary coke.

"In one of the shafts, after passing through 50 feet of strata, below coke, we come upon a bed of bituminous coal. "In the deepest of the three shafts the seam now wrought, under the intelligent direction of Colonel Worth, corresponds to the coking coal about described."

Prof. W. R. Johnson, in the Proceedings of the "Academy Natural Society, Vol. 1, 1841 - 43", mentioned that he had made trials to determine the volatile and earthy ingredients of the so-called Natural Coke from Virginia. "This substance presents in its exterior appearance a strong contrast with all known qualities of either anthracite or bituminous coal. "It is wholly wanting in lustre. "It has lost, if it ever possessed, all continuous slines or cleats, and even the surface of deposition appear to be in a great degree obliterated. Its texture is porous."

"Two samples were tried by Professor Johnson for the purpose of

ascertaining the amount of earthy matter, volatile matter and fixed carbon," with the following results:

	Sample 1	Sample 2
Volatile Matter	11.16	14.82
Carbon	77.86	82.75
Earthy Matter	10.98	2.43

"The distillation of this substance by the immediate application of a red heat, produces a gas which burns with a steady, clear flame, of a yellowish white color, accompanied by a little smoke, which, however, nearly or quite disappears when the access of air is free and abundant. "The distillation produces no enlargement of volume or adhesion of the particles of carbonaceous matter."

"At the Tippecanoe pits," Clover Hill, Professor Johnson states, "In the southern part of the Virginia Coal field is a dike of trap. "Where this trap dike cuts the coal seam it has converted the coal in immediate contiguity, partially into coke. "Its color is a dead black, and it might readily be mistaken for a very dense artificial coke, but it preserves, in some the columner structure of the coal. "Subjected to a bright red heat, it retains the form of its fragments unchanged, but loses -

	Volatile Matter	14.83 percent
and when incenerated, gives -	Fixed Carbon - - - -	76.89 percent
Leaving	Earthly Matter	8.28 percent

Manufacture of Coke from Richmond Basin Coal

The following quotation is taken from the U. S. Census Report for 1880:

"A number of attempts have been made to coke the coal from the mines near Richmond, and some coke was made in this vicinity during the recent ware, for cupola use, but it was very poor stuff and could only be used under the circumstances then existing."

According to a statement made to the writer by Mr. Lucas, State Mine Inspector, coke was made in heaps between 1865 and 1870, near Winter-

rock and was shipped currently at that time.

There is also a report which states that two coke ovens were at one time operated in the field, but no date or details were given.

Professor Woodworth states (U. S. Geological Survey Annual report, 1900-01) that "the coal of the Richmond basin is normally bituminous and coking. "Some y ars ago, a few coke ovens were erected at Dayton and a limited amount of good coke was produced, which found a ready market in Richmond."

ANALYSES OF COALS FROM THE RICHMOND FIELD

While a number of analyses of Richmond field coals have been published, most of them were made during the period 1840-1860, then methods were crude and not in accord with todays practice. For this reason these analyses are not of much value at present, especially so, since no description is given of how or where the samples were taken. However, as of interest and as a matter of record, the available published analyses are given in the following tables.

I. The characters and composition of certain coals from the Richmond rea, from W. R. Johnson's"Report of Experiments on the evaporative power nd other properties of coals made under authority of the Navy Department of the U. S.", 1844.

Designation of Coal	Specific Gravity	Composition in 100 parts Moisture	Volatile Matter	Fixed Carbon	Sulphur	Coke	Earthy Matter
Barr's Deep Run	1.362	1.785	19.782	67.958	-	78.42	10.475
Crouch & Gnead's Mine	1.451	1.785	23,959	59.976	0.427	74.26	14.280
Midlothian Coal Co. from shaft 900' deep	1.437	1.172	27.278	61.083	-	71.55	10.467
Creek Coal Company (Creek Coal)	-	1.450	26.790	60.30	2.890	-	8.570
Clover Hill Mines (Clover Hill)	1.285	1.339	32.210	56.83	0.514	-	10.132
Chesterfield Mining	1.289	1.896	30.676	58.794	1.957	67.428	8.634
Midlothian Coal Co. average	1.294	2.460	29.796	53.012	0.580	67.749	14.737
Tippecanoe Pits	-	1.840	34.540	54.620	0.380	-	9.370
Midlothian, New Shaft 800' deep	-	1.170	27.280	61.080	-	-	10.470
Midlothian, screened lump	1.283	-	34.700	54.060	0.200	-	9.660
Midlothian, coal from Navy Yard, Washington	-	1.010	29.120	56.110	2.380	-	14.140

The following descriptive notes regarding the Richmond Coals tested are given by Mr. Johnson.

1. Barr's Deep Run, near Richmond, October 10, 1843.

2. Crouch and Gnead's Mines, Henrico County, 12 miles from Richmond.

3. Midlothian Coal Company's Mines, from shaft 900 feet deep.

4. Creek Coal Company, Chesterfield County, south side of James River, 12 miles from tidewater, with which mines are connected by a railroad.

5. Clover Hill Mines, on Appomattox River, 20 miles above Petersburg. Coal shipped from City Point. J. H. Cox, President, June 14, 1842. Contract for 800 tons for Navy Yard at Gosport then in effect.

6. Chesterfield Mining Company Pits, situated in Chesterfield County 12 miles from Richmond. Formerly known as Black Heath pits and lately purchased by English capitalists. R. I. D. Gifford, General Manager. June 9, 1842.

7. Midlothian Coal Mining Company. A. F. Cooldridge, President, June 13, 1842. Midlothian mines lie about 13 miles west of Manchester and are connected with tidewater by a railroad, where the coal is shipped in vessels carrying less and up to 7,000 bushels.

8. Tippecanoe Pits, near Petersburg, Virginia, June 17, 1843, J. C. and J. W. Osborne & Company, Agents, Tippecanoe Coal Company.

9. Midlothian Coal Company "New Shaft," 700 to 800 feet deep.

10. Midlothian Coal Company, Screened lump.

11. Midlothian Coal Company, Average coal from Navy Yard, Washington.

It should be noted that none of the samples tested were taken by Mr. Johnson, but were shipped by the coal companies, except No. 11,

The U. S. Bureau of Mines, in Bulletin 85, published 1914, given three analyses, two of coal and one of natural coke, from the Richmond field, and also a description of the samples, together with brief notes regarding the mine. As these analyses, etc., are the only ones made by the Bureau of coal from this field, and also the only available analyses of samples known to have been taken according to standard methods, the entire report given in Bulletin 85, is quoted as follows:

"VIRGINIA
HENRICO COUNTY
GAYTON, CARBON HILL MINE

Sample: Semi-bituminous coal; Richmond basin field.
Mine: Carbon Hill, a slope mine 1 mile from Gayton, and connected by private railroad line to the Chesapeake and Ohio Railroad at Loraine.
Coal Beds: B. and C. Triassic age, Newark series. The bed has an approximate dip of 35° to the west. Occasional faults are encountered. The B. seam contains numerous bands of shale.

The floor of the B. bed is an under-clay; the roof of the B. bed and the roof and floor of the C bed are shale. The C bed has been coked in places by the heat of igneous intrusions.

The B bed was measured and sampled at one point and the C bed at two points in the mine by H. I. Smith on November 3, 1912, as described Below:

SECTIONS OF C. BED IN THE CARBON HILL MINE

Section	A		B	
Laboratory number	16050		15052	
Roof, Shale	feet	inches	feet	inches
Natural Coke	(a) 0	2	2	2
Coal	3	4	(a)1	0

Floor, Carbonaceous shale
Thickness of bed
Thickness of coal sampled

Note: (a) Not included in sample.

Sections of B bed in the Carbon Hill Mine

Laboratory number	15051	
	Feet	Inches
Roof, "draw slate"	1	0
coal, hard		
shale	(a)0	1
Coal streaked with shale	0	6
Shale	0	1/2
Coal, very friable	1	0
Shale	0	1/2
Coal	0	11
Shale	(a)0	1
Coal	1	3
Floor, clay		
thickness of bed	4	11
Thickness of coal sampled	4	9

Section A (sample 15050) was taken on the main gangway opposite room 45 (C bed).

Section B (sample 15052) was taken on the main gangway opposite room 32 (C bed).

Sample 15051 was measured at the face of right gangway 1 off slope 3, 20 feet ahead of room 11 (B bed).

Notes: "The carbon Hill mine is opened by a slope which strikes the coal a short distance from the surface and follows the dip of the coal."

"At the time of sampling the coal was undercut by hand and shot down with a permissible explosive. "The coal mined was washed on account of the "Slate" partings in B bed being very brittle. "It is estimated that one-fourth of the coal mined was lost in washing by breaking to a very fine slack. "It was claimed that the mine had been worked at intervals for 100 years, and that it had a probable life of 100 years more. "The future tonnage was to be derived from both pillar and advanced workings. "Pillars had not, as yet, been pulled. "The daily output of the mine was 150 tons, with a maximum days run of 345 tons. This amount was to be increased to 600 tons. "Pickers were employed on both the cars and on belt. "The coal loaded was fine, containing practically no lump.

"There were two leading tracks with a capacity of 15 loaded cars and 15 empty cars. "Only the "B" and "C" beds were being worked."

Virginia Henrico County.	Sample Laboratory Number	Condition	Moisture	Proximate Volatile Matter	Proximate Fixed Carbon
Gayton, 1 mile from, 5 miles north of Lorraine Carbon Hill mine, C. bed (in main gangway opposite room 45, 3 ft. 6 in. bed. 3 foot 4 inch cut	15050	1	2.81	25.70	62.47
		2	-	26.44	64.28
		3	-	29.14	70.86
Same (in main gangway opposite room 32 3 ft. 3 in. bed 2 ft. 3 in. cut)	15050	1	2.54	16.28	70.24
		2	-	16.70	72.07
		3	-	18.81	81.19
1 mile from, 5 miles north of Lorraine, Carbon Hill Mine, B bed (face of right gangway off slope 3, 20 ft. beyond room 21, 4 ft. 11 in. bed, 4 ft. 9 in. cut	15051 15051				
		1	2.11	23.58	56.95
		2	-	24.09	58.18
		3	-	29.28	70.72

Condition
1. As received
2. Dry
3. Ash and moisture free

In "Technical Paper" No. 365, issued in 1926, the Bureau of Mines also gives the foregoing analyses, with the addition of determinations of the Ash-Softening temperature of the samples, as follows:

Sample No.	Softening temperature °.
15050	2160
15051	2250
15051	2510

Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Air Drying Loss	Calorific Value Calories	Calorific Value British Therma Units
9.02	1.43	4.90	76.55	1.81	6.39	1.9	7496	13493
9.28	1.47	4.72	78.76	1.86	3.91		7713	13883
-	1.62	5.20	86.82	2.05	4.31	-	8502	15304
9.94	1.31	-	-	-	-	1.9	-	-
1.23	1.34	-	-	-	-	-	-	-
	1.51	-	-	-	-	-	-	-
7.36	2.16	4.44	69.22	1.59	5.23	1.4	6778	12200
7.73	2.21	4.30	70.72	1.62	3.42	-	6924	12463
-	2.69	5.73	85.96	1.97	4.15	-	8416	15149

ANALYSIS OF COAL GIVEN
BY
PROF. W. B. ROGERS: 1840
FROM
"GEOLOGY OF THE VIRGINIAS"

Designation of Coals in 1840	Fixed Carbon	Volatile Matter	Ash	Color of Ash
North side of James River				
Capt. Thos. M. Randolph	66.15	30.50	3.35	Light red
Coalbrookdale, 2nd seam	66.48	29.00	4.52	Light grey
Anderson's pits, 1st seam	66.78	28.30	4.92	Light grey
Barr's pits - 1st seam	70.80	24.00	5.20	Faint red
2nd seam	54.97	22.83	22.20	Strong red
3rd seam	65.50	24.70	9.80	Light Brown
4th seam	56.07	21.33	22.60	Strong red
Crouch, upper seam 110' deep	64.60	30.00	5.40	- -
Scott's pits (formerly Woodwards)	60.86	33.70	5.40	Light grey
Waterloo Shaft	55.20	26.80	18.00	- -
Deep Run pits	69.84	25.16	5.00	- -
Southside James River				
Stonechange	58.70	36.50	4.80	Light reddish
Engine Shaft				
Maidenhead	63.97	32.83	3.20	Strong red
Heth, Potts & Co.	62.35	37.65	2.80	Reddish yellow
Mills & Reid's Creek pit	57.80	38.60	3.60	Buff
Mill's pit	62.90	32.50	4.60	Light brown
Greenhole Shaft	67.83	30.17	2.00	Light red
Capt. Heth's Old English Shaft, 30' to 40' thick				
Bottom	53.36	35.82	10.82	- -
Middle	66.50	28.40	5.10	- -
Top	61.68	28.80	9.52	- -
Powhatan pits (Pinney)	59.87	32.33	7.80	- -

From the American Journal of Science, Vol. 42, 1842, is taken the following interesting and detailed report by two well-known chemists of that day, on the analysis and character of the Richmond basin coal, entitled:

Chemical Examination of Bituminous Coal from the pits of Midlothian Coal Mining Company, south side of the James River, 14 miles from Richmond, Chesterfield County, Virginia," by B. Silliman, Professor of Chemistry, Yale College, and O. P. Hubbard, Professor of Chemistry, Dartmouth College.

The analyses of the coal shows in the general average -

Carbon	58.26
Ashes	7.67
Volatile Matter	33.62
Coke	66.31

properties of solid carbon and volatile matters which render it well adapted to the most important purposes in the arts, and probably, with a low well-aged heat, to the production of gas for illuminating. "Its ashes are of a kind and in such a state as to offer no inconvenience in using it as a fuel.

Should there be occasion to convert the Midlothian coal into coke, it would afford that very important fuel to an excellent quality.

"The Midlothian coal contains so little sulphur, that for every practical purpose, it may be regarded free from that combustible.

"From repeated trials made by smiths in the city, it appears perfectly well adapted to their uses.

"This goal is an excellent fuel for parlor grate; on breaking a heated mass by the poker, there is no liquid tar covering the separated fragments but a bright flame instantly kindles on the newly exposed surface which radiate heat powerfully and illuminate the room with a cheerful radiance.

"We presume that it would prove an excellent fuel for locomotives and steam engines.

"The Midlothian coal being very free from pyrites, there appears to be no serious danger of its producing spontaneous combustion.

"Presuming, of course, that the coal furnished us by the President of the Midlothian Company presents a fair average of the produce of the mines, we hesitate not to recommend it as an excellent fuel, which has no occasion to shun a comparison with the best mineral coal of this country or of Europe.

"Other old analyses are given in Bulletin 29, Virginia State Geological Survey, as follows:

Analyst	Location of Mine	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur
Alexander, J.H.	Midlothian	-	31.60	61.10	7.10	-
Andrews, G.W.	Coxe Mine (Clover Hill)	-	38.50	55.00	6.50	-
Andrews, G.W.	Richmond Coal	-	32.00	59.25	8.75	-
Clemson, T.G.	Gillis Pit, Aetna Shaft		28.50	66.70	4.60	-
"	Anderson Pit, Dover	-	26.00	64.20	9.80	-
Heinrich, D.J.	Carbon Hill Upper Seam	1.40	20.60	60.80	17.20	-
"	Carbon Hill 2nd Seam	0.40	18.60	71.00	10.00	-
McCreath, A.S.	Midlothian, Grove Shaft, Screened	1.03	38.23	54.27	6.47	1.52
"	Midlothian, average	1.05	36.49	46.70	17.26	2.23

In "Virginia," Edited by Jed Hotchkiss and published by the State Board of Immigration, at Richmond, in 1876, appears the following statement regarding the Richmond coal field, together with the results of the analyses mentioned:

"Bituminous coal and natural coke are found in extensive beds in the Triassic, especially in the "Richmond coal-field" portion. "Over a million tons were taken from this field in the twenty years 1822 to 1842.

It has been longer known and worked than any other field in America, but never to the extent that the value of its coals would seem to justify.

"A recent (1873) analysis of these coals made in Glasgow, Scotland, by Dr. William Wallace, gives the following results from seven analyses of samples from different mines and locations."

Volatile matter	14.26 to 34.57 percent
(Fixed carbon	56.23 to 81.61 "
Coke (Sulphur	0.04 to 1.10 "
(Ash	2.24 to 8.88 "
Water (at 212° F.)	0.82 to 1.80 "
Dry coke, per ton of coal	12 cwt. to 3 qrs. 13 lbs to 16 cwt. 3 qrs. 10 lbs.
Coke, percent	64.33 to 34.18 or
Sulphur in volatile matter	1.14 to 0.78/in all 0.18 to 1.83
Heating power calculated	8.35 to 11.04
Specific gravity	1.219 to 1.321
Weight of a cubic foot	77.6 to 82.3 pounds
Weight per inch per acre	123 to 133 tons

Doctor Wallace says: "In this respect (fixed carbon) the whole of the coals are of excellent quality, and are considerably superior to the average of the New Castle coals."

Attention is called to the apparent differences in volatile matter content as shown by the analyses given between the coals mined north of the James River and those produced on the south side, the latter having, in general a much higher percentage.

For instance, analyses of coal from the Carbon Hill mines made by the Bureau of Mines show from 23.58 to 25.70 percent volatile matter, while A. S. McCreath's analysis of average Midlothian coal shows 36.49 percent.

The analyses following were furnished by Mr. J. G. Moltzclaw, President Virginia Electric & Power Company. The samples were taken from the Scott mine, which is about 25 miles west of Richmond on the south side of the James River.

	Sample No. 1 Lump - Top of Seam		Sample No. 2 Surface - Middle of seam	
	As Received	Dry	As Received	Dry
Moisture	2.09	-	1.81	-
Volatile	32.89	33.60	32.08	32.59
Fixed Carbon	60.31	61.59	59.28	60.45
Ash	4.71	4.81	6.83	6.96
	100.00	100.00	100.00	100.00
B.t.u./lb. -	13,900	14,220	13,840	14,100

Analyses of coal from the Midlothian mines have been furnished by the Southern Railway, and will be found in Appendix "C".

Other analyses of coal from the Midlothian Property will be found in the report of R. V. D'Invilliers, contained in Appendix "E" which gives descriptions of the samples analysed, with comments and conclusions.

The Richmond field coal is described by Heinrich as being highly laminated, bright black, bright black, resinous and composed of thick lamine in thin layers, alternating with dull, black laminae. The Tracture is generally conchoidal. Joint planes are developed at right angles to the bedding planes, which are well developed, causing the coal to break into cubical and rectangular blocks.

Specific gravity determination, made in 1923 by J. K. Roberts, of coal from four mines then in operation, ranged from 1.292 to 1.362 or an average of 1.332.

Impurities:

The principal impurities found in the Richmond field coals are pyrite and shale or slate. Pyrite occurs in small masses, although sometimes disseminated throughout the coal as scale, especially in the thinner beds. The shale partings vary considerably in thickness.

To put this coal on the market in competition with other fuels and coals, it will probably be found necessary to install some type of mechanical cleaning equipment at the mines.

SUMMARY - CONCLUSIONS.

Coal was discovered in the Richmond field about 234 years ago (1700-1701) and there has been a generally continuous development of mining in the field ever since, until 1924, although little is known about its first fifty years. We do have, however, an apparently reliable written record, dated 1759, of "Coal mines" having been opened on the James River previous to that year.

Exploration - Prospecting:

Notwithstanding the many years which have passed since its discovery there have been no systematic explorations or prospecting of the field, as a whole; only around the margin of the basin, not over a mile from the outcrops and at a comparatively few scattered localities, have there been shafts and a few drill holes put down, and many records of these have been lost or destroyed.

There is no definite and exact information on record regarding the condition of the coal beds in the central area of the basin, whether they exist in workable condition and thickness, how deep they lie beneath the surface and whether they have "flattened out."

There is also a decided lack of data regarding the exact locations, and extent of the old workings, and there is little available accurate information regarding the underground conditions found. Some of the pits are now either filled with water or caved in so that it will be difficult to explore them for any distance.

AMOUNT OF

MINABLE COAL IN RICHMOND FIELD.

The only known estimates of the total amount of coal in the Richmond basin are those of Professors Shaler and Woodworth, as given in the annual Report of the U. S. Geological Survey, 1897-1898, and of O. J. Heinrich in 1873.

[illegible] estimate is based on an average bed thickness of 12 feet over 96,000 acres and "allowing for occasional strips of coal crushed by faulting and for treatment in the breaker" amounts to a total of 1,152,000,000 tons; "this reckoning, it should be said, rests altogether on probabilities." If we deduct 35 percent for losses in mining (probably 50 percent or more in the old workings) and a total of 8,000,000 tons mined out, there remain 740,000,000 tons of recoverable coal as of today.

According to Mr. Heinrich, actual production 1822,1877, averaged 11,295 tons "per acre worked." If this production is a plied to the entire 96,000 acres in the basin, deducting 8,000,000 output to date, there is obt ined a total of 1,076,320,000 tons of recoverable coal remaining in the ground today.

It is probable that both of these estimates are too high, but there is not sufficient data with which to check their accuracy. It is here pointed out that, as far as there is record, in no case was the mining of coal stopped at any of the mines in the Field on account of the coal having been entirely worked out. This statement is confirmed by men familiar with both the old and more recent operations on the field, among them the State Mine Inspector, now 79 years old, who and his father before him worked from boyhood at various mines in the Richmond field and whose written and signed statement is contained in Appendix "A" -

Coal Beds:

From two to five beds have been found and worked at various localities, the reported thicknesses ranging from 2 to 60 feet.

Shaler and Woodworth estimate an average thickness of 12 feet of workable coal over the entire basin. Heinrich reports that 19,000 tons of coal were actually mined and raised from one acre at Midlothian.

At the Murphy Corporation Mines, a total thickness of from 7 to 11 feet, 6 inches in all beds (3), was reported in 1921.

At Carbon Hill, in 1912, 12-1/2 feet total thickness in three beds, besides a 10 foot bed of coke was reported.

Production:

The production of coal in the Richmond field has always been on a comparatively small scale, the maximum output in any one year not exceeding 150,000 net tons, an amount produced annually by each of over 300 bituminous coal mines in the United States. It is on record that there have been at least 60 mines opened in the Richmond field, and the total output to date is estimated to have been about 8,000,000 net tons.

Development - Mining:

As one writer (an English Mining Engineer) described it in 1887, "the history of the Richmond field has been one of failure, disaster and death. But," he goes on to say, "some day this field will be successfully and profitably worked, but not until some one who can and will afford to make a really fresh start, clear of old workings, and develop the field in accordance with sound mining knowledge."

Another mining engineer, with several years experience in

"We have here an area of 96,000 acres of coal measures, having upon it seams or pockets of coal from five to sixty feet in thickness, as proved by workings in various places, which is left unimproved, unproductive, and almost unknown at this day.

"These (fires underground) and many lamentable disasters could have been avoided if a suitable system of mining had been pursued in all the collieries. This, and a series of other errors, too numerous to mention here but all due to ignorance, want of system and false economy, have concentrated all the worst elements imaginable to prevent the continuous prosperity of these mines."

In Appendix "A," "Report on Mine Explosions at Carbon Hill in 1911-1912," there are given also the comments of a mining engineer of wide experience in this country and abroad, on conditions at this mine (the only one then in operation in the Richmond field), from which the following quotation has been taken:

"Apparently from the beginning there has been entire absence of knowledge on the part of successive owners of this property, in dealing with dangerous conditions, such as they have in this mine ....., "I think that they (stockholders and directors) should be informed of the dangerous conditions that prevail and the horrible conditions that have existed in the past. In fact, it seems incredible that such mining conditions should have been permitted in any state."

This mine was closed in 1912, and since that time there has been only one mine (not including small pits for local consumption) opened in the field, in 1920, after producing a small tonnage (50,000 tons in 1923) was closed, it is reported by the State Mine Inspector, and in addition, was in financial difficulties.

It seems to be the general and unqualified opinion of all mining engineers and geologists who have examined the field and its mining operations, as well as of other qualified to give an opinion, that the failure of the numerous attempts to successfully mine the Richmond field coals have been due primarily, if not entirely, to the following general causes:

1. Lack of knowledge and mining experience, with inefficient management and supervision.

2. Ignorance and misunderstanding of underground conditions, with failure to do the necessary prospecting, and neglect to keep records of drillings, mine workings, etc.

3. Insufficient financial resources, and misdirected use of the funds available.

To these might be added the lack of any supervision by the State until 1914, in spite of the numerous fatalities in the mines, which totalled from 1839 to 1933, xxxxx as recorded by the U. S. Bureau of Mines, 277 from explosions alone, all caused by lack of knowledge and proper supervision. It should also be stated that

previous to the Civil War all the miners and laborers in the field were slaves and that even after that time a large percentage of the workers was made up of negroes, although in later years, there was in influx of foreign labor, including some English miners, but mostly Bohemians and Slovaks.

Development, Future:

It is apparent, from the foregoing statements and other given elsewhere, that the production of a large tonnage of properly prepared coal from the Richmond field, at a reasonable cost per ton, is an undertaking that will require -

1. More information than is now available regarding underground conditions.

2. Careful selection of the location and type of mine or mines to be opened and the necessary equipment.

3. Intelligent and effective planning and operation, with close and competent supervision.

4. Accurate knowledge of the character and quality of the coals and their suitability for different uses.

5. Ample financial resources, sufficient to operate without wasteful economy and with the most efficient equipment and personnel.

All of the general requirements mentioned are in addition to the acquisition of the necessary property and/or mineral rights.

As a preliminary step, it is recommended that a detailed investigation of the field should be made, to include all existing and probable future conditions that would or might effect mining and mining and production costs, and the safe, economical and systematic development of the area or areas selected, as may be necessary to obtain the desired output.

The study might include specific subjects, as follows:

1. Underground and outcrop conditions.

2. Selection of location for mine or mines.

3. Kind of opening, shaft or slope, number and size.

4. Mining system and method to be followed.

5. Equipment and buildings.

6. Preparation of the coal - method and equipment.

7. Labor conditions and supply.

8. Safety requirements.

9. Ventilation and Pumping - Timbering - Haulage.

10. Housing, Welfare, Sanitation, etc.

11. Operating organization.

12. Power requirements.

13. Probable cost of preliminary development.

14. Production costs, probable.

Careful consideration should be given to the question of prospecting the interior of the basin for the purpose of ascertaining underground conditions. Up to date all efforts have failed to determine definitely whether coal beds of workable thickness and condition exist in the center of the basin, and at what depth.

A thorough study should also be made of the character and quality of the coals and the uses for which they are or may be useful, as little accurate information is available covering these important points.

There should be undertaken systematic sampling of the coals, to include the entire field. Samples should be taken according to the standard methods of the American Society of Testing Materials, and should include not only samples of the entire beds, but also separate samples of the different benches of each bed.

These samples should be analysed by realible coal chemists and calorimeter and ash-softening temperature determinations should also be made. Tests should be made of the coals with respect to -

1. Grindability characteristics.

2. Suitability for by-product coke and gas manufacture.

3. Slacking and weathering (storage).

4. Use in pulverized form.

5. Use characteristics in various types of stokers.

6. Use as locomotive fuel.

7. Use in the ceramic industry.

8. Characteristics and suitability for use in certain chemical and metallurgical processes and furnaces.

9. Use for domestic heating.

A study should be made of -

1. Transportation facilities, methods, rates, and costs, to include rail, water and trucking.

2. Markets and consumption.

3. Competitive fuels, their source, distribution, uses and prices.

"Natural Coke" (Nature's Coke):

Natural coke or carbonite has been found and worked at several localities, especially near Dayton and Midlothian, and occurs in beds ranging from 2 to 15 feet in thickness. The coke varies in appearance and character, volatile matter percentage ranging from 9.64 to 17.00 and ash from 2.24 to 15.00, as reported.

Oven Coke:

It is known that coke has been made from at least some of the Richmond field coal, but details are lacking as to its quality and amount. It has been stated that the Koppers Company were prepared to construct a by-product coke plant near Richmond, using the Richmond basin coals, but the writer has found no record of actual tests of these coals either in by-product ovens or in the laboratory.

Conclusions:

1. The successful mining of the Richmond field coals presents no greater difficulties than are met with in other producing fields, both in this country and abroad.

2. And just as all authorities who have reported on the field account for its failure by stating the ignorance, inefficiency, carelessness and lack of money that brought them about, so they are all agreed that there are no mining conditions in the field so difficult that they cannot be readily overcome, and that the Richmond basin has great possibilities as a successful producer of coal, if developed in accordance with sound knowledge and judgment, with efficient management and sufficient financial resources to ensure the acquiring of the necessary equipment for economical production.

3. In my opinion, based on all available information and a previous study (1928) of the Richmond Coal Field, the conclusions stated in paragraphs #1 and #2 preceding, are fully justified, namely, that (first) there are no more difficult mining conditions in that field than exist in many other producing fields; (second), that the Richmond Field has great possiblities as a successful producer of coal; (third) that the mining failures in the field were due to the causes given on page 123 of this document.

On pages 78-82 and 119-121 will be found discussions regarding the amount of unmined coal in the field.

Finally, I have no doubt of the existence of a large body of minable coal of fair to good quality in the Richmond Coal Field as described in the foregoing pages.

F. R. Wadleigh

4. The advantages of location with respect to market consumption, possessed by the Richmond field have been stressed by every one, and they do exist, of course. But, location is not everything, when it comes to marketing coal, and favorable differences in transportation costs should not be allowed to hide the necessity for efficient mining and preparation, plus accurate knowledge of the character and quality of the coal as well as of the uses for which it is, or may be suitable.

APPENDIX "A"

STATEMENT

OF THE

CHIEF MINE INSPECTOR

STATE

OF

VIRGINIA

REGARDING MINES AND MINING

IN THE

RICHMOND COAL FIELDS

- - - - - - - - - - - -

Commonwealth of Virginia

DEPARTMENT OF LABOR AND INDUSTRY

COMMISSIONER'S OFFICE

Richmond

March 15, 1933

Hon. John Hopkins Hall, Jr.,
Commissioner of Labor,
Richmond, Virginia.

Dear Sir:

I am giving below a brief historical review of coal and coke mine operations in the Richmond Coal Basin. I have included more detailed information regarding the quality and thickness of the coal and coke seams in the mines in which I worked at Gayton and Winterpock, and about which I can speak from personal knowledge. The dta on many others was gathered by my contact with the general development of the field over a period of 40 years.

WINTERPOCK

(FORMERLY CLOVER HILL)

I was born September 7th, 1855 at what is now known as Winterpock, but at the time of my birth was known as Clover Hill Mines, Chesterfield County, Virginia. I lived there until I was nearly nine years of age when my father moved his family to Carbon Hill (now known as Gayton) where he assumed charge of the Coke Mine until about 1866. At about this time the mine property was sold to Northern Capitalists, and my father quit and moved his family back to Winterpock.

About 1868 my father became fireboss and foreman in what is known as Raccoon Slope at Winterpock. He held these positions until 1872 when he was stricken with pneumonia and died. While he was foreman and fireboss he employed me to travel with and assist the fireboss; after his death, I became a mule driver, and then a coal miner in Raccoon Slope until about 1878 after which I became fireboss in this slope. In sinking Raccoon Slope the Company went down with the vein never 1 hundred feet to the property of a Mr. Robinson consisting of small acreage. In order to carry the Slope direct to company property below, a right-of-way was obtained through the Robinson tract and developments were extensively carried on below the Robinson tract on the Company property. The slope went to a depth of about 4,300 feet and was still in excellent coal when operations were interrupted by a dispute between the Coal Company and Mr. Robinson over a question of royalty to Mr. Robinson for bringing the coal through his property. Mr. Robinson secured an injunction against the Company and James R. Worth, General Manager of the Coal Company became so enraged at Robinson's actions that he abandoned the Slope from the surface edge of the Robinson property and allowed it to fill with water, leaving the slope, entries, rooms and pillars below standing. An enormous amount of coal has therefore been closed in and apparently lost forever from

this dispute. He did, however, take all pillars out from the Robinson property to the surface, thereby causing this part of the mine to cave, making it impossible to ever again make an opening at the original point of operation. I was employed to take out all steel rails, pumps and pipes and other valuable materials from the abandoned part of the mine which took several weeks and as that part of the mine was abandoned finally I was absolutely the last person in it. The vein of coal worked in this slope was about 7 or 8 feet thick. The handling of water in this Slope was less than the ordinary mine water problem. At the height of this operation there were from 225 to 275 men employed inside the mine.

After completing the work of taking out the steel and other valuable material from the Raccoon Slope, which was in 1884, I left Winterpock and accepted the position of general mine foreman of the Coke Shaft of the Gay and Loraine Co. at Gayton, Virginia, which position I held for about 5 or 7 years, during which time the property was purchased by Haddock-Shunk & Co. and I was then transferred by them to the Coalbrook Slope at Gayton, Virginia, which position I held until 1902 when Haddock-Shunk & Co. ceased operations. Coalbrook Slope was down 1800 feet in a fine quality of coal about 6½ or 7 feet thick.

During the time I was foreman in the Coke Shaft it became necessary time after time to work night and day to fill urgent orders for the coke to be shipped by boat to Boston and other places. The Coke seam varied from 0 to 15 feet thick in the Coke Shaft. There were three veins of coal worked from the Coalbrook Slope as follows:

Bottom Seam	- 8 feet thick
Middle Seam	- 3½ to 4 feet thick
Top Seam	- 6 feet thick, all of these seams contained coal of good quality.

The Coke seam referred to above was on top of all Coal Seams in this field. When the Coke was being mined it was sold in competition with the best grades of Pennsylvania Anthracite Coal in Boston, New York, Philadelphia and elsewhere, having always been considered an excellent domestic fuel.

In my statements above relating to Coal and Coke Mine operations at both Winterpock and Gayton, I have given you absolute information from personal activities in same as laborer, miner, and foreman in charge of operations from the years 1864 to 1902 which indicates the great possibilities that still exist for further profitable mine development in the Richmond Coal Basin extending through Goochland, Henrico, Chesterfield and Amelia Counties. For your information, I am giving you a list of names of as many mining operations as I can think of at this time which produced coal on the Eastern outcrop.

Following is a list of mines which were operated either in Coal or Coke Seams on the eastern outcrop starting with Barrs Mine on the southern end and finishing with Sanders Shaft at Gayton on the northern end of the field.

Barrs Mines Note: Mr. Barr is supposed to have been the first person to open a coal mine on the eastern outcrop in the Richmond Coal Basin.

Park Hill Shaft
Raccoon Slope Note: About 1862 or 1863 and again 1878 or 1879 explosions occurred in this slope killing a number of men in each explosion.

Retreat Slope
Hall's Slope
Pump Slope
Beaver Slope
Bright Hope Shaft Note: In April 1867 an explosion occurred in this Shaft killing every man in the mine, numbering 79, and fire broke out making it necessary to flood and seal it. About 1873 this mine was set on fire from engine and boilers which had been installed inside of the mine to enable them to go deeper in the vein.

Jawbone Shaft
Mann's Shaft
Vaden Shaft
Cox's Shaft
Grove Shaft Note: About 1882 an explosion occurred in Grove Shaft killing about 34 men. Following this explosion the mine took fire and was flooded and sealed preventing any effort at recovering the bodies of the men killed.

English Company
Jewitt Coke Pitts, Shaft & Slope, Coal Vein
Garrison Shaft
Coalbrook Slope
Coke Shaft, Coke Vein
Snaders Shaft, Coke Vein

The following is a list of operations on the Western outcrop of the Richmond Coal Basin.

Manakin (formerly known as Dover) North of James River.
Scotts Mines on the James River South of James River.
Powhatan Coal Co. Note: There were two shafts to this mine, one for ~~hax~~ hoisting coal, and the other for ventilation. One shaft was 35 yards deep, the other 60 yards deep. A slope was driven on the Coal vein from the bottom of the Shafts about 680 feet. The coal was two feet thick at the start but about 10 feet thick at the face of the Slope. The Slope pitched east about 25 to 30 degrees. Three seams were out in these Shafts, one Slope was in the top seam and a shorter slope in the second seam.

There have been several other operations in the Richmond Coal Basin, the names of which I cannot remember at this time. Practically all the mines in the Richmond Coal basin were successfully operated with limited facilities and were abandoned for one reason or another. I will state, however, from general knowledge of the field that none that were developed to a Coal Seam were abandoned for the want of coal.

I trust the information given in this report will prove of real value to the Department.

Respectfully submitted,

(Signed) A. G. Lucas,
Chief Mine Inspector.

APPENDIX "B"

REPORTS

ON

EXPLOSIONS

AT THE

CARBON HILL MINES

1912

- - - - - - - - - - - - -

December 7, 1912

CARBON HILL MINE, GAYTON, VA.

I enclose herewith preliminary report on the gas explosion which occurred in the Carbon Hill mine, Gayton, Va., on July 16, 1912.

Investigations disclose a very remarkable state of affairs in this mine. Apparently from the beginning there has been entire absence of knowledge on the part of successive owners of the property, in dealing with dangerous conditions, such as they have in this mine, spontaneous fires, fire damp and coal dust. Apparently the present operators, since the last explosion, have tried to remedy conditions, but it would not appear that they have realized the full dangers, since standing gas is allowed to remain in the mine; or in other words, the mine is worked while there is standing gas in same; and entirely inadequate provision is being made for the future in ventilation through failure to provide air courses parallel with the entries or levels. Break-throughs between rooms, will not take the place of an air course. Further, the absence of barrier pillars between the different levels or between the level and the rooms on the next level below, makes ventilation uncertain, and there is no opportunity to fight fires that may become started.

Supporting suggestions, my recommendations would be that a local management should be obtained which is thoroughly familiar with a gaseous mine, (2) that air courses should be driven and maintained; (3) that locked safety lamps or electric lamps of approved type shall be used to the exclusion of open lights or other dangerous lights.

I am informed that the relations between the stockholders and directors are not harmonious, therefore the situation may be delicate in advising the company. Nevertheless, I think that they should be informed of the dangerous conditions that prevail, and the horrible conditions that have existed in the past. In fact, it seems incredible that such mining conditions should have been permitted in any State. Apparently the operations might be made profitable, as a good price is obtained for the coal, but the operators should learn that it is to their interest in the long run to proceed with the utmost care, and spend money in the development underground. I am sending two copies of the report in case you consider it expedient to send a copy to the operator.

Very respectfully,

(Signed)

APPENDIX "C"

SOUTHERN RAILWAY, THE

INFORMATION FURNISHED

REGARDING THE MIDLOTHIAN MINES

OF THE

MURPHY COAL CORPORATION

- - - - - - -

SOUTHERN RAILWAY

THE INFORMATION REGARDING MIDLOTHIAN COAL

The information given in the following pages has been taken from the files of the Southern Railway, through the courtesy of Mr. J.C. Williams, and refers solely to the mines at Midlothian, operated at the time by the Murphy Coal Corporation, of Richmond, Virginia.

Analysis No. 1. - No information given regarding this analysis or the sample from which it was made - it would appear to be a selected sample, probably a single lump.

Analysis No. 2. - The analysis made by Perry Barber, (well known Fuel Engineer and Chemist, of Boston, Mass.) can be relied on as being accurate, but as the sample consisted of only one lump it cannot be taken as representative of the Midlothian coal.

Analysis No. 3. No information given regarding the sample and how it was taken; name of the chemist not given. It will be noted, first, that there is considerable difference in the percentages of volatile matter given in the three analyses; second that the percentages of volatile matter differ widely from those given by the bureau of Mines in Bulletin 83 for coal from the Carbon Hill mine near Dayton, which are 26.44 and 24.09 (dry basis), this mine being north of the James River.

The locomotive test described is not of much value, except possibly the description of the kind of clinkers formed.

The letter signed by Mr. S. Dixon is of value as showing actual conditions at Midlothian and the underground operations proposed.

Mr. Dixon had been for many years and was until his death a few months ago, engaged in coal mining operations in the New River (West Virginia) field, and was President of the Prince Hill Colliery Company at the time of his death.

(COPY)

#1 Analysis sample of coal from new opening in Richmond Virginia Coal Field: April 3, 1934 File 985.

Moisture	.00%
Volatile Combustible	40.46
Fixed Carbon	53.82
Ash	5.72
Sulphur	1.36
B. T. U.	14663.

- - - - - -

#2 THE MURPHY COAL CORPORATION
RICHMOND, VIRGINIA

MIDLOTHIAN COAL

Case No. 218-h-2 Sample No. 42225
Sample of coal consisting of one lump, submitted by C. M. Sprague & Son Company,
April 11, 1922
Sample as received (Weight one lump) 17.5 lbs.
Temperature at which ash was completely fused, 2310 degrees F.

	DRY BASIS
Moisture	--
Volatile Matter	33.25
Fixed Carbon	60.49
Ash	6.26
	100.00
Sulphur, separately det'd	1.41
B. T. U. per pound	14486.

Testing Laboratories of
Perry Barker, Fuel Engineer,
850 Old South Building,
Boston, Mass.

Respectfully submitted

(Signed) PERRY BARKER

April 14, 1922.

Washington, Feb. 5, 1921, hvg.

Mr. Degram:

In conference here today with Mr. G. Dixon of the firm of the Murphy Coal Corporation, Richmond, Va., I am advised that the Midlothian mine has been very nearly cleared of water, and that within the next week or ten days the company will be in a position to begin loading coal. The operations for a time, of course, will be small and the market will have to be worked up.

The following is an analysis of sample just taken from this mine:

Moisture	1.1[illegible]
Volatile Matter	36.38
Fixed Carbon	54.86
Ash	7.84
	100.00
Sulphur	1.07
B. T. U. per lb. of dry coal	13984.
Fusing point:	
Centigrade	1331
Fahrenheit	2428

The Murphy Coal Corporation is prepared to negotiate with you for a portion of your fuel supply and suggest that you try the six inch screen coal, and, if your desire, also the straight run of mine.

I suggest you get in touch with them at your convenience.

Mr. Dixon's address is Price Hill, West Virginia, or you can make an appointment at any time through Mr. Drake.

L. G.

Richmond, Va., Aug. 1921 - am.
T-1688

Mr. Shelton:

Your 1174 of the 18th inst., and other letters in regard to test of Midlothian coal.

I am very sorry that I am unable to give you a report on this coal that I expected to be able to do, as I described to you personally. Other matters prevented my being on the ground the entire time of the test, which was intended to cover the period necessary to consume the entire carload of coal, about 54 tons, except that amount which would be left in the engine tank at the completion of the last trip.

Master Mechanic and Road Foreman of Engines were requested to look after the matter personally in the manner I outlined to them. I was away when the test was started, and did not return until after it had been discontinued, it only being taken on two trips and then not in the manner I had arranged for it to be taken.

The only report I am able to give you is as follows, which covered two round trips - 296 passenger train miles, using 22,330 lbs. coal:

Pounds of coal per engine mile	75.1	
Pounds of coal per passenger car mile	18.8	
Pounds of ashes	4620	or 211 lbs of ash to each 100 pounds of coal.

The actual road performance is a little better than the above per engine and car mile, as the coal consumed at the terminal not estimated and therefore not deducted.

The coal is reported as burning with a long flame, igniting quickly showing its volatile character, but the observation was that it was a very light coal and while the engine steamed well under a light draught, it did not steam well on heavy grades or where it worked hard, which is not an unfavorable condition, as it could only be necessary to lighten the draught of the engine, in order to suit the coal where used.

The character of the clinker formed was entirely different from what has been said about the coal in the past, its reputation was that it formed a soft plastered clinker on the grates, obstructing the admission of air. The test developed to the contrary, it formed a small hard clinker, which formed or was easily broken into small particles that could be shaken through the grates. Only one clinker of any size, about a foot in diameter and four inches thick, which was soft and broke when struck by the bar, was formed.

If the use of the coal develops this type of clinker, it would be distinctly favorable, as it would be little or no trouble to keep the cinders or clinkers shaken through the grate.

Yours truly,

Superintendent.

- - - - - - -

July 30, 1923

Mr. A. H. Sands,
American National Bank Bldg.
Richmond, Va.

Dear Sir:

Regarding conversation about Midlothian had with Mr. Green, Vice President, Southern Railway, in his office in Washington, D. C., on Tuesday last, the 24th, and information asked for by Mr. _____:

I submit the following as a fair statement of the physical and financial standing of the Murphy Coal Corporation:

Money invested and expended to date:

1st.	Cost of plant as of November, 1920	170,000.00
2nd.	Cost of Material, Machinery and buildings (Since the purchase)	65,000.00
3rd.	Cost of unwatering, cleaning up and driving main slope to date	115,000.00
		350,000.00

The above is within a few hundred dollars either way of actual cash spent upon the property; an audit of the records will show the exact figures.

1st Cost of Plant:

1900 acres land in fee (at Midlothian).
3 acres in the City of Richmond on deep water.
33 houses and miners dwellings, five of which are new
1 store building and 2 acres of ground on Midlothian Pike.

2nd. Power Plant at Slope:

2 - 125 H. P. Boilers
1 - Flory Double Engine Hoist
1 - 40 H. P. Generator and Engine
1 - Direct Connected 200 K. W. (1 small fan) Generator on Foundation, ready to run
1 - Blacksmith Shop and contents
1 - Office and Howe 200 ton scale
1 - Tipple with three tracts under same holding 30 cars
1 - Sullivan air compressor
3 - Boiler Water Tanks and air receivers
40 - Tons Mine Rail and other material

Power plant at Grove Shaft, (1000 feet away)

1 - Hoise Engine, large, with ropes
3 - Boilers in use, but old
3 - Feed Pumps
1 - Air Compressor in good order and receiver
1 - Small Hoisting Engine
1 - Large fan installed
2000 Feet 3" pipe
2 - Boiler Water Tanks
15000 Feet Dressed Lumber for Buildings
2 - Punchers and quantities of other materials

Material in mine:

2 -	Power pumps, new costing	$3,000.00	New
1 -	Electric Hoise and Rope		"
1 -	Compressed Air Hoise		"
4 -	Pumps		
30 -	Mine Cars		
1 -	Large Pump, cost	1,200.00	"
2000	Feet 4" Pipe		"
1000	Feet 3" Pipe		"
2500	Feet 40 lb. Track laid		
3000	Feet 20 lb. " " with Sheaves, etc.		

The above, to other with quantities of tools and surplus material represent the cost of property and expenditures for supplies and materials since the commencement.

3rd. Cleaning up and unwatering the mines:

Commencing October, 1920, we have pumped the water from the old workings and cleaned up the falls in the main slope for a distance of 1800 feet and the falls were persistent and heavy. Also retimbered the old Grove shaft, cleaning up the Dodd Incline which was completely closed by reason of the fire which compelled its closing down some years ago.

We have driven the main slope 500 feet and cross headings right and left to the old workings, unwatering these old places as we went down and all in coal in the C seam of from 42" to 74" in thickness.

Main slope is 2300 feet down and on an average of 45° pitch. At this point the slope and 40 to 30" coal ran off level on a fold for 135 feet and has now turned over at 72% with about 12" coal and will connect with the regular seam in 25 feet and then take its normal dip and thickness.

The 3rd and 4th Right Headings stand in good C seam coal, two hundred feet from main slope, up against the old entries driven years ago and now full of water with little pressure which we are draining. The end and 3rd Lifts are driven out into the old Dodd Incline and workings, the 4th Lift ran into the same roll or fold developed in the main entry. We have driven through this and beyond. The coal shows in the face of the 4th Left, 350 feet from main entry (see map) commencing on top, coal 38", rash 28", coal 29", rock 8", coal 18" and the place not on the granite.

A place turned to right off the 4th left and within 75 feet of face shows commencing roof slate, coal 69", slate 9", coal 16", and this place is not on the bottom granite. The sections of this place on the right would indicate the rash or coal and slate mixture was a pocket and runs out driving to the dip. The Richmond Basin at Midlothian carries coal fairly uniform as under - beginning on the granite floor:

C Seam	40" to 72" Coal
Parting	9" to 30" Slate
B Seam	24" to 40" Coal
Parting	9" to 18" Slate
A Seam	18" to 24" Coal
Granite Floor	

Conditions at Guyton about 15 miles East in the same Basin are as follows:

C Seam	44" Coal
Parting	72" Slate
B Seam	42" Coal
Parting	60" feet Slate
A Seam	50" Coal - Laminated
Granite Floor	

There is no question about the coal at Midlothian being in paying quantities since we have proven the seam in the main basin to run reasonably uniform. The present fold or roll in the main entry will be over-come by the driving of main entry from 25 to 40 feet when the uniform dip of the coal will then continue.

Three thousand feet ahead of present main slope and a little to the East, a bore hole known as "Jewetts" shows 13 feet coke; this coke I have no doubt includes the two partings the three seams, A, B, and C.

Funds needed to mine coal in quantities.

There are 33 houses on the property, 28 of which are from 40 to 70 years old and unfit for habitation. We should have:

50 new houses @ $1,500.00 each	$75,000.00
1 Commissary office building and merchandise	25,000.00
2 new boilers	5,000.00
Mine Cars	10,000.00
Tripple Changes	10,000.00
Main Slope Improvements, etc.	25,000.00
	$150,000.00

With this new capital, an output of 300 to 350 tons per day can be attained easily and at a cost of less than $2.25 per ton. We pay our men for digging and loading $1.25 per car of 1½ tons or 1.00 per ton and the dead work and labor can be done for about the same amount, paying wages to justify men in coming and staying. The surroundings can be made an ideal coal plant location, free from adjacent coal fields and labor agitation.

By the installation of additional generators and a battery of boilers, all the small coal and impurities in the coal can be crushed and converted into electric current and sold to the Richmond Street Railway, who will build a line 8 miles to the mines and take all the current made at a price, thus permitting the mine to screen and sell the lump coal in nearby towns at lump and domestic coal prices.

Mr. Murphy. together with myself and friends are anxious to see the success of this property, not only because of our financial investment but because we have demonstrated that the Richmond Basin contains coal in quantities that can be mined at a profit.

Our handicap, since unwatering and cleaning up the shaft and two entries has been in having no mine maps of the old operations. We have driven the main slope between these old workings but have been unable to open up area for an output. The map will show the extent of the solid coal we have to work in. The writer believes that on the left we will tape the face of the Dodd Incline which is the lowest place on the left and I also believe that the workings on the right were driven down to the present roll or fold and then stopped, hence the new development beyond the fold can be pushed through without the fear of interruption or danger from old workings.

I will be glad to show any practical mining man the plan and the coal, also the coal prospects as they appear below the old workings of years ago.

Yours very truly,

(Signed) W. Dixon,
Mrs. Murphy Coal Corp.

This report was signed by E. V. D'Invilliers, one of the best known coal geologists of his time. The copy of the report furnished the writer gives me indication as to whom it was addressed nor for what purpose it was made.

Some of the statements and conclusions given do not apply to todays conditions, and it will be noted that the tract of land specially reported on makes up only a small part of the Richmond field.

At the time this report was written (1903-04) there was some mining activity in the field, production in these years being recorded as 18,084 net tons in 1903 and 2,100 tons in 1904; whether any of this tonnage was produced at the "Midlothian Property" is not recorded.

It is also pointed out that the sampling and analyses reported on give some attention to the differences in quality of the different benches of the seams, a matter not touched upon in any previous or later reports.

APPENDIX "D"

RICHMOND, FREDERICKSBURG, AND POTOMAC RAILROAD COMPANY,

INFORMATION FURNISHED BY

Mr. John B. Mordecai, Traffic Manager of the Richmond, Fredericksburg and Potomac Railroad Company, furnishes certain information regarding the Richmond field coal as follows:

I enclose herewith copies of certain papers with respect to the so-called Gayton coal mined on the north side of James River about eight or ten miles west of Richmond, viz:

Copy of report of June 4th, 1909, from Mr. J. W. Heron to our General Manager, Mr. W. D. Duke.

Copy of analysis made May 10th, 1932, by Froehling & Robertson, Inc., of Richmond, on a sample of West Virginia coal such as used by this Railroad.

Copy of Mr. Duke's letter to me March 29th, 1933, stating the experience of this Company in the use of some of the Gayton coal during the period June 1910 to December 1912.

(Signed) J. B. Mordecai
Traffic Manager.

From: W. D. Duke, General Manager

To: J. B. Mordecai, Traffic Manager

March 29, 1933

File 023

Replying to your favor of March 25th, Desk A, File 626, asking for information about our experience with the Gayton or Midlothian coal we used for fuel some years ago:

We used this coal from June 1910 to December 1912 and I estimate from the records that I have been able to find that during this period of two and one-half years we used about 15,000 tons. In fact we used all of the high volatile that they produced while the mine was being developed at Gayton by the Old Dominion Company. The price paid averaging from $1.50 to $1.85 per ton, plus 35 cents freight charges.

This coal performed satisfactorily on our locomotives and was about equal to the Kanawha coal which we have used almost exclusively for locomotive fuel for many years. It was necessary, however, to put it through an expensive process of preparation at the mine. It had to be screened, washed and picked so as to remove the impurities, such as slate, bone, etc. I enclose a report on this coal made by Mr. J. W. Heron, dated June 4, 1909, which I will be glad if you will return to my file when it has served your purpose. Mr. Heron was at that time employed by the C. & O. Railway and was a coal expert, he having charge of the car distribution, or rather the rating of the mines, on the C. & O. I also enclose you, for comparison, a chemical analysis, dated May 10th, 1932, by Froehling & Robertson, Inc., of the high volatile Kanawha coal which we are using on our locomotives at this time.

(Signed) W. D. Duke.

Proehling & Robertson, Inc.

Richmond, Va.

May 10, 1932

No. A. - 549

Analysis of Sample of Coal

Made for R. F. & P. R. R. - Mr. C. H. Perry, Fuel Engineer

Market - "Soft Gas Lump from Mine 5 - CLO 70930

West Virginia Coal & Coke Co., Omar, W. Va.

	Moisture free	As received
Moisture		1.66%
Volatile Matter	37.06%	36.45%
Fixed Carbon	51.69%	53.78%
Ash	8.25%	8.11%
	100.	100.
Sulphur	1.62	1.40
B. per 1 lb. coal	13.930	13.720

Respectfully,

(Signed) Proehling & Robertson, Inc.

BIBLIOGRAPHY

1. ASHBURNER, C. A., Coal: U. S. Geol. Survey, Min. Res., pp. 10-73, 1885: pp. 324,-377, 1886, pp 169-394, 1887; Triassic of Richmond Basin, p. 69, 1885; pp. 352-361, 1886; p. 361, 1887.

2. CLARK, F. W., Analyses of trap rock, coke and coal from the Newark system: U. S. Geol. Survey, Bull. 42. 1887.

3. CLEMSON, T. G., Analysis of some of the coal from the Richmond mines: Pa. Geol. Soc., Trans., Vol. 1, pp. 295-297, 1835.

4. CLIFFORD, WILLIAM, Richmond coal fields, Virginia: Manchester Geol. Soc., Trans., Vol. 19, pp. 326-354, 35[illegible]-358, 188[illegible]. Abs. Geol. Mag., Vol. 6. pp. 138-140, December 3 1889.

5. _____, Additional notes on the Richmond coal fields, Virginia, in reply to criticisms: Manchester Geol. Soc., Trans., Vol. 20, pp. 247-256, 1889.

6. CORYELL, MARTIN, East Virginia coal field: Amer. Inst. Min. Eng., Trans., Vol. 3, pp. 228-231, 1875.

7. _____, Remarks on mining and on natural coke in the Richmond coal field, Virginia: Eng. and Min. Jour., Vol. 19, p. 35 1875.

8. DADDOW, S. H. and BANNAN, B., Coal, iron and oil, Pottsville, Pa., 808 PP. Map 1866.

9. FIELDNER, A. C. Analyses of coal: U. S. Bureau of Mines, Bull. 85, 1914.

10. FONTAINE, W. M., Mesozoic strata of Virginia (Notes): Amer. Jour. Sci., ser. 3, Vol. 17, pp. 25-38, 151-157, 229-239, 1879; Abst. Amer. Nat., Vol. 13, pp. 284-292, 1880; Neues Jahr., pp. 137-138, 1881.

11. GAY, W. B., Discussion of a paper on "the Richmond Coal Basin, Virginia" by J. B. Woodworth: Amer. Inst. Min. Eng., Trans., Vol. 31, pp. 1011-1012, 1901.

12. GRAYMAN, JOHN, An account of the coal mines in the vicinity of Richmond, Virginia; Amer. Jour. Sci., Vol. 1, pp. 124-130, 1818.

13. HEINRICH, OSWALD J., The Midlothian Colliery, Virginia: Amer. Inst. Min. Eng., Trans., Vol. 1, pp. 346-359, 360-364, 1873.

14. _____, The diamond drill for deep boring, compared to other systems of boring: Amer. Inst. Min. Eng., Trans., vol. 2 pp. 241-263, 1874.

15. _____, Deep boring with the diamond drill: Amer. Inst. Min. Eng., Trans., Vol. 3, pp. 183-186, 1875.

16. _____, Remarks on trap dikes and on natural coke in the Richmond coal field, Virginia; Eng. and Min. Jour., Vol. 10, p. 35, 1875.

17. _____, An account of an explosion of fire damp at the Midlothian colliery, Chesterfield County, Virginia, Amer. Inst. Min. Eng., Trans., Vol. 5, pp. 148-161, 1876.

18. _____, The Midlothian colliery, Virginia; Amer. Inst. Min. Eng., Trans., Vol. 4, pp. 308-316, 1876.

19. _____, The Mesozoic formation of Virginia: Amer. Inst. Min. Eng., Trans., Vol. 6, pp. 247-274, 1878.

20. HOTCHKISS, JED., On the Virginias: their agricultural, mineral, and commercial resources: Soc. Arts (London) Journal, Vol. 21, pp. 238-251, 1873.

21. _____, The resources of the Virginias on and near the proposed route of the Richmond and Southwestern Railway: in the "Virginia", Vol. 3, p. 13, 1882.

22. _____, The production of coal in the United States by coal fields for the Census Year ending June 1, 1880: In the "Virginias", Vol. 3, p. 13, 1882.

23. _____, The natural coke of Virginia: In the "Virginias", Vol. 4, p. 164, 1883.

24. _____, The Richmond, Virginia, coal field: In the "Virginias", Vol. 4, p. 171, 1883.

25. HUNT, T. STERRY, Remarks on natural coke in the Richmond Coal Field, Virginia; Eng. and Min. Jour., Vol. 19, page 35, 1875.

26. JOHNSON, W. C., Description, of the Richmond coal field; Report of the Commission on National Foundry, Doc. 168 p. 41, 1839.

27. JOHNSON, W. R., Analysis of natural coke from the Richmond coal field, Virginia: Phila. Acad. Nat. Sci., Proc., Vol. 1, pp. 223-224, 1841-42-43.

28. _____, American coals: Report to the Navy Department of the United States, Washington 607, pp., 1844.

29. LYELL, SIR CHARLES, On the structure and probable age of the coal field of the James River basin, near Richmond, Virginia: Quart. Jour. Geo. London, Vol. 3, pp. 261-280, 1847.

30. _____, A second visit to the United States: London, 2 Vols., 1st ed. 1849, 3rd ed. 1855.

31. _____, Remarks on the age of the Richmond coal field, Virginia: In Marcou's Geology of North America, p. 16, 1858.

32. _____, Elements of geology, London and New York: Published as a Manual of Geology. 6th edition published 1866.

33. NEWELL, F. H., Richmond coal field, Virginia: Geol. Mag., vol. 6, pp. 138-140, Dec. 3, 1889.

34. NICOLLS, W. J., The story of American coals: Lippincott, Phila. and London, 2nd. ed., 396 pp., 1904.

35. BATTON, J. H., Natural resources of the United States: New York and London, 523 pp., 1888.

36. PIERCE, JAMES, Practical remarks on the shell marl region of the Eastern Shore of Virginia and Maryland and upon the bituminous coal formations in Virginia and the contiguous region: Amer. Jour. Sci., Vol. 11, pp. 54-59, 1826; Trans. pp. 57-59.

37. PRIME, FREDERICK, The coals of the United States: Rept. of the Mining Industries of the United States, by Pumpelly, Tenth Census of the U. S., Vol. 15, pp. 605-687, 1886.

38. RAYMOND, R. W., The natural coke of Chesterfield County, Virginia: Amer. Inst. Min. Eng., Trans., Vol. 11, pp. 446-450, 1883; in the "Virginias", Vol. 4, pp. 145-146.

39. ROBERTS, JOSEPH K., The Triassic of northern Virginia: Dissertation for Doctor's degree, Johns Hopkins University, Baltimore, Maryland, June, 1922. 189 pp., 4 maps, 68 figs. Abs., Pan-American Geol., Vol 39, pp. 185-200, 289-296, 1923; Vol. 41, pp. 22-30, 1924.

40. ROGERS, H. D., On the geological age of the coal formation of the vicinity of Richmond, Virginia: Phila. Acad. Nat. Sci., Proc., Vol. 1, p. 142, 1843.

41. ROGERS, W. B., Report on the geological reconnoissance of the State of Virginia: Philadelphia, 143 pp., pl. 1, 1836. Reprinted in the Rogers' annual reports and other papers relating to Virginia geology, New York, pp. 21-122, pl. 1, 1884.

42. _____, Report on the progress of the geological survey for the year 1836: Richmond, 14 pp. 1837. Reprinted in the Geology of the Virginias, pp. 123-145, 1880.

43. _____, Report on the progress of the geological survey for the year 1839; Richmond, 161, pp., 2 pls., 1840. Reprinted in the Geology of the Virginias, New York, pp. 285-410, 1880.

44. _____, Report on the progress of the geological survey for the year 1840: Richmond, 132 pp. 1840. Reprinted in the Geology of the Virginias, New York, pp. 411-435, 1884.

45. _____, On the porous anthracite or the natural coke of eastern Virginia: Amer. Jour. Sci., Vol. 43, pp. 175-176, 1842; Amer. Assoc. Geol. and Nat. Proc., P. 68, 1840-42.

46. _____, On the geologic age of the Richmond coal field, Virginia: Phila. Acad. Nat. Sci., Proc., Vol. 1, p. 142, 1842.

47. _____, Observations on the subterranean temperature in the coal mines of eastern Virginia: Amer. Assoc. Geol. and Nat., Trans., pp. 532-538, 1840-42; Abs., Amer. Assoc., Geol. and Nat., Proc., P. 69, 1840-42; Amer. Jour. Sci., Vol 43, p. 178, 1843.

48. _____, Observations on the occurrence of natural coke in the Richmond coal field, Virginia: Boston Soc. Natl Hist., Proc., Vol. 5, pp. 53-56, 1845; Abs., Ann. Sci. Discov., pp. 320-322, 1855. Reprinted in the Geology of the Virginias, Vol. 4, pp. 158-159, 1883.

49. _____, On natural coke in the Richmond coal field: Am. Acad. Arts. Proc., Vol. 3, pp. 106-107, 1852-57.

50. _____, List of geological formations found in Virginia and West Virginia, Redfield's American geological railway guide, pp. 179-185, 1879.

51. _____, Geology of the Virginias (a reprint of the annual reports and other papers), New York, D. Appleton and Company, 1884. Copyright by Emma Rogers, xv and 832 pp. 15 pls., 1 map. Reviewed by H. D. and J. L. Campbell, American Jour. Sci., ser. 3, Vol. 30, pp. 357-374, 1884; Vol. 31, pp. 193-202.

52. _____, The Newark System: U. S. Geol. Survey, Bull. 85, 344 pp., 13 pls., 4 figs., 1892.

53. SCHMITZ, F. T., the structure of the Richmond coal basin: Amer. Inst. Min. Eng., Trans., Vol. 24, pp. 397-408, 1896.

54. SHALER, N. S. and WOODWORTH, J. B., Geology of the Richmond basin, Virginia: U. S. Geol. Survey, Nineteenth Ann. Rept., pt. 2, pp. 385-516, 30 pls., 26 figs., 1899.

55. SILLIMAN, B., Note on the Richmond coal field, Virginia: Amer. Jour. Sci., Vol. 43, p. 14, 1842.

56. SILLIMAN, B., and MURRAY, G. P., Chemical examination of bituminous coal from the site of the Midlothian Coal Mining Company, south side of the James River, 14 miles from Richmond, Chesterfield County, Virginia: Amer. Jour. Sci., Vol. 42., pp. 369-374, 1842.

57. STEVENS, A. P., Remarks on the natural coke or "carbonite" of the Richmond Coal field, Virginia: New York Lyc. Nat. Hist., Proc., Vol. 1, ser. 2, p. 73, 1874.

58. TAYLOR, R. C., Richmond coal basin and its coal trade: Pennsylvania State Jour., Vol. 2, p. 567, 1833-34.

59. _____, Memoir of a section passing through the bituminous coal field near Richmond, Virginia: Geol. Soc. Pa., Trans., Vol. 1, pp. 314-335, 1835.

60. _____, Statistics of coal.....Philadelphia, 1st. ed., 1848; 2nd ed. 1853.

61. _____, Mineral resource of Virginia, Lynchburg, Virginia: 613 pp., 83 Pls., 101 Figs., 1907.

62. _____, Mineral production of Virginia for 1908; Virginia Geol. Survey, Bull. 1-A, 1909.

63. _____, Mineral production of Virginia for 1909 and 1910; Virginia Geol. Survey, Bull. VI, 1910.

64. _____, Mineral production of Virginia for 1911 and 1912, Virginia Geol. Survey, Bull. VIII, 1913.

65. WILLIAMS, ALBERT, JR., Coal: U. S. Geol. Survey, Mineral Resources, (1883 and 1884), 1885.

66. WOODWORTH, J. B., The Atlantic Coast Triassic coal fields: U. S. Geol. Survey, Twenty-second Ann. Rept., Pt. 3, 1900-01.

67. _____, The history and conditions of mining in the Richmond Coal basin, Virginia: Amer. Inst. Min. Eng., Trans., Vol. 31, pp. 477-484, 1 map and 1 section, 1902.

68. WOOLDRIDGE, A. J., Geological and statistical notice of the coal mines in the vicinity of Richmond, Virginia: Amer. Jour. Sci., vol. 43, pp. 1-14, 1842.

69. YURTZ, H., Preliminary note upon the "Carbonite" or so-called natural coke of Virginia: Amer. Inst. Min. Eng., Trans., Vol. 3, pp. 456-457, 1875.

C A R B O N I T E

Excerpts
from the
press

Apr. 8, 1912

25071

The James River Coal Company adopt this method of answering the many inquiries that are made for information relative to the "Carbonite" which the Company is now mining on its lands in Virginia, and of which remarkable fuel the James River Coal Company has the exclusive control.

Extracts from the New York Press.
[From Savard's Coal Circular, Dec. 17th, 1873]

"The Carbonite," or Natural Coke, Found on the Property of The James River Coal Company, near Richmond, Virginia.

What is known as Carbonite, or natural coke, is mined in Henrico county, Virginia, some thirteen miles west from the city of Richmond. It is peculiar to the district on the north side of the James river. It burns with less flame than the common coal, is easily kindled, leaving but a small quantity of heavy ash.

The James River Coal Company, who have an office at 111 Broadway, own and lease upwards of 3,000 acres of land, part of which is underlain with the Carbonite, the other being underlain with the rich, fatty, caking, bituminous coals. The veins of coal on their estate have been traced for upwards of two miles, and range in thickness from 4½ feet up to 7 feet. The company own their own railway from the mines to the James River and Kanawha Canal, four and a half miles. From this point to Richmond the distance is twelve miles.

At Richmond this fuel is known as "soft coke," and is used for domestic and manufacturing purposes. The Architectural Iron Works claim that it serves all the purposes of anthracite coal. It is sold by the cartload of 25 bushels for $6.50, which is equal to about $8 per ton.

Dr. Wallace, of Glasgow, in a report made last spring, gives its heating power as 11.04, while Johnson's report gives but 9.48 for the average of the best anthracite coal. It contains 95.87 of combustible matter, while anthracite has but 93.14.

The freight from Richmond to New York will vary from $2 to $2.50; but when a constant business is done, vessels can, no doubt, be had regularly at $2 per ton. Under these circumstances, the com-

pany can afford to deliver coal at New York for $7 per ton, and the Carbonite at $10 per ton by the cargo.

The mining in this district has been carried on in a very primitive manner, but now that Northern capital and energy have taken hold of this coal field, we may expect a largely increased business to be done. Indeed, the engineer of the James River Coal Company, Mr. Torrey, thinks their product will be about 100,000 tons annually, within a short space of time.

A great advantage which the coals here produced have over other coal of a similar nature is, the short distance from a tide-water shipping point, and the fact that shipments can be kept up all the year round.

Dr. W. Wallace, of Glasgow, gives the following analysis of the Carbonite:

Volatile matter	14.26
Fixed carbon	81.61
Sulphur	.33
Ash	2.24
Water at 212° Fah	1.56
	100,00

Coke, 84.18. Specific gravity, 1.250. Weight of cubic foot, 77.9 lbs.

[From McGarlane's Coal Regions of America (Appleton), p. 508]

"Natural Coke" of Virginia.

It has the aspect and composition of a coal which has been in a great part deprived of its volatile ingredients by heat, accompanied by such a pressure of the overlying strata as would prevent the puffy and cellular texture usually assumed by coke. Retaining all the carbon of the original coal, this material has great value as a combustible, yielding the intense and steady heat of anthracite, at the same time that, from its less compact texture, it is more readily ignited than coal of that description.

[From the Scientific American, Dec. 20th, 1873.]

A New Fuel--Carbonite.

A new fuel has recently made its appearance in our market, which, on account of its intrinsic value, as well as its novelty, is deserving of notice. Although a natural production, it can hardly be called a coal; and although possessing, to some extent, the properties of coke, it is not produced by any of the methods common to the manufacture of

coke. The proprietors have given it the appropriate name of "Carbonite." It is found to a limited extent in the bituminous coal fields of Central Virginia, constituting a distinct vein by itself, which is now fairly developed, and yielding a steady supply. It is sold in lumps like cannel coal. The surface when broken is dull in appearance, instead of glossy, as in the case with cannel or anthracite coal. It burns with a bright flame when first ignited, and almost without smoke, and subsequently settles down into a bed of bright coals not unlike anthracite in appearance, and at the same time more enduring. It seems to be especially suitable for open grates, and more particularly for parlor use, on account of its freedom from smoke or bituminous smell, and also from the small proportion of ashes (only 2½ per cent) resulting from combusion. The ashes are also of such density that, in the process of stirring or removing, they do not rise the room.

The analysis recently made by Dr. Wallace, of Glasgow, and given below, shows a larger proportion of combustible matter than is found in any known fuel, being 96 per cent that is available for producing heat. It has but a slight trace of sulphur, and is therefore free from the pungent odor and gas incident to anthracite coal. It is superior to any other fuel in the power of producing steam, and may prove especially desirable for steamships making long voyages, on account of its economy of space.

This unique product of the earth is accounted for as follows: Originally a vein of bituminous coal, but lying upon and covered with a fire clay, it appears to have been subjected to heat by an overflow of trap rock on the surface, thereby condensing the gaseous and volatile properties of the coal. A process of nature has thus accomplished, on a grand scale, a more perfect result than is attainable by artificial means, and has delivered for human use a deposit of natural coke, so condensed by the process under which it was formed, as to acquire a specific gravity nearly the same as bituminous coal, and possessing a heating powerfully equal to our best anthracite.

[From the Journal of Commerce, Jan. 16th, 1874.]

A New Fuel

About two months ago there was placed on this market a new fuel known as Carbonite, which is attracting considerable attention as a rival of cannel coal. It is sold by the ton, in lumps similar in size and external appearance to the cannel coal. When broken, the surface fractured is dull, instead of glossy like anthracite or cannel coals. It kindles readily; burns with a clear, bright flame, almost without smoke; and then crumbles into a bed of red coals, which diffuse a steady heat, somewhat less intense than that of anthracite, but lasting longer. On a test made by dividing a grate through the center, and

putting anthracite on one side and Carbonite on the other, with equal draft, the anthracite fire lasted 18 hours, and the Carbonite 36 hours. The Carbonite does not emit the disagreeable odor of sulphur and pungent gases, which is developed by some other coals, and can be used in open parlor grates. The ashes resulting from combustion are about 2½ per cent, of the bulk of the coal, and are of such density that they do not rise through a room when the coals are raked or removed.

It comes from the mines of the James River Coal Company, situated on the north side of the James river, twelve miles west of Richmond. During the last war it was used extensively in Richmond under the name of soft coke. At the close of the war, and when Southern industries became for a time paralyzed, the mines were closed, and became filled with water and rubbish. Recently they have been reopened and worked. The present cost in this market is $11 per ton.

THE JAMES RIVER COAL COMPANY, NO. 111 Broadway, are now prepared to receive orders from dealers for early delivery, at the following prices:

"Carbonite," on board vellel at Richmond,	Gro. Ton.	$6 50
At the dock, N. Y. harbom,	"	9 00
James River Bituminous Coal, on board vessel at Richmond,		4 00
At the dock, N. Y. harbor		6 50

J. H. PRATT, Tresurer,

No. 111 Broadway,

Room E.

New York, March 1st, 1874.

The following persons have used the Carbonite, and are hereby referred to:

ALL RESPECTABLE FAMILIES in the City of Richmond, Va.
(having made use of it for fifty years, in preference to any other fuel).

NEW YORK CITY

Fields & Sherman.....4 Pine st.
Aug. T, Post..... .....25 Nassau St.
W. A. Guest.....17 "
P. Lorillard & Co.....16 Chambers St.
R. A. McCurdy.....62 West 56th St.
O. D. Munn Office Scien, American, 37 Park Row, 14 East 22nd St.
Alfred E. Beach 39 West 23rd St.
John T. Gilchrist.....138 Pearl St.
Dr. L. F. Warner.....39 East 19th St.
Dr. L. V. Sayre.....285 5th St.
Wm. M. Caldwell.....58 East 34th St.
Z. S. Ely.....26 West 26th St.
Samuel Boardman.....20 East 32nd St.
R. L. Schieffelin.....18 East 22nd St.
C. A. Morford.....39 West 17th St.
C. M. Childs.....14 West 20th St.
H. A. Bostwick.....128 West 44th St.
G. S. Rice.....316 Madison Ave.
Frangopulo, Agelesto & Co..... 17 William St.
Wood Brothers & Co.....740 Broadway
M. F. Benton.....130 East 35th St.
E. P. Gardner.....21 West 19th St.
William Caldwell.....324 West 15th St.
J. S. Warren.....15 East 41st St.
S. W. Torrey.....Cor. Lexington Av. and 44th St.
Jesse Oakley..... .....68 West 49th St.
G. W. Cass, Northern Pacific R. R. Co.....23 Fifth Avenue
W. T. Pelton.....15 Gramerey Park
James Colles, Jr.....34 West 30th St.
Thorne, McFarlane & Co.....76 Gold St.
Geo. H. Moller.....6 West 20th St.
Gebhard Fire Insurance Co.....141 Broadway
John B. Scott.....258 West 24th St.
J. B. Simonson.....31 East 22nd St.

BROOKLYN.

J. C. Meacham.....486 Classon Av.
A. W. Humphrey.....71 Columbia Heights.
Rev. H. W. Breecher.....124 "
David M. Stone.....Franklin Av.
Samuel P. Ross.....79 Willoughby Av.
H. E. Simmons.....488 Classon Av.
H. C. Bowen.....90 Willow St.
J. Wintringham.....73 "
John Arbuckle.....82 "
J. B. Greenman.....143 Summit St.
James Sheldon.....151 Congress St.
Charles H. Jewett.....11 Monroe Place
Chas. Jenkins, President East River Nat. Bank.....22 "
Ha. A. Newhall.....61 Irving Place
R. Phillips.....60 Sands St.
C. M. Nichols, Jr.....185 Amity St.
T. Edward Fleet.....880 Fulton Sq.
John Silsby.....103 Gates Av.

MISCELLANEOUS.

Henry White.....Montclair, N. J.
Henry A. Dike..... " "
Samuel Wilde..... " "
S. C. Mount.....Bergen, N. J.
O. Ward.....Jersey City, N. J.
R. B. Campbell.....Mamaroneck, N. Y.
J. H. Whitehouse.....Astoria, N. Y.
W. S. Carr.....Yonkers, N. Y.
Baggs' Hotel.....Utica, N. Y.
B. L. Franklin.....Riverdale, N. Y.
Webster Woodman..... " "
Dr. F. H. Thomas.....West New Brighton, S.
Dr. J. H. Smith.....New Haven, Conn.
James B. Herreshoff.....Bristol, R. I.
Eliphalet Whittlesey.....Washington, D. C.