PRELIMINARY REPORT

CONCERNING THE

RESOURCES OF THE COUNTRY ADJACENT TO THE LINE OF THE PROPOSED

RICHMOND AND SOUTHWESTERN RAILWAY.

BY N. S. SHALER, S. D.

State Geologist of Kentucky.

CAMBRIDGE:

PRINTED FOR THE COMPANY BY W. H. WHEELER,

1880.

INDEX.

As the resources of the country adjacent to this proposed railway have been considered by districts, it seems desirable to give a brief summary of them in a classified form. The reader will find below, in the form of an Index, reference to each of the important resources that will affect the future of this road.

This page in the original text is blank.

PREFACE.

The following report has been prepared in some haste to set forth in a brief way, the general conditions of the district it is proposed to traverse by the Richmond and Southwestern Railway. It should be regarded as a mere preliminary statement, which is to be followed up by a very detailed final report for which the field work is now well under way, but which cannot be finished before the end of the year.

It is but just to myself and to the reader to give some account of the opportunities I have had of becoming personally acquainted with the country adjacent to the line of this road. Some service as geologist in the Coast Survey in the Virginia district, and later, several summers in charge of the work of the Harvard Summer School of Geology, in central and western Virginia, have served to make me pretty familiar with the districts it is proposed the road shall pass through in that State. A service of over six years in charge of the geological survey of Kentucky has brought me into every county of that State which the road will enter. I may fairly say that I have seen a good deal of every natural division of the line. Others have made more detailed studies on particular divisions of the belt than I have been able to make, but my opportunities for seeing the whole line have been better than have fallen to the lot of any other one person.

In the published and unpublished reports of the Kentucky survey, I have repeatedly urged the building of a railway through this belt of country, for the purpose of opening up this region, which, considered from the point of view of its mineral resources, is the very heart of the continent. It has long been clear to me that we have here a remarkable combination of the resources best calculated to make the foundations of rich and prosperous communities: an admirable climate, fertile soil, forests rich in manufacturing woods, and a singularly varied store of mineral wealth. On either side of the great Appalachian mineral and forest belt we have states with large and growing populations, which are just shaking off the lethergy that their old conditions imposed on them. These conditions insure to the road the large traffic that has been given to every railway that has yet been built across the Appalachian mountains. This road will, it seems to me, enjoy especial advantages from the fact that it not only gives access to a region rich in mineral resources, but also affords a very short line from the Mississippi to the sea, over a country where grades are easy, construction timber cheap, and fuel very accessible to the road. The rapid growth of the export trade of Baltimore shows that circumstances are not unfavorable to the shipping of produce from ports at this distance south of New York. The port of Gloucester is one hundred and forty miles nearer the sea than Baltimore, and is very much easier and cheaper of access. With the line completed from the Mississippi to the sea this railway would, it seems to me, enjoy peculiar advantages for the export of a very great range of American products.

I have not ventured to say very much concerning the advantages of the narrow gauge system of railways. This is a matter on which I cannot consider my opinion of value. I can only say that this system is peculiarly well suited for the purpose of developing the mineral resources of the Appalachian district. It is, also, clear to me that the valley of the Ohio has many and is to have many more of these roads, and any trunk line that gives them access to the sea, will, as long as it is the only line of this description, enjoy the monopoly of their trade.

In closing, I wish to affirm my conviction that the belt of country lying between the parallels of 36° and 40°, and from the Atlantic west to the Mississippi, contains the greatest and most varied mass of mineral resources of any equal area on this continent — resources destined to play a very great part in the future industries of this country. This proposed road will have the advantage of following, perhaps, the best possible line through this belt.

N. S. SHALER.

HARVARD UNIVERSITY,
CAMBRIDGE, MASS., May 1, 1880.

This page in the original text is blank.

PRELIMINARY REPORT.

I.

General Account of the Physical Conditions of Railways across the Appalachians.

Some understanding of the general conditions to which railway lines from the Mississippi to the Atlantic coast are subjected should precede the study of the economic resources of the line now under consideration. This understanding can only be obtained by glancing, first, at certain general structures of the continent.

The continent of North America consists, in part, of a wide inland basin occupied in its central and southern portions by the drainage systems of the Mississippi and the St. Lawrence. This basin, containing the largest connected body of arable land in the temperate zone, is separated from the oceans that border the continent on the east and the west, by great mountain systems. That of the Appalachians, on the east, though less difficult to cross than the Cordilleras on the west, is still one of the most continuous mountain systems in the world. On the north, the valleys of the Hudson and the Mohawk give free passages through its wall, but these passages are into the valley of the great lakes and not into the main area of the continental basin. It is only by a considerable detour that access is had to the central regions of the Mississippi valley. South of Albany and north of Chattanooga there there is no break in this line, where the traveler can pass from the Atlantic to the Mississippi waters, without rising about two thousand feet above the sea.

On the Atlantic face of this system is a wide border of plain and low table lands which will always contain a large population that must be closely dependent on the agricultural peoples in the central valley.

The mountain belt that lies between these regions averages about two hundred miles in width. It consists of two essentially different portions, — an eastern and a western section. The eastern is commonly known as the Appalachian range and consists of very old, much altered rocks, granites, syenites, mica schists, etc.; the western and wider section is composed of much newer beds, which extend from the coal measures downwards.

These parallel mountain belts differ in their forms as well as in their rocks. The eastern range is narrow and wall-like, the ruined line of one of the oldest mountains. In it, are many low gaps that give ready passage to roads and streams. In a given distance of a few miles it is generally possible to pass this range, at least north of the Carolinas, without rising more than a few hundred feet above the sea. Between the western flank of the old range and the eastern face of the newer mountains on the west, there is a broad mountain trough, — one of the noblest upland valleys of the world. In New York it is called the Hudson valley, in Pennsylvania the valley west of the South Mountain, in Virginia the valley of the Shenandoah, and in Tennessee the valley of the upper Tennessee. Except when crossed by rivers that cut the eastern range, this valley is a continuous trough, with its floor, in good part, of beds of limestone which furnish a very deep rich soil.

The western range of mountains is much broader than the eastern range. It consists of a great number of parallel ridges that rise to a height of about four thousand feet above the sea. These have but one break, through which water runs, in the whole line from New York to Georgia, and this, the New river, practically affords no line of passage through this chain on account of its tortuous and northward course.

In Pennsylvania and the northern part of Virginia these mountains are only rounded in form, like overturned boats: as

we pass south from the Potomac, however, these ridges begin to be broken by long faults, the rocks on either side of the break being forced out of their original positions. As we pass further to the southward these breaks increase in importance, so that from southern Virginia southward, all semblance of distinct folds is lost, and in their place we have a succession of long wall-like ridges that run in the same N. E. and S. W. direction as the ordinary ridges in the northern section. These ridges are much more nearly parallel to each other than in the more northern range of mountains. They are oftener cut through by streams, as, for instance, by the branches of the New River and the Tennessee; and through their numerous gaps it is easy to make a general easterly and westerly roadway, with less tunnelling than in the ordinary mountains of Pennsylvania.

Although these two mountain ranges are a considerable obstacle to water communication between the coast region and the Mississippi valley, they are, in the physical resources they afford, of immeasurable value to the whole country. It is well known that mountains differ much among themselves in the extent to which their soils are barren, though the Appalachian mountains, from the Potomac southwards, have less of the disabilities ordinarily found with mountains than any other such structures that are known to me. North of the Potomac, where these mountains have been recently (in a geological sense) ground over by the glaciers, their surface is generally too rude for agriculture, owing to the small amount of soil upon them and the coating of boulders that lies upon their surface; but as we pass south of Maryland the ice sheets only crowned the highest hills, and along the line of the Richmond and Southwestern Railway there is scarcely a trace of this ice work. The slow decay of many geological periods has accumulated a deep coating of soil upon the highest, and often upon the steepest hills. This soil bears heavy forests of varied hard wood timber, with some areas of yellow pine upon the higher ridges, and of hemlock along the mountain streams. Not one per cent of all this mountain surface is without a forest covering except where it has been removed by man.

The same quality of soil that gives heavy forests on this belt makes the greater part of its surface fit for tillage. All through this region extensive settlements of farmers may be found, on the very tops of the highest ridges, at heights of two to four thousand feet above the sea. In this regard the region south of the Potomac is in marked contrast with the region to the north of that line, for the mountains are generally untillable, either from the poverty and thinness of the newly made soils, or from the thick covering of boulders that lies upon them. The same cause diminishes the size of the forests, which are not nearly as good in that region as in the country to the southward.

I am satisfied that the average agricultural value of the mountain belt between the Potomac and the North Carolina line is nearly as great as the average of the Ohio valley.

Although the food producing capacity of this district is a matter of importance in considering the prospects of its future, it is not in the resources of this character that we find the element of greatest interest to the economist. Its economic future lies in the fact that it is the richest field of mineral wealth known in any country. Placed between the agricultural districts of the Atlantic slope and the Mississippi valley, these vast stores of coal, iron, copper, zinc and other mine products are admirably situated for the use of the populous states that are now growing up in those sections. No one can doubt that this peculiarly fortunate relation of rich mineral resources to the rich tillage soils of this continent will lead to a great commerce between the two.

The two elements of these mountains, the old Appalachian axis and the newer Alleghany chain, are very happily combined for the commercial future of the regions where they lie and for those adjacent to them. In the older eastern axis and upon its foot hills on the east, we have the metallic products characteristic of the older rocks. Gold bearing rocks occupy a wide area there, and even with the older mining processes in use from 1820 to 1860 many million dollars worth of bullion was produced from them. Iron ores of the magnetite

and specular groups abound here. Extensive deposits of copper, such as those which further south, in North Carolina, are now yielding great profits to the miners, occupy a large field along the main axis of the range. Other metallic products and a great variety of building stones, such as are found among our older or hypogene rocks, abound in this mountain system. In the western, or Alleghany mountains, we have the mineral resources of the newer rocks of the geological series. Coal of fair quality and in great quantity exists along this range, nearly fifty thousand square miles of it, an area at least seven times as great as that of Great Britain — lying in this system, between New York and Alabama. This coal varies from the non-flaming anthracite to the torch-like cannel coal. In the section proposed to be traversed by this railway, the amount of anthracite is quite small and may not be of great relative value, but the less changed coals are practically limitless in quantity and of such varied qualities as to fill all the needs of the arts that depend upon them. In this western belt there are also great quantities of iron ores belonging to the group of clay iron stones (limonites, siderites, etc.), which though lower in their per cent of metal than the older ores, are yet, on account of their close proximity to the coal and of certain peculiar properties they possess, of great value.

This Alleghany range of mountains also contains in its folds and on its flanks, great areas of petroleum, and several levels where waters thickly charged with salt are found. There are also abundant deposits of fire and pottery clays in the coal series. Taken in its entirety, this coal bearing belt is, by the quality of its coals and their fitness for use in all the arts that demand fuel, the richest field in either America or Europe.

Thus we see that the Appalachian system of mountains, while it seems to form a barrier between the plains of the the east and west, is, in fact, a most beneficial arrangement of surface for the whole adjacent region. But for these foldings of the earth's crust, the mineral resources of its deeper beds could not have been made accessible to man.

The peculiar advantage promised by railways across the Appalachians, one that will secure them a certain basis of large profits, is found in these conditions of the mountains they traverse. At either end of the route are vast districts occupied by agricultural and manufacturing populations, which will afford a large and constantly growing market for the products of the mines as they are opened up along the lines. This advantage is shared to a greater or less degree by all the roads that cross both these mountain ranges, from New York southward. The line of the Richmond and Southwestern road has, it seems to me, certain especial advantages over any other, in that it crosses the coal and iron belt at its widest part, where there is the heaviest timber, and where, moreover, the peculiar configuration of the surface is most favorable to the construction of a road with low grades at small cost. Other advantages afforded by this mountain region will be made evident in the further consideration of the subject.

Beyond the Appalachian mountain belt, the line of this road enters into the great plain of the Mississippi river system, and in the five hundred miles of its proposed course in Kentucky, it traverses the eastern half of those rich lands that characterize the Ohio valley.

To show the peculiar advantages of this section, it will be necessary, first, to notice that the regions north and south of the Ohio differ widely in the character of the rocks that come to the surface, and consequently in their soils as well as in their underground productions. North of the Ohio, we have rocks of a tolerably uniform character, lying in perfectly horizontal positions; but from a point a little north of Cincinnati, southward to Alabama, we have a distinct geological ridge that passes through the central portions of Kentucky and Tennessee. This ridge, though it does not appear as a mountain ridge, lifts the whole district of central Kentucky into a table land that averages one thousand feet in height above the sea. It also exposes a lower series of rocks than those that appear on either side of it.

North of the Ohio, the soils have generally been affected by

the drift period, which by mingling the waste of many different regions gives to the soil a rather uniform character. South of the Ohio, the soils are derived from the rocks immediately beneath, and are, on account of the great variety of the rocks exposed by the tilting action of the Cincinnati axis, much more varied than in the northern region. The result is a wide, and on the whole, an advantageous difference in the natural fertility of the various areas of land in this southern district. This difference is marked in the variety and distribution of the timber,—the natural crop of the soil, and also in the tillage crops. The timber along this section is more varied in its species than that along any other east and west line in the district east of the Mississippi. The subsequent chapters of this Report will give more of the details of this difference and show that over thirty species of economic woods are found, in varying quantities, along this line. In the tillage crops we find the same variety. The fact that within the last four decades the United States census show Kentucky to have been at various times the first of the States in the production of corn, wheat, tobacco, and hemp, is a slight indication of the natural variety of the agricultural products within her borders. It is a fact that the variety of crops in this area is greater than in almost any other State in this country, though the State itself has not half the climatal variation that may be found in some others, and its area is much less.

In the central region of Kentucky, after passing beyond the coal bearing series of rocks, the line of this railway descends quickly upon the limestone rocks that underlie the fertile blue grass district of that section. This region includes about ten thousand square miles, an area almost as large as Massachusetts and Connecticut combined, and is probably the most permanently fertile body of land in this country. Many of the prairies are, at the outset, as fertile as the best of these limestone soils, but cultivation soon exhausts their store of phosphates and rapidly diminishes their yield. In this central Kentucky region, the subsoil and the rocks below it contain the same substances

as the soil, and deep plowing will restore worn fields to their pristine fertility. Though manuring is much neglected, yet the soils have not been lessened in their fertility by eighty years of cultivation. I am personally well acquainted with the conditions of the fertile lands of this country and of Europe, and I have never seen another body of land equal to this for the purposes of a cheap and varied tillage.

Passing out of this central belt of the Cincinnati axis, we come upon the western coal field, which, in a remote day, was connected over the central geological arch with the eastern field, but has since been worn away from it. This western coal field is the southward extension of the area commonly known as the Illinois coal field. It includes in Kentucky, an area of about four thousand square miles of country, and though, on the whole, less advantageously placed than the eastern or Alleghany field, it is still the best of the central coal districts of the Mississippi valley; and on account of its position, may be regarded as being as valuable as any part of the eastern field. Owing to the lower level of the surface of the country, which here falls to about three to four hundred feet above the Mississippi and to about seven hundred feet above the sea, the coals of this area are generally below the drainage level of the country, while those of the eastern field are generally above that level; but this, as well as other disadvantages, are compensated for by their close proximity to the waters of the Mississippi, and to the great centres of population that are rising along its course. This region contains about twelve known workable coals, including a total thickness of about forty feet. Amongst these we have cannel of excellent quality, though limited in area, and a considerable variety of bituminous coals, of both the caking and block varieties.

In this area we have also several very rich varieties of iron ore of three main classes, stalactitic, fossiliferous, and black band. Some of these ores have been proven to be of excellent quality for the manufacture of a good grade of iron and steel. They need only transportation to bring them into prominence and to make them the basis of extensive industries. This

mineral belt is bordered on either side by a wide extent of country that must always look to it for those twin staples of modern industry — coal and iron. This advantage it possesses in common with other portions of the Appalachian district; but more fortunate than they, it is swept on the west by all that immense number of navigable waters included in the Mississippi system. It also shares, in a fair degree, the agricultural capacities of the whole region, for though the soils are thinner than those of central Kentucky, yet the majestic forests of white oak which it carries, and the vast amount of tobacco it now produces, sufficiently attest its strength and fertility. Marls, fit for agricultural purposes, are also found in great abundance, though as yet the beds have never been worked.

Compared with other railways, running east and west, across the Appalachians, it may be claimed that this road, whilst it shares with any and all others, the general resources of the Alleghany system of mountains, crosses a wider mineral belt than any other; that the average soil of this mineral belt is better, and, furthermore, that the other sections of the country through which it is proposed to pass, possess a far greater natural range of agricultural products. These and other advantages, however, will be treated more in detail in the subsequent chapters of this Report.

II.

CLIMATE OF VIRGINIA AND KENTUCKY.

The climatal relations of a district give us some of the most important elements of its economic conditions. The district now under consideration consists of several diverse areas, the differences being produced by the various levels of the land above the sea. Along the sea shore, we have a belt of country which may be regarded as extending as far west as Lynchburg, where the general level of the country is less than three

hundred feet above the sea. This is a region the climatal conditions of which are well known. The mountains in this belt are on the whole of temperate heat; snow rarely lies on the ground for more than three or four days at a time, and the ground rarely remains frozen for a longer period. The springs are early, fully a month or six weeks earlier than in New Enggland. The summers are long and rather hot, though the heat of any single days does not exceed that of warm days in northern New England. That this region is on the whole favorable to human life and strength is shown by the excellent condition of the people, who having been for two centuries or more on this soil, furnished as enduring and valorous a body of infantry as fought in the Confederate army. Than this there could be no better test of climatal conditions. In this belt consumption is rather rare. That part near the shore, where there is a good deal of swamp land is somewhat malarious, but even throughout this section there are abundant high lands for residence where settlers can escape this evil. The fever is of a simple type, not worse than that common throughout the States of Indiana, Illinois, Missouri, and Kansas, and settlers readily become acclimated to it.

In the higher lands west of the meridian of Richmond, this disease disappears except in very peculiar positions. On this more elevated land, typhoid fever is the prevailing disease, due probably, in all cases, to carelessness in placing wells near the house drainage. The disease is generally of a very mild form, and although somewhat more prevalent than in New England, does not contribute a larger share to the deaths. No other types of fever of an epidemic character occur here. This somewhat greater liability to fever is more than compensated for by the relative freedom from consumption that characterizes this belt of country. Statistics show that the average death rate in this section is lower than in equal areas in the storm belt of New England. At this distance south there is no necessary process of acclimatizing gone through, by settlers from more northern countries; persons from New England or from Europe, do not find it more difficult to become accustomed to

the conditions than do those who settle in Pennsylvania or New York.

Beyond Lynchburg the country rises rapidly in height until we attain an average elevation of from one to two thousand feet. This brings about two somewhat important changes in the climate. The rainfall rapidly increases, and the average temperature is lessened. The climate, by these changes, becomes admirable in all regards. The greater rainfall causes a more luxuriant vegetation and a greater abundance of streams and springs. It is an assertion that any one conversant with the climatology of this country will warrant, that the elevated level between the eastern face of the Blue Ridge and the upper part of the Kentucky and thence, at the same height above the sea, southward to Georgia, is the most favored region in this country. I have spent a number of summers in this region in the most active out-door exercise, afoot, and have always had with me from twenty to sixty persons, entirely unaccustomed to the climate, mostly students and teachers from the northern part of the northern States, and have never had a serious case of illness in my parties. Twice these expeditions have been in seasons when the towns in the extreme southwest, along the Mississippi, were stricken by yellow fever, and when even the lowlands, exempt from this disease, were suffering from other high grade malarial fevers. These mountain valleys were crowded with fugitives from the infected districts, but in not a single case north of Chattanooga did the pestilence take root, though many persons who came with the disease died of it here. It may well be doubted whether such immunity would have been given to the lowlands of more northern districts under similar circumstances of exposure.

This section apparently enjoys a singularly low rate of mortality from consumption. Statistics are not sufficient to show the full facts, but a long experience in the district and much questioning of the local physicians have convinced me of this fact. As a whole the death rate of this district is low. The State of Kentucky has a mortality assigned to it by the statistics of the last United States census as low as eleven per thou-

sand, which seems almost incredibly small, but there is an apparent justification for the statistics in the large per cent of very old people in this section.

The general character of the climate in this region is well shown by the fact that the section from central Kentucky to Richmond is peculiarly favorable to the growth of apples, pears, and peaches. This assemblage of fruits, when grown as they are here, with peculiar success, is good proof of a climate of a strictly temperate character. Great excesses of heat or cold are certain to render one or the other of them unsuccessful. It is only in a few perfect climates that they will attain their best growth together. The fact that wheat, maize, and oats are successfully grown in every county west of Richmond, is also another though less essential proof of the general goodness of the climatal conditions. But of all the evidence, I prefer that given us by the admirable physical condition of the people whose race has been many generations upon the soil.

III.

POPULATION.

One of the most important questions that presents itself to persons seeking information about the investment of capital in little known regions, concerns the nature and spirit of the people among which they are to hazard their property. It will, therefore, be worth while briefly to consider the character of the population along this section from the sea to the Mississippi.

It is a well known fact that the population of this country has spread itself westward from the original points of colonization on the shore. It has been, however, little remarked that these lines of westward extension have, rarely, crossed each other's track, until after they entered the valley of the Mississippi. It results from this, that the bulk of the population of western Virginia is derived from the colonists who

found their way to her shores. As is well known, this settlement was originally made up of English people from all parts of the mother country. It is commonly assumed that there was a great difference between the Virginia English and those who came to New England, and this difference is indicated by the statement that the Virginia element was cavalier, and the New England, roundhead or puritan. This tradition embraces a grain of truth, though it is a fact that the bulk of both populations consisted of middle class English of rather puritanical humor, drawn from the same great substratum of society that gave strength to the mother country. The greatest difference, perhaps, was that Virginia had rather more of the rural population and New England rather more of the town people of the mother country among their first settlers.

At the close of the Revolutionary war, Virginia ceded her rights in the northern part of the Mississippi valley to the Federal government, reserving only the district of Kentucky for her own citizens. A large part of this reservation was issued to her soldiers who had survived the war of independence, and who still were willing to continue their battles in the struggle with the wilderness and the Indians. From 1789 to the early years of the nineteenth century, this western emmigration of the Virginia soldiers laid the foundations of Kentucky; so that this State had its beginning made by a very vigorous population. To this original frame-work some additions have been made by chance immigrations. From the Pennsylvania Germans a considerable body of immigrants came into the valley of the New River and the upper Tennessee. From easternmost North Carolina, also, some blood has been derived. Fortunately this is not large in amount, as this population, from its peculiar history, furnishes much less satisfactory material, of out which to make a State, than any other in this belt. Between Lynchburg and the Kentucky line there is a large admixture of Scotch and Scotch Irish. These originally settled in Rockbridge and the neighboring counties, and have spread westwardly. It is unnecessary to say that this element affords admirable material for citizens. In Kentucky is found

the same essentially British blood, probably ninety-five per cent of the whites being of that strain. The admixture is, principally, of Pennsylvania German, recent German immigrants to this country, and about the towns, a sprinkling of Irish. As we pass west of the Tennessee and Nashville Railway, the population is more heterogeneous, resembling in this respect the other populations of the west. Its general vigor is shown by the appended table which gives the measurements of Kentucky and Tennessee troops in the Union army.* It should be remembered that these Union troops did not, on the whole, represent the population from the richest soils of these States, and they are, therefore, rather under than over the average of size of the natives in this region. This table makes it clear that the population in this district is of more vigorous mould than any other people in this country or Europe.

---

* TABLE OF MEASUREMENTS OF AMERICAN WHITE MEN,

COMPILED FROM REPORT OF THE SANITARY COMMISSION, MADE FROM MEASUREMENTS OF THE UNITED STATES VOLUNTEERS DURING THE CIVIL WAR.

BY B. A. GOULD.

Mean height by nativities.		Mean Weight by Nativities.	Mean Circumference of Chest.		Mean Dimensions of Heads.	Proportional number of Tall Men in each 100,000 of same Nativity.
Nativity.	Height in inches.	Pounds.	Full Inspiration in inches.	After each Expiration.	Circumference around the forehead and occiput in.	
New England	67.834	139.39	36.71	34.11	22.02	295
New York, New Jersey, Pennsylvania	67.529	140.83	37.06	34.38	22.10	237
Ohio and Indiana	68.169	145.37	37.53	34.95	22.11	486
Michigan, Missouri, and Illinois	67.822	141.78	37.29	34.04	22.19	466
Seaboard Slave States		140.99	36.64	34.23	21.93	† 600
Kentucky and Tennessee	68.605	149.85	37.83	35.30	22.32	848
Free States West of Mississippi River	67.419		37.53	34.84	21.97	184
British Provinces, exclusive of Canada	67.510	143.59	37.13	34.81	22.13	237
Canada	67.086	141.35	37.14	34.35	22.11	177
England	66.741	137.61	36.91	34.30	22.16	103
Scotland	67.258	137.85	37.57	34.69	22.23	178
Ireland	66.951	139.18	37.54	35.27		84
Germany	66.660	140.37	37.20	34.74	22.09	106
Scandinavia	67.337	148.14	38.39	35.37	22.37	221

† Slave States not including Kentucky and Tennessee.

It remains now to speak of the Negroes in these States. This part of the population is very irregularly distributed: between the shore line and Lynchburg it constitutes nearly one-half of the total number. From Lynchburg west to central Kentucky the average is probably not more than about five to eight per cent of the whole population. In central Kentucky the blacks are much fewer in number than in eastern Virginia, constituting, at present, only about fifteen to twenty per cent of the population. From the Louisville and Nashville Railway to the Mississippi, they are not more numerous than in the section from Lynchburg to central Kentucky.

All persons who know the south will agree that the Negro population of Virginia and Kentucky constitutes the best part of their race. The reason for this evident superiority of the blacks in those districts, is to be found in the fact that, in the old days, these States were slave exporting countries. When the question came of selling a part of the slaves of a plantation, it was, naturally, the custom to dispose of those who were the least satisfactory. This method of selection, in time, served to retain the best strains of Negro blood here and to remove the poorer to other States. Moreover, slavery in this region was generally household slavery, by which the Negroes were brought in close relations to the masters and were elevated by the contact. The result is that the blacks in these States are on a distinctly higher level than in planting States to the south. A long and careful study of this element of the population has convinced me that it is steadily gaining in all the qualities that go to make good citizens, and that it will not in the future be any hindrance to the advance of this region. It may be noted also that the Negro is irresistably attracted to the towns, and there falls into domestic or semi-domestic service. It now seems pretty certain that in this part of the old territory of slavery, the Negro is not likely to increase in numbers, and that with the growth of population he will soon be forced to occupy a very subordinate place. Along with these considerations of the existing populations, it is worth while to give a brief ac-

count of the recent immigration into this belt of country. Before the war, slavery was a natural bar to immigration. Owing to the peculiar disruption of society in the south in the years just succeeding the war, and also to the period of commercial depression just past, there has been but little movement of population to these areas during the last score of years. There has, however, been a certain amount of ingress from the north and from foreign countries, which is chiefly valuable as showing that there is no natural barrier to this movement. A number of English of the better agricultural class have made their homes in the Piedmont region or in the belt between the Blue Ridge and the tide water country. A considerable stream of immigration has also set down the Shenandoah valley from the central district of Pennsylvania. In Kentucky the larger part of the large gain in population, during the last decade, is due to the immigration of persons from beyond the seas, principally Germans. There are some counties in the State where from five to twenty-five per cent of the population is of German birth.

The general condition of the governments of these States is good. Virginia has an excellent reputation for the proper administration of a stringent general code. The financial condition of the State is, it must be confessed, unsatisfactory; but it has been clearly shown that the State, even in the present undeveloped condition of its great resources, can pay the interest on its debt, and in time extinguish the principal. All the intelligence and honor of the commonwealth are pledged to maintain its credit, and they have so far succeeded in balking the efforts of those who would needlessly and ignorantly debase its good name. The plan proposed by the debt payers contemplates no heavier burden of taxation than that borne without difficulty by many other commonwealths. Kentucky is essentially without State debt. State taxation is very low, and the county debts, with few exceptions, inconsiderable. Public report has not given the State a good name for the law-abiding qualities of its citizens. A careful consideration of the facts justifies me in saying that, on the whole, the State compares

well, in this respect, with any population of equal size elsewhere. At the same time the reputation for a certain willingness to take life is not altogether undeserved. It should be noticed, however, that nearly all the homicides in the State are between men who choose this method of settling their quarrels, and who regularly notify each other of their intention to end disputes in this way. It is in fact a survival of the duel, and will doubtless soon be a thing of the past. As against this prevalence of bloody combats between enraged men, we may fairly set the fact that murder for money is exceedingly rare and is punished with the utmost severity, and that crimes against women are almost unknown. The bloodthirstiness is a relict of the old combative life of men bred in the wilderness, who regard themselves as the individual sources of all law, and is not in the least degree menacing to the quiet man. If any further light is needed on this point, it may be said that all the statistics obtainable go to show that deaths from violence are not more common here, in proportion to population, than in Massachusetts or New York; and that while it is difficult to get a jury to convict men who have given each other the chance of battle, the law goes very hard against him who kills for gain.

The greatest disadvantage that is urged against the rural districts of these States is the lack of good schools. This evil is no greater than in other regions where the population is as sparsely scattered as it is here, and is, in fact, a necessary consequence of that very sparseness. There are only three or four States in this country that give, through their general government, as much for school purposes as is given by Kentucky, and any local community here will be less taxed than in most other States to supplement this gift. In Virginia the school system, though wrecked by the war, is fast reviving. This State, in the times of direst need, has given liberally to its institutions of higher learning. Those excellent schools, the University of Virginia and the Military Institute, are mainly supported by State appropriations.

IV.

SYNOPSIS OF THE RESOURCES ALONG THE LINE OF THE RICHMOND AND SOUTHWESTERN RAILWAY.

We will now take up in detail the several natural sections of this line, and consider their relation to the resources in soil, timber and minerals of the regions through which they pass.

This line naturally divides itself into several distinct divisions limited by the geography of the regions they cross. First, we have the section from the sea port of Gloucester to Richmond, which we may term the tide-water section, adopting the name that in Virginia is commonly given to this belt. Next, we have the section from Richmond to Lynchburg, which may fairly be called the James River section, from the fact that it lies altogether in the basin of that river. Next, the section through the Blue Ridge to the waters of the Clinch, which may be termed the Blue Ridge section. Then, the section from the waters of the Clinch to the central district of Kentucky, which we may designate as the Cumberland section, from the fact that it crosses the northern end of that mountain, and finally, there is the division from central Kentucky to the Mississippi, which, from the fact that it lies in western Kentucky, may be called the western section. All these sections have some distinct features that deserve special consideration.

The statements given in connection with these sections of the road are for the most part the result of my own observations; when taken from other authorities the source of the information will generally be given. It should be stated that a report on the resources of the line, which will furnish geological facts in great detail, is now in preparation.

The Tide-Water Section.

This section includes a belt of low lying deposits of tertiary age bordering the granitic rocks, the worn down outliers of the

Blue Ridge. So far, there have been no deposits of a valuable sort found beneath the soil in this section, nor is it likely that any such will ever be unless, perhaps, of workable marls for manuring purposes, and of clays for brick or pottery uses, which here, as elsewhere, are found in this series of rocks.

The soils in this belt are generally sandy loams of a light, easily tilled nature, which, though quickly exhausted by a careless system of cultivation, are yet valuable for certain crops. In a general way, the soils closely resemble those of New Jersey, which though long neglected, are now much valued for market garden purposes. They are in the main composed of the waste of the Blue Ridge range, and though not suited to the rude husbandry to which they were subjected in the old days of slavery, are well adapted to careful tillage. Very similar soils in the neighborhood of Norfolk have proved admirably suited to hand tillage.

From Mr. Jed. Hotchkiss, to whom I am indebted for a great many of the facts stated in the following pages, I have the statement that the blue, white, and greensand marls abound in this section. The carriage of this latter marl should furnish here, as it does in New Jersey, a large amount of transportation, for it is admirably fitted to enrich the soils along the line of road to the westward.

James River Section.

Near Richmond we pass out of the tertiary rocks of the tide water region. The general position of this transition may be traced on the maps by the heads of the broad inlets that intersect this part of the coast. All the great sounds and bays of this coast end at the easternmost outlier of the Blue Ridge, which is, geologically, a mountain axis of granite and allied rocks, that has been planed down to the general level of the country by the agents of decay. This granitic axis, wherever exposed, as is only the case where the larger streams cross it, can furnish good building stones, of kinds now extensively

used in Washington and elsewhere, and which are essentially like the Quincy or Cape Ann syenites. This granitic ridge is not very wide. On its western slope it includes a number of troughs and folds of newer rocks, which, generally, are of an age only a little less than those that make up the easternmost ridge of the system. They are principally of low hills, highly metamorphosed, micaceous, and chloritic schists, some of which rise to the height of five or six hundred feet above the level of the sea. Their mineral contents are various and valuable. Many gold veins are found in this section, some of which have yielded largely. In Goochland and Buckingham counties, where the gold belt is about fifteen miles wide, there are a dozen or more of these mines. In most cases these ores were long ago worked down to a point where the gold ceased to be "free," and passed into the state where it was held by iron pyrites. The old methods of working these iron pyrites were so imperfect that a large part of the gold could not be extracted. Many of the heaps of tailings that lie about the old mines are worked over and over again by the country people with profit. It is believed by many who have carefully examined this field, that, owing to the improvements in mining, the present efforts to reopen these mines will meet with success.

This belt of gold-bearing rocks is the same that extends southwards from the Potomac through the Carolinas and into Georgia, and the promise of the mines in this section of Virginia seems fully as great as in those States.

In this section we have also several coal basins belonging to the triassic or jurassic age, a period subsequent to the true coal time, though the coal making conditions were still active. These basins occur in Goochland and Buckingham and some other counties. They have been little explored except at two or three points, but enough has been done to show that coal of valuable qualities may be had from them. In the district on the south of the James River, near Richmond, these basins have for many years yielded large quantities of good coal. They have been worked to greater depths than any other of our coals outside of Pennsylvania. Indeed, their

depth beneath the sea exceeds that of any other American coal mines. Though the fact that these coals have to be worked below the water line, together with the great dislocation they have suffered in the mountain building movements of this district, diminishes their economic value, there can be no doubt that their good gas and cokeing qualities, and their nearness to tide-water, will make them valuable in the development of the country. There is, also, in these basins a bed of what is called natural coke, that promises to be useful for smelting purposes. These coal basins are small, but there are a good many of them. Probably there are many in this district that, owing to the depth of the detritus and the thickly wooded nature of the country, have not yet been discovered. In its course, this road will pass within a few miles of two or three of these known basins. Professor W. B. Rogers, late State geologist of Virginia, calls attention to the occurrence of excellent iron ores in connection with these coals. One analysis shows 85.15 per cent of peroxide of iron and only fifteen per cent of silica. I am not certain, however, that these ores have ever been brought into use.

In this district we have, also, some deposits of copper pyrites that has been already marketed in small quantities; and it is possible that they may be found to be of considerable value. A large part of the copper marketed in the first half of this century from the mines of Canada, Tennessee, Pennsylvania, and Europe, are from this class of ores. In this section, especially in Goochland county, we have deposits of iron ore, plumbago, and asbestos, that await further developments before their commercial value can be ascertained. Beds of excellent slates occur in this district. Mr. Hotchkiss states that an extensive experience in their use shows them to be of the very best quality. In the western half of the section, from Richmond to Lynchburg, there are extensive deposits of magnetic and specular iron ores. Professer Rogers describes one bed which has been traced for seven miles along its outcrop, and which, at one point, showed over fifteen feet thick of good ore; limestone fit for fluxing is found in close juxtaposition with

these iron ores. I know of no undeveloped part of this country that promises the variety of mineral resources that are found in this district. Some of them may prove valueless, but as a whole, it is only a question of time when many of them will be developed. The iron, coal, and gold mines I feel sure will at once prove their value to a railway either in the transportation of their products, or in increasing the population of the region along the route. The value of the other mineral products is a matter for the future to determine.

The soils of this section contain much more clay than those of the tide-water belt. They are derived from the decay of the ancient rocks of this district. In a general way they resemble those of the whole Piedmont region. In many cases, a vicious system of agriculture, neglect of manuring, and long continued cultivation of exhausting crops have damaged the old farms. But owing to the fact that these soils are immediately derived from the rocks that lie below them, deep plowing and a little care, such as is already shown in the improved system of agriculture now practised in Virginia, will speedily restore them to their original fertility. The general nature of the soil is essentially the same as that of the upland fields near Philadelphia and along the South Mountain, where careful farming gives admirable returns. The timber of this region is of fair quality. There is abundant material for railway construction, and in the forests, away from the river, much that would be available for shipment. The forests in this section, as in most of the central part of the Appalachian mountains, are self-preserving in so far as the same original species of forest growth are constantly renewed; and hence the land not given up to tillage bears a constant crop, with a rate of growth somewhat more rapid than in regions further north.

The agricultural products best suited to this region are tobacco, maize, flax, fruits, such as apples, peaches, and pears, all of which are peculiarly successful on this belt of soils. It is in places, also, fairly well fitted for the growth of small grains. It is in the northern edge of the cotton belt, and will

in time, as the southern fields become more occupied, doubtlessly produce a considerable quantity of this staple, but at present this product cannot be reckoned on as an element in its exports.

This region is extremely well watered, being traversed by many streams, and the local sources of water supply are abundant and of excellent quality,—as they are in all granitic countries. The annual rainfall is about forty-five inches. The winter season is not cold, the average winter temperature being 57° F., while in central New York it is 45°. Snow falls during the winter, but it is rare that it lies on the ground for more than a few days. Maize is commonly planted in April. The average summer temperature is 75° F., and the first frosts commonly do not appear until October. The general conditions are such as to give a very healthy climate that well combines the good features of those to the north and the south. The soil is capable of sustaining a population several times as great as that which now dwells upon it, and the mineral deposits offer the basis of extensive industries. This section of the road, moreover, connects the two largest cities in the State — Richmond and Lynchburg — by a more direct route than that offered by any existing railway.

Blue Ridge Section.

This section leaves the eastern outliers of the Blue Ridge and climbs the main axis of that chain. The increase of height is on the average not far from one thousand feet over that of the preceding section. Though the range of height is considerable, the highest points on the line rising above two thousand feet above the sea, the first thirty miles or so of the line lies in rocks of essentially the same general character as those of the section from Richmond to Lynchburg. These rocks are of the earlier geological formations, being principally highly metamorphic mica schists and slates, quartzites, etc., and in general aspect like those of the South Mountain in Pennsyl-

vania or the Berkshire hills in Massachusetts. The general topography is much like that of the last named region, except that the belt of highlands is narrower and the transverse valleys are more deeply cut into the range.

The isolated groups are higher and have rather freer forms owing to the comparative immunity from the action of glaciers. As yet little is known of the detailed geology of this ridge, especially of its economic features. This same ridge, however, in the regions to the north and south of the place where this line crosses it, contains an abundance of copper ores of somewhat peculiar character. They are epidotic rocks carrying from one or two to ten per cent of copper. So far, these copper ores have never been reduced, but there is reason to believe that with the increased demand for this metal it will be found profitable to work these beds. I do not know of any deposits near the line of this road, but the plentiful occurrence of copper ores at other parts of the range leads me to hope that they will be found, also, in this very similar section. The iron ores of this section form numerous and extensive deposits. They lie on the west flank of the Blue Ridge range, in the rocks of Palæozoic age that make up the floor of the great Appalachian valley. Professor W. B. Rogers, in his reports on the geology of Virginia, says: "Of the twelve rocks, each marked by certain distinctive characters, composing the mountains and valleys of this region, it has been determined that at least eight are accompanied by beds of iron ore; each one has distinctive marks by which it may be recognized, and peculiarties of composition fitting it for certain uses to which others would be less happily adapted."

These iron ores consist of several distinct classes near the Blue Ridge, and especially in the southern tier of counties of the State where these ores are much metamorphosed by the changes produced by heat. In the foot hills, on the west side of the Blue Ridge, many very extensive deposits of brown hematite, derived from the decay of the other classes of ores, have been found; in fact they occur, from point to point, along the whole of this belt. In the Appalachian valley,

there are deposits containing sulphurets and carbonates of lead which have been worked, in Wythe county, for more than a century. Hotchkiss estimates that these mines have yielded about 25,000,000 pounds of metal. Zinc ores have, also, been mined to a certain extent. This set of rocks is traversed by the proposed line of road to the westward of this locality, but I deem it not unlikely that they will be found upon the line of the road where it crosses the junction in Bottetourt county. At any rate, the proposed narrow gauge road up the New River will bring the Richmond and Southwestern road into connection with this field.

In the course of the road through Bottetourt, Corey and Giles counties, it passes near the belt of semi-bituminous or semi-anthracite coals, that form a remarkable feature in this district. These coals are the southward extension of the anthracite belt of Pennsylvania, and owe their anthracite character to the same conditions that have made the similar deposits of eastern Pennsylvania. As a whole, these beds are thinner and much less valuable than those of Pennsylvania, but as there are about one hundred square miles of them in the long narrow basin, and the coals in some are of fair quality, there is reason to believe that they will prove valuable for smelting purposes and in the reduction of the other ores of this region.

Rogers gives the following analysis of some anthracite from Montgomery County: —

Carbon,	80.20
Bitumen,	13.60
Ash,	6.20

From Bottetourt County: —

Carbon,	78.80
Bitumen,	16.20
Ash,	5.

In Washington and Wythe counties, which lie to the south of Tazewell and Russell, through which this road runs, there are extensive deposits of gypsum, which as yet have been but

little worked. These deposits, in time, are certain to furnish a very considerable export of this valuable fertilizer. In natural relation with these gypsum deposits, we find extensive masses of salt which lie at about two hundred feet below the surface. At Saltville, in Wythe county, this deposit has furnished the brines for a long continued production of salt. It is said that the bed of rock salt from which they flow has been penetrated to the depth of one hundred and seventy-five feet without passing through it. A short branch from the Richmond and Southwestern Railway would furnish this district with much needed fuel in the shape of cheap coal, and at the same time give the road access to the salt and gypsum of this section.

At or near Tazewell Court House, the line of this road enters the valley of the Clinch River, and comes into contact with the peculiar iron ores of the Clinch and Powell's valleys. These ores are, in the first place, the "fossil ores" or dyestone ores of the Clinton limestone, and are similar in position and somewhat, in general character, to the Clinton ores of New York and Pennsylvania. Although undeveloped in this region, there is reason to hope that they will be found in workable form in Clinch Mountain, and Birch Mountain, though their best development is on the waters of Powell's River, a branch of the Clinch. To pass through Pound Gap, this road would naturally leave the main valley of the Clinch at the mouth of Guests River, following up that stream to near its head. If this route be taken, it would be necessary, in order to obtain access to the best parts of this iron field, to build a branch through the gap at the head of Powell's River, and thence southward as far as Pennington Gap, or even as far as Cumberland Gap. The whole of Powell's valley is very fertile, limestone land, so that there would be an agricultural basis for such a road, though access to this set of ores should be the main aim of such a branch.

The peculiar advantage of these deposits is the large extent of country underlaid by them, the ease with which extensive areas of ore may be obtained by stripping or shallow mining,

and the proximity of coals that can be easily worked in the furnace, even, as I confidently believe, without caking.

These ores have been fully proven by the local furnaces, one of which, a small Catalan forge, has for years furnished a large county with a very good iron; another, an ordinary furnace at Cumberland Gap, has at various times marketed a good quality of product in Chattanooga. Moreover, these same ores are extensively used at Jacksboro and in other Tennessee furnaces. The following analysis will show the general character of the ores. They are made from carefully arranged samples taken by the officers of the Kentucky Survey. (See appendix.)

The considerable per cent of phosphorus in these ores seemed at one time to make them less desirable than many other ores for making the most valuable iron, but some recent improvements in the construction of furnaces does away with this objection. The singular continuity of this deposit gives this valley an eminent advantage for this industry. I have examined many points between the gap at the head of Powell's River and Big Creek Gap of the Cumberland Mountain, a distance of about one hundred miles, and have never failed to find this ore in workable quantities. I believe that it forms nearly, if not quite, a continuous belt for this whole distance, and that it may practically be regarded as workable for the whole of its line of outcrop. Through Big Creek, Pennington, and Big Stone Gaps, ready access, by grades not exceeding sixty feet to the mile, may be had to the unlimited deposits of varied coals in the four thousand feet of coal measures that lie in the upper Cumberland trough. At Cumberland Gap a short and easily made tunnel will also give access to this admirable coal field. The coals at the base of this series are dry and block like. On the Ohio River, coals of the same level, which, closely resembling those from the Cumberland section, are extensively used in their raw form in the iron furnaces with perfect success. There is, therefore, great reason to hope that a like result may be attained with the similar coals in this district. The coals from the same level at Jacksboro, Tenn., much nearer this district, are extensively used in the manufacture of

iron, and it is claimed that this iron can be marketed at a less price than that of as good quality from any other district in this country.

In addition to this fossil ore on the west side of the valley, a similar deposit occurs in the rocks of the same age on the east side of the river. I do not know that this eastern face of the valley holds the ore in the same abundance, but I see no reason why it should not be of equally good quality.

This district also affords satisfactory fire clays and limestones for furnace use. The main stream of Powell's River is of sufficient size and permanence to furnish good water powers, which may be used for the purpose of blowing furnaces, thereby dispensing with steam power if it is desired. Extensive timber grounds for the making of charcoal exist on the flanks of the Cumberland and Powell's Mountain. The timber is self-renewing, and the land covered with it can be bought at nominal prices. On the whole, I do not know of any unoccupied district in this country so well suited for the making of cheap iron as this valley affords. Labor of fair quality exists in abundance; the valley has an admirable climate for all forms of industry; the heats of summer being modified by its elevation and the near presence of high mountains, while the winters give no extreme cold.

Kentucky River Section.

Between the mouth of Guests River, on the Clinch, and Richmond, Ky., on the edge of the blue grass district, we have the southward extension of the great Alleghany coal field. This district, though laid down on our maps as mountainous, is, in fact, a region of tolerably elevated table land. The rocks have been affected by mountain building forces at only one point, viz., at Pine Mountain. Except for this narrow ridge, the rocks lie with a gentle, scarcely perceptible, depression to the east, a slope that does not exceed, on the average, but thirty feet to the mile. The upper surface of

this table land lies about two thousand feet above the sea; it is intersected by the very numerous ramifications of the streams that form the headwaters of the Kentucky, the Cumberland, the Licking and the Big Sandy or Chatterawah Rivers. These streams abound in small branches with narrow, flat, and not very tortuous valleys. The bottoms of these valleys are generally four or six hundred feet below the summits of the hills. This disposition of the surface is very favorable for giving ready access to the mineral stores of the hills. Although the larger part of the coal in the central portion of this basin, lies below the drainage level, yet in these belts there are generally three to five workable beds of coal which may be explored without pumping and hoisting machinery, and where the product will descend by gravity to the floor of the valley.

The coals in this district are of the same general character as those that have won a great reputation in West Virginia, Pennsylvania, and Ohio. In the total section of between three and four thousand feet, about twenty levels of workable coal have come under my observation, but from the fact that the region is very nearly a wilderness, where there has been no local demand for these coals, I am justified in believing that not half of the workable beds have yet been found. Beds of coal are generally softer than the rocks that enclose them; therefore they retreat into the hillside, under the action of the frost and rain, and become covered by the waste of the overlying harder beds. In this way, even in countries long explored by mining operations, coal beds frequently escape observation.

This question of the number of beds has, however, no practical importance; there is enough in the known beds of coal in this district to supply any demand that can be made upon them for centuries to come.

These coals are of two different qualities, ordinary bituminous and cannel. The ordinary bituminous varies a good deal in its properties. In part it is a caking or coking coal, *i. e.* a coal that runs together when heated. This is marketable for home purposes and for use in generating steam in ordinary

furnaces and for gas or coke making. In part it is a non-caking coal, and is not fit for making gas, but has especial fitness for use in furnaces or for generating steam in locomotive boilers, where coals that do not run together are desired. The latter class of coals seems to be more common near the base; the former abound in the upper parts of this section.

The central part of this field, including the greater part of Breathitt, Perry, and some of the adjacent counties, contains a large cannel coal field, in which are found one or more beds of this quality of coal of remarkable thickness and purity.

It is now well known that these cannel coals were formed in the lakes that were enclosed in the swamps of the coal period. These lakes were generally of small size, and passed by insensible gradations into the swamps on either side, so that the cannel coals that were formed from the mud accumulated in these waters passes generally into ordinary bituminous coal on either side. It results from these circumstances of their formation that cannel coals occupy, in most cases, a very small area compared with the larger limits of a bituminous coal field. This cannel coal field of eastern Kentucky probably covers an area over three thousand square miles, and is much the largest known to me. This peculiar sort of coal has always commanded a higher price than the ordinary bituminous coals of this and other countries. A cannel coal of no better quality than the best from this region now retails in the Boston market for sixteen dollars per ton. This coal is brought from Wales. In the New York market, on February 27, cannel coal from Cannelton and Peytona mines of West Virginia was quoted at ten dollars per ton, while the best anthracite coal was held at four dollars per ton.

These cannel coals are used, in part, for gas making and for domestic use in the open hearth. Experience shows that they can be sold for at least one-fourth more than the ordinary bituminous coals in all the markets of the Ohio valley, and that the demand is indefinitely large. In the coal areas of the upper Kentucky they can be mined at no greater cost than ordinary bituminous coal, or for less than one dollar a

ton. The waste in handling is less than that of the bituminous varieties, and it keeps well without housing, as it does not slake from the action of rain and frost.

I regard access to this cannel coal field as one of the greatest advantages that will accrue to the Richmond and Southwestern Railway, for it ensures the road a coal that can stand the cost of a long transportation and still be marketed at a large profit. Nor do I regard the conceivable risk of a cessation of the demand for it in the manufacture of illuminating gas as seriously threatening the market, as it will always have the preference for domestic use in the grate or open hearth, for which its cleanliness, bright flame, and great heating power especially adapt it.

The iron ores of this valley have, on account of its isolation, remained essentially unexplored. Near the western part of the coal basin, there are, however, at least two horizons of valuable ores, both of which have been extensively proven by practical and extensive tests. The first of these is encountered where the road will pass near Miller's Branch of the Kentucky, between Beattyville and Irving, in Estelle county. This ore lies on top of the sub-carboniferous limestone, and is commonly termed a limestone ore. This deposit, apparently, is co-extensive with the top of this limestone, and thus underlies a very broad field in eastern Kentucky. For many years it has been used in the manufacture of excellent charcoal iron, which has found its way out to Mount Sterling by wagon over difficult roads, or to Louisville, by the more difficult and precarious route of the Kentucky River. The Red River, Estelle, and Cottage furnaces represent several hundred thousand dollars worth of furnace property upon this belt of ores.

Below the levels of the last mentioned ore lies the horizon of the Clinton iron ore, so extensively exposed in the valley of Powell's River. In Bath County, Ky., this ore is richly developed, the beds at one point exceeding twenty feet in thickness. It has never been sought for in the valley of the Kentucky River, and whilst it probably exists there, it is doubtful how valuable it may prove. The rocks at the base of the coal field in eastern

Kentucky contain considerable amounts of salt. On the south fork of the Kentucky River the amount is sufficient to afford the basis of an extensive industry. There is reason to believe that this salt horizon extends beneath the whole of this coal basin, but it is not yet known over how large a field it is likely to furnish brines strong enough to prove profitable.

Several explorations have been made in the rocks of this district for petroleum. It does not seem very likely that it will be found here in the same level in which it is found in Pennsylvania and western Virginia. Below that level, however, separated from it by the sub-carboniferous limestone, we have the horizon of the Devonian Black shale — the Ohio shale of the Kentucky deposits. This shale is probably the source of a great deal of coal oil, and from it probably comes that which is found near the Cumberland River in Clinton and adjacent counties. We are not yet certain just what are the conditions that favor the formation and storage of petroleum in this region, but it seems likely that in a wide trough of rocks, such as underlies this basin between Pine Mountain and the central district of Kentucky, the essential conditions for the retention of the coal oil produced by the Black shale will be found. I am, therefore, hopeful that future investigations may discover profitable amounts of petroleum in a lower horizon than it has yet been sought for in this district.

Of less importance, yet not without their value, are the clays suitable for pottery and fire brick that abound in this region, and which are found in immediate connection with many of the coals. These clays are as good as those that are extensively worked in the regions north of this line.

The timber in the belt of country to be traversed by this line constitutes the finest forest of virgin hard wood known to me in this country. It especially abounds in the black walnut, a tree now becoming scarce in all the regions adjacent to railways or other lines of transportation. Besides this valuable wood there are extensive forests of white oak which are also no longer readily accessible in large quantities. There are some areas of white pine which, how-

ever, does not reach its best development in this region, though there are about twenty other species of marketable woods that do attain their best conditions in this belt. A special account of these forests will be given in the final report.

The general surface of this country, though not mountainous, is rough, and whilst but little of the surface is incapable of tillage, a great deal of it consists of steep hillsides, suitable only for grass husbandry or the growth of fruits. Along the streams, there is more or less of level land, and on the hill tops there are extensive areas of excellent soil. Fruits, flax, and tobacco are the products for which these latter are best fitted, and for which they appear extremely well adapted. Small grains are raised for local consumption, but the region is not naturally fitted for this form of agriculture. Nature has meant it for a permanent forest, and in this form of culture it will probably prove, on the whole, more profitable than in any tillage. These forests show a singular activity of growth and quickly reproduce themselves. Some of the old furnaces in this region have been cutting charcoal timber on the same ground for over fifty years. It is found that the woods renew themselves with great rapidity, and in seventeen or eighteen years are again ready for the axe. The greater part of the Ohio and Mississippi valleys are naturally destitute of good timber, and it is to this region that they must look in the future for their supply. These forests should play the same part in the development of the industries of the Ohio that the Black forest does in that of the Lower Rhine. In a few years it will be found that, in timber alone, they will pay better returns than in any other form of cultivation, and that the soil will withstand the exhaustion incident to this crop better than any other. In this way they will furnish exports more valuable for a railway than they can under tillage. This region is naturally well fitted to become the seat of those extensive industries that require wood and iron for their basis, as, for instance, agricultural implements, the manufacture of railway cars, etc.

From this region there is now a considerable export of timber to the eastern States and to Europe. From the Big

Sandy district great quantities of staves for wine casks are sent down the Ohio to New Orleans, and thence by ship to Europe. The furniture and decorative woods, cherry, black walnut, maple, etc., are taken by river to Frankfort and then sent by cars to the east, whence much of it finds its way to Europe. The natural outlet of these woods would be by rail to the sea coast.

On the border of this eastern Kentucky coal and iron district, we have a belt of limestones of the sub-carboniferous age, about two hundred feet in thickness. This series of rocks affords some excellent building stones; and stones suitable for the coarser sort of lithographic printing have been quarried from it in considerable quantities. Near Irving, in Estelle county, there is a mill for the preparation of such stones for the market.

Still further to the west we traverse a belt of black shales known as Devonian or Ohio Black shales. These once furnished a considerable amount of petroleum which was obtained by a process of distillation. On the discovery of great deposits of coal oil, which could be obtained by boring, these shales ceased to be used for this purpose. Should the wells become exhausted, as they most likely will in time, or their production fail to supply the demand, it is to these deposits that we will have to look for the supply of this substance. Beds of this description abound in Ohio and Kentucky, so that this deposit is not a peculiar feature in this region, though it promises to have a value in the future.

Below and further to the west we have, in the upper part of the silurian section, thick deposits of a clay suitable for pottery purposes. In Madison County this clay is now used in the manufacture of ordinary pottery that has quite an extensive sale. A proper mingling of this and the clays from the coal series will make it possible to produce a much greater variety of articles than are now furnished by these potteries. They have made their beginning at great disadvantage owing to the want of cheap fuel and of the transportation which this railway would supply.

A few miles east of Richmond, in Madison County, this railway enters upon the central district of Kentucky, and for about one hundred miles it traverses the richest part of this remarkably fertile area. This portion of Kentucky is commonly known as the "blue grass region," a name given to it on account of the vigorous growth of the grasses known now to botanists as Poa pratense and P. compressa. These grasses occur all over the world, but they find themselves in such peculiarly favorable conditions in this district that they take on a vigor of growth unknown in other lands. The singular success that has been attained in the rearing of high grade horses and cattle in this district is, probably, to be attributed to the nutritive quality of the pasturage that these grasses afford. Large export crops of cattle, horses, mules, and sheep, as well as considerable amounts of grain, hemp, and tobacco, are now produced. The present tendency of the agriculture of this region is to increase the raising of stock, and to diminish the agricultural productions, except hemp and tobacco. As nearly every acre in this central district is good land, this change will tend to increase the production of exportable articles which must, to a great extent, find their markets to the eastward. The amount of these exports in the present condition of production is shown by the fact that the Cincinnati Southern Railway, during the year just passed, when only completed to Somerset, Ky., and therefore not a through line, did enough way business to pay a profit.

There are few agricultural regions of this country where so arge a proportion of the products are calculated to furnish eastward freights. As this section was first of all the districts west of the Alleghanies to be settled, the occupation of the soil is probably more complete than in any other district of equal area in the west; and yet not much more than two-thirds of the tillable ground has been reclaimed from the original forest, and even that is not producing more than one-half what it can furnish with careful husbandry. There is, however, at present a rapid advance in the agricultural processes of this district.

This region is well suited to manufacturing industries. The climate is more equable than that of the most of the Mississippi valley. Its height above the sea, on the average one thousand feet, protects it from the great heats of summer proper to this latitude; and the winters are generally mild and open, though exposed to a sharp cold for brief periods. These conditions of climate favor bodily labor. Along the lines of railways that reach the coal fields, fuel will be cheap, and along such lines manufactures of hemp, cotton, etc., will find suitable conditions for their development.

The mineral resources of this region are very small. There are some veins of lead but they are not likely to prove profitable. Some good building stones are found, especially along the Kentucky River, but these, though excellent for local use, are not good enough to pay railway carriage for any great distance.

The region is more likely to prove profitable to the Richmond and Southwestern road than if it held the same stores of mineral wealth that are found to the east and west of it. It is sure to maintain a large and wealthy agricultural population, which must look for its supplies of coal, iron, timber, etc., to the mineral belts traversed by this railway, and which must receive and send large quantities of freight in its commerce with the eastern districts. At present, coal is the principal fuel used. It comes, in the main, from the Ohio River, down which it is brought from Pittsburg. The average price exceeds four dollars a ton, while the cost of mining and carriage by this road should not, on the average, exceed one-half this sum, as the distance from the eastern coal fields to Louisville, by this line, would be shorter than by any other.

Where this road leaves Louisville it follows the Ohio River all the way to its proposed western terminus. In this course it skirts the western border of the Kentucky coal field and traverses a thickly settled district. From Louisville to the mouth of Salt River, it runs through a low but fertile belt of country that lies upon the upper Silurian and Devonian rocks. At the crossing of this river, it ascends

the steep escarpment of the sub-carboniferous limestone. Through Meade and Breckenridge counties it continues upon this formation, passing in its course some excellent building stones which will repay railway carriage. These stones are varieties of white, warm tinted and grey limestones, and are already in extensive use for building purposes in Louisville, where they are brought from Barren county, a point over twice as far from that market as they are by this line. The best of these stones are rather soft when they leave the quarry but solidify, on exposure, to the hardness of ordinary marble. They are singularly enduring, retaining, after fifty years of exposure, the finest marks of the chisel. They are more suitable for decoration by the chisel than any other stones known to me in this country. In the ease with which they are quarried, their uniform endurance under exposure, and their homogeneous nature as regards color and hardness, they are, in my opinion, superior to any other American building stones. In the rocks beneath this series of deposits, viz., in the Devonian black shale and the underlying sandstones, there is a zone of salt deposits the exact nature and extent of which is not yet known. This zone has already been proven to be of value by salt wells that yield rich brines, and at the same time furnish a supply of gas sufficient to evaporate these brines, thus reducing the cost of manufacture to a low point.

In this section the road passes over a series of soft marly shales that give promise of great usefulness as agricultural fertilizers. They contain considerable amounts of potash and soda, and enough phosphate of lime to add something to their general value. These deposits are sure to be used as sources of manures for the tobacco lands of this State.

In Breckenridge County, this line enters the eastern border of the western coal field, and near the first point of contact it passes the only workable cannel coal area in this western field. This area is not large, probably less than ten square miles, though as yet its full extent is not known; nevertheless on account of the excellent quality of the coal, and its nearness to the centres of consumption, it is certain to prove of great

value. Before the civil war, this field was considerably worked, the product being used for the manufacture of coal oil and of illuminating gas. During the war, the line of railway to the Ohio and the mining buildings were destroyed, and since that time the mine has not been reopened. This railway will nearly touch this property, and the mines can then be reopened at small cost. The coals now used for the purposes to which this coal can be applied are now brought to Louisville from the Kanawha River. It will be a carriage of only about eighty miles by the proposed railway to markets that would probably take one hundred thousand tons of this coal per annum. Should the road be continued along the Ohio River to Cincinnati, carriage to that city would be profitable at a freight rate of one dollar and fifty cents per ton. Careful estimates show that this coal can be mined and loaded for one dollar per ton, leaving a considerable margin on the lowest market price.

Between the line that separates Breckenridge and Meade counties and the mouth of Tradewater River this part of the route of the proposed road passes over the western coal field. West of Tradewater River there are only a few good outliers of this coal field, but in the intervening district it is uninterrupted. As yet it is little developed along this line, but there are several beds of excellent quality that can be easily approached at any point. The bituminous coal of this district is less pure than that of the eastern coal field; it contains more sulphur and more ash, but it is still of very good quality. A large amount of it is marketed from mines along the line of the Elizabethtown and Paducah Railway, which passes through the country at a distance of about fifty miles south of the Ohio. This coal is well suited for domestic and steam producing uses, and can be used to advantage in smelting furnace work after washing — a process that is easily applied to it at an expense of a few cents per ton. Some of these coals make excellent coke without washing. There are no profitable deposits of iron ore known along this line where it traverses the coal field.

When this line passes to the west of the coal field it again encounters the building stones found in the counties of Meade and Breckenridge, but they have not been proven in this district. In the counties of Livingston and Crittenden, are considerable deposits of lead ore and fluor spar. The lead mines have been a good deal worked at various times, and at the present price of lead can probably be mined at a profit.

In the section between the Tennessee and Cumberland Rivers, there are extensive deposits of iron ore of the peculiar quality known as stalactitic ore. These deposits have for many years been the basis of a considerable industry. They are practically in inexhaustible quantities, and recent studies of the ores by the metallurgist of the Kentucky survey have shown that they are of a quality suitable for the manufacture of steel. There are two other valuable iron ore fields at points to the south of this main line, to which access might be had by branch roads. One of these is in Edmonson County, the other in Butler and Muhlenburg counties, on the waters of Muddy River. Both these fields furnish iron ores of high grade; their deposits are in very great quantities and can be easily mined.

In both these regions we have good smelting coals and beds of iron ores of from one to five feet in thickness. The conditions for the manufacture of iron are as good as those found in the Hocking valley, and the products will not be further from the great iron markets of St. Louis, Evansville, and Louisville than are the products of the Hocking valley furnaces from their points of sale. From the line of this road to either of these fields the distance will not much exceed fifty-four miles, and the future of these iron fields is so certain that, notwithstanding this distance, I venture to contemplate the possibility of the construction of branch lines to them. Especially as these branch lines pass through a very good agricultural country.

The whole of the country on the line of this road, between Salt River and the Tennessee, contains agricultural land of good quality. In the main the line is to follow the meanderings of the Ohio River, cutting across some of the more

tortuous bends. In the alluvial plain of the river the land is of very high quality. This belt of alluvial soil varies in width, but generally speaking, it may be regarded as, on the average, about a mile wide, though it gains somewhat as we descend the river. The soil is of great depth and of inexhaustible fertility. Back of this belt we have, in Meade and Breckenridge counties, a set of escarpments generally of high altitude which lead up to the surface of the rolling country that lies beyond the alluvial plain. The soil on these uplands is from the decayed limestone that underlies it, and is of excellent quality though it has been very badly farmed. It brings excellent and varied crops, — tobacco, wheat, and Indian corn being among its staple products. This soil changes its character when we pass from the limestone rocks of the sub-carboniferous to the sandstones and shales of the coal field. Yet the change cannot be said to lessen its fertility in any important respects. As a whole, the soil of the western coal field is much more fertile than that of the eastern. It has an advantage from the fact that in this field the rocks contain a number of beds of limestone which have given their waste to increase its fertility. Moreover, the surface is much less uneven than that of the Appalachian coal field, so that less of it lies at steep angles to the horizon.

Experience has shown that western Kentucky is peculiarly well suited to the growth of tobacco and flax, and is fairly well fitted for the other field crops of the Ohio valley. The district included in the four thousand square miles of this field now produces more tobacco than any other of its size, even though, probably, not one-tenth of the available tobacco ground is as yet in use. Flax is only grown for local use, but a single specimen, sent by an officer of the Kentucky survey to the Centennial Exhibition at Philadelphia, won a high prize for fineness and strength of fibre. Lands are still very cheap, the average price of wooded tracts not being over two and a half to three and a half dollars per acre. It is not uncommon to buy a tract of land and pay for it with the product of a single crop of tobacco.

This section is, on the whole, healthy. It has never been ravaged by epidemics; and the only local disease is malarial fever which prevails along the borders of the streams. In this regard it is no worse off than the adjacent lands in Indiana and Illinois. Of late years some Germans have settled in this section, and they have done well in every respect.

The timber resources of this district are great. It contains the finest body of white oak and hickory trees left in this country in addition to an abundance of poplar, some black walnut, and a great deal of beech and other common woods. The streams are not generally available for transporting logs, and as the railways are few and far between, the timber in this belt has been less culled than in any other hard wood area as near the centre of the Mississippi valley. A glance at the map will show the peculiarly favorable condition of this district for supplying timber to the prairie district of the west. Although this proposed line passes on the outskirts of this great mass of forest, it will be possible, by temporary branch roads of small cost, to obtain access to the timber that is found in great abundance within ten to twenty miles of the river. The character of the surface will easily admit the construction of cheap railways.

This part of Kentucky is the least settled of any part of its territory west of the eastern coal field. This is owing to the fact that it was heavily timbered, while the adjacent regions were prairie-like, the timber having been burned off by the Indians to afford earlier and better pasturage to large game. As the soil of this coal district does not bring as good grass, there was not the same inducement for the aborigines to extend to it the system of firing that led to the destruction of the timber on the so called "Barrens," that existed on the east, south and west. The greater part of the settlements in this district, away from the Ohio River, having been made within the last forty years, the soil still remains more nearly virgin than in any other part of the State west of its mountain district.

West of the Tennessee River, this railway will enter upon a belt of tertiary deposits, of about the same age as those which

lie under its easternmost section between Richmond and Yorkmouth; and it will run at an elevation of about three hundred feet above the sea, through a section of country more nearly level than any other district passed through between Richmond, Va., and the Mississippi.

The only mineral resources of this district likely to prove of sufficient value to justify transportation are certain pottery clays and glass sands that especially abound along the bluffs of the Mississippi River. The former are already used in a small way in this district and have proved to be of excellent quality. This region also contains a considerable amount of Lignite or brown coal, a substance that has not received the action of the compacting and metamorphic forces that have changed the ancient peat deposits into coal. Although this deposit will doubtless prove of some local value, it is not likely to be worth transporting to any distance. An extensive deposit known as Paducah gravel is now being used as a paving material, for which it is very well suited. Streets covered with it wear better than when made of any other road material. It is not likely, however, that it will prove profitable to transport it by railway to distant markets. It is now being taken to Memphis by river to replace the wooden pavements which, it is asserted, have proved so injurious to the health of that unhappy city. The soil of this district is of excellent quality, being generally a deep loam much resembling in general character that of the neighboring district of southern Illinois. It is capable of raising any of the grain crops of the Mississippi valley. Some cotton is grown here and the soil is as well fitted for the production of short staple cotton as are the lands of Tennessee. The region is on the whole fairly healthy, immunity from the malarial fevers that are found here as well as in the neighboring section of Illinois, Indiana and Missouri, being easily obtained by selecting a building site above the level of the swamp lands that border the sluggish streams. The timber resources of the district are great, and as yet have been but little drawn upon. In the swampy belt next the streams, the swamp or bald cypress

abounds. This tree affords an excellent wood suited to nearly all the uses of white pine, and is much more enduring. Its great size and the small amount of waste it makes in cutting add to its value. White oak and hickory abound in the higher lands. The carriage of these woods to a market can only be effected by railways, as the small streams are not navigable to rafts, and have not fall enough to make it possible to shoot the timber as detached logs.

This region is peculiarly fitted for market garden purposes, as, owing to its relatively southern position and low level above the sea spring comes in early. The soil is a quick, rather sandy loam, full of humus, which particularly suits this form of cultivation. There is no doubt that this is the use to which the greater part of it will in time be put.

V.

GENERAL CONSIDERATIONS.

It is worth while to notice some advantages this railway gives to the country adjacent to the Mississippi River. In the Mississippi River system we have not less than ten thousand miles of waters that may fairly be termed navigable at the present time, and to these we may add at least fifteen thousand miles that will be made navigable as soon as we utilize and improve our rivers as has been done in France. Experience has shown that it is easy to pass freight trains across the Mississippi River on steamers. Many of the roads that extend beyond this river, as well as the Ohio, ferry all their trains with little cost or delay, and it seems to me that many narrow gauge roads might be brought into connection with this proposed trunk line, without the expense of building complete connections, simply by extending this system of train ferries. The train once on the boat, in these permanently navigable waters, there would be no difficulty in carrying it for hundreds of miles up or down the stream. In this way two or three large

train boats on the Mississippi could bring this line into connection with many narrow-gauge freight roads, built or to be built in the country adjacent to its shores. These would be particularly useful in the district south of the terminus of this road, and even in the valleys of the Missouri, Arkansas, and upper Mississippi, and connected streams, there are extensive agricultural regions that much need transportation for their products. By this plan local narrow gauge roads would bring them into immediate connection with the Atlantic ports. Experience is, on the whole, rather against the shipment of most classes of produce raised in this region via New Orleans. I am informed that grain heats in the transit. Of this I do not feel assured, but it is clear that the shipment of live stock or fresh meat by this route is an impossibility. These are the principal exports from the region adjacent to the Mississippi, except cotton. As a large part of the cotton produced near that river now finds its way by rail to the Atlantic coast, there seems no reason why this road should not do a large business in the carriage of this staple, especially it should have some system of immediate railway connection with the cotton producing districts.

I am disposed to make yet another suggestion concerning the future of this railway line. It seems pretty certain that within ten years there will be an extensive system of railways of this gauge penetrating the narrow defiles of the Rocky Mountains. There are already several such roads operating in that section, and it is easy to any one, who knows that difficult country, to see that no broad gauge system can do the work of carriage that must be done there without very disproportionate cost of construction and operation. If these roads become the accepted mode of carriage in the Rocky Mountain valleys they will naturally seek some road to the Atlantic without breaking bulk; and thus if this road be completed to the Mississippi the necessities of the greatest mineral region in the world will probably force the building of a line to connect with it. It seems pretty clear that the Rocky Mountains must look to the Mississippi valley for its fuel and to the coal beds east of that

valley for its smelting coals, so that in these needs there is a basis for a great amount of traffic, in years to come. The amount of the freight that is to be shipped from the Rocky Mountains is likely to be underestimated: it will soon include the larger part of the lead entering into commerce, much copper, zinc, soda, etc. It is also the opinion of many metallergists that the ores of that region that can be concentrated to a value of above one hundred dollars per ton, can be more advantageously shipped to the central parts of the Mississippi valley for treatment than they can be worked in the mining districts. All this points to an active commercial exchange between the central parts of the country and the mineral belt of the west, and any road that can give unbroken connection between the mines, the central districts and the shore will possess peculiar advantages.

It seems to me that narrow guage roads, because of their economy and the ease with which they can make their way through a rugged region, are especially fitted for the development of a mineral country. It is seldom, if ever, possible to get by railways a satisfactory hold on the mineral resources of a district without a complicated system of branches. To lay the foundations for the large coal and iron carriage from eastern Kentucky and southwest Virginia, that the future will demand, will require, in time, a thousand miles of branch roads, which would, on account of the narrow and crooked valleys they have to traverse, be at least twice as costly if built of the ordinary width as they would be if built on the narrow gauge principle. This is true also of the section between the Blue Ridge and the Kentucky State line. That region is full of mineral resources. As a whole, I believe it has a larger and more varied amount of them than any other region I have ever seen; but it is a region not easy of access by railways of the ordinary width of track, though it is eminently suited to such roads as they are now building in Colorado, where the engineers not do fear to make grades of three hundred feet to the mile, and curves of two hundred and fifty feet radius. Leaving out of sight, then, the advantages derived from the greater

cheapness of construction of branch lines, I deem this scheme of narrow gauge roads peculiarly available for the development of a mountainous mineral bearing country. The same arguments that have led to the building of narrow gauge roads in the Rocky Mountains will force their adoption in this section. Competent engineers affirm their fitness for through transportation. I can only assert that in the local development of a mining district, such as is found in the Appalachians, they have peculiar advantages.

APPENDIX.

Below the reader will find a few analyses of iron, coal, etc., found on or near the line of this road. As far as these analyses pertain to substances found in Kentucky they have been made under my own direction, and I am prepared to guarantee their trustworthiness — where they are from Virginia, they are from authorities I feel bound to respect. Extra pains were taken to secure true averages in all the Kentucky analyses.

IRON ORES.

ANALYSES OF IRON ORES from Appomattox, Campbell, and Buckingham counties. From Rogers' Report.

LOCALITY.	COUNTY.	COMPOSITION IN 100 PARTS.					Per Cent. Metallic Iron.
		Peroxide of Iron.	Alumina.	Silica, &c.	Water.	Loss.	
1. Ross Furnace	Campbell	81.11	0.28	6.54	11.10	0.97	56.77
2. Stonewall Creek	Appomattox	76.00	0.50	13.00	10.00	0.50	53.20
3. Elk Creek		84.00	0.85	7.60	7.10	0.45	58.80
4. Falling River	Campbell	84.20	0.56	4.50	10.00	0.74	58.94
5. New Canton	Buckingham	72.00	1.33	16.47	10.04	....	50.40
6. Chesterfield County		85.15	4.00	4.20	6.50	....	....

ANALYSES OF MAGNETIC AND SPECULAR ORES from the James River District in Virginia, made by Professor F. A. Genth.

	No. 1. Specular.	No. 3. Magnetic.	No. 5. Blue Magnetic.	No. 6. Specular.	No. 10½. Magnetic.	No. 11. Magnetic.	No. 16. Magnetic.	No. 18. Specular.	No. 14. Brown Hematite.
Silicic Acid (Quartz)	30.86	4.10	14.67	3.04	16.60	11.32	3.29	25.08	24.02
Titanic Acid	0.20	0.15	0.22	0.10	0.18	0.22	Trace	0.43	. .
Phosphoric Acid	0.37	0.02	0.08	0.11	0.54	0.70	0.08	0.55	0.93
Ferric Oxide	55.04	90.74	82.38	91.39	75.69	81.86	95.24	64.40	62.29
Manganic Oxide	0.17	0.11	0.32	0.17	0.29	0.20	0.09	0.27	0.19
Alumina	10.24	4.43	1.96	4.20	3.76	3.06	0.53	7.07	3.03
Magnesia	0.88	0.12	0.06	0.15	0.25	0.18	0.07	0.45	0.10
Lime	0.97	0.29	0.23	0.20	1.29	1.38	0.04	0.71	0.20
Water	1.27	0.04	0.18	0.64	1.40	1.08	0.66	1.04	9.24
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Metallic Iron	38.53	65.71	57.68	63.97	52.98	57.30	66.32	45.08	43.60
Phosphorus	0.16	0.009	0.035	0.048	0.237	0.307	0.035	0.24	0.41

ANALYSES OF DYESTONE ORES FROM POWELL'S VALLEY, BY DR. ROBERT PETER.

No. in Report.	County.	Specific Gravity.	Iron Carbonate.	Iron Peroxide.	Alumina.	Lime Carbonate.	Magnesia Carbonate.	Manganese Carbonate.	Phosphoric Acid.	Sulphuric Acid.	Silica and Silicates.	Water and Loss.	Per cent of Iron.	Per cent of Phosphorus.	Per cent. of Sulphur.	Per cent. of Silica.	Remarks.
1271	Boyd	3.362	66.854	0.276	4.260	2.460	4.086	0.573	0.709	0.885	18.360	1.538	32.366	0.308	0.354	15.500	Blue-Block Ore, Wilson's Creek.
866	Carter . . .	n. d.	87.527	0.778	0.984	trace	1.024	1.324	0.207?	0.013	6.080	. . . .	42.807	. .	. .	. .	Blue Kidney, Star Furnace.
1393	" . . .	. .	62.662	10.024	1.600	0.240	2.838	3.251	0.127?	0.521	13.720	3.017	37.285	0.055	0.208	n. e.	Old-Orchard Diggings.
1395	" . . .	. .	44.242	27.296	1.560	6.580	1.046	0.842	0.732	4.587	11.160	1.955	40.465	0.321	1.855	n. e.	Horsley Bank.
1399	" . . .	. .	30.708	31.544	1.779	2.730	0.144	0.060	0.421	0.491	25.430	6.523	36.627	0.184	0.196	10.560	Mt. Savage Furnace Ore.
937	Estill	. .	78.086	1.050	2.460	1.290	4.508	3.492	0.438	0.176	8.670	. . . .	38.461	. .	. .	n. e.	Gray Ore, Cottage Furnace.
1044	Grayson . .	. .	16.598	42.761	4.994	2.840	n. e.	n. e.	1.017	trace	20.830	8.054	37.945	0.444	trace	n. e.	Glady Ore, West of Bear Creek.
1503	Greenup . .	3.297	78.722	0.204	2.746	2.250	0.380	0.421	0.505	1.160	11.340	2.272	38.146	0.221	0.524	9.700	Blue-Kidney Ore, near Laurel Furnace.
1507	" . .	n. d.	55.258	13.468	0.670	4.880	4.528	0.090	0.368	1.043	15.600	4.065	36.103	0.200	0.416	13.360	Main-Block or Gray Ore, " "
1611	Muhlenburg.	"	42.950	29.618	2.454	2.490	4.828	1.083	0.083?	1.595	9.030	5.868	36.916	0.035?	0.638	6.220	Slate Ore, Old Buckner Furnace.
149	"	"	62.420	3.380	0.950	3.650	7.410	2.490	0.100	n. e.	15.270	(*a*) 1.570	33.520	. .	. .	. .	Black Band, William's Landing.
150	"	. .	64.900	7.410	0.600	3.250	6.570	1.180	0.350	n. e.	7.070	(*b*) 0.110	36.540	. .	. .	. .	Black Band, Battist Creek.

(*a*) Bituminous matters = 2.41 per cent. (*b*) Bituminous matters = 7.81 per cent.

ANALYSES OF VARIOUS DEPOSITS OF IRON ORES IN KENTUCKY.—*Limonite Ores.*

No. in Report.	County.	Iron Peroxide.	Iron Carbonate.	Alumina.	Manganese br. Oxide.	Lime Carbonate.	Magnesia.	Phosphoric Acid.	Sulphuric Acid.	Combined Water.	Silica and Silicates.	Moisture and Loss.	Per cent. of Iron.	Per cent. of Phosphorus.	Per cent. of Sulphur.	Per cent. of Silica.	Remarks.
1279	Bath	76.077	. .	2.592	0.430	0.130	0.281	0.731	0.030	12.300	8.180	. .	53.254	0.319	0.011	6.160	Old Slate Furnace Ore.
782	"	82.120	. .	0.820	1.340	trace	. .	0.220	0.386	5.420	8.980	. .	57.510	. .	. .	. .	Limestone Ore, Clear Creek.
1274	Boyd	58.960	. .	7.284	0.480	0.430	0.227	0.376	0.206	10.800	21.210	0.127	41.272	0.164	0.082	19.980	Yellow Kidney Ore, Star Furnace.
1275	"	51.802	10.596	4.543	trace	7.480	0.440	0.570	0.089	8.772	15.730	. .	41.357	0.231	0.035	13.161	Limestone Ore, Bellfont Furnace.
1277	"	55.022	8.821	7.194	"	2.540	1.271	0.526	0.091	10.126	13.430	. .	43.473	0.229	0.036	11.660	Yellow Kidney Ore, Buena Vista.
1371	Carter . . .	81.640	. .	3.160	"	0.180	0.919	0.060	n. e.	11.280	2.600	0.221	57.148	0.026	n. e.	n. e.	Horsley Bank, Boone Furnace.
1373	" . . .	65.657	. .	4.921	"	trace	0.040	0.893	0.604	10.740	17.780	. .	45.959	0.391	0.241	15.960	Potato Knob Ore.
1375	" . . .	38.285	. .	5.455	0.120	0.460	0.065	1.000	0.071	9.500	44.760	0.284	26.799	0.436	0.030	40.960	Royster Hill, Lambert Ore.
1376	" . . .	57.557	. .	2.727	trace	trace	0.065	1.746	0.185	11.700	26.180	. .	40.290	0.760	0.074	n. e.	Smith Hill, German Ore.
1381	" . . .	71.502	. .	8.557	"	"	0.054	0.466	0.800	9.500	9.030	0.091	50.051	0.203	0.320	7.640	Old Mt. Tom, Main Block Ore.
1384	" . . .	71.680	. .	4.155	0.090	0.380	0.050	n. e.	0.270	10.800	12.650	. .	50.176	n. e.	0.108	11.560	Graham Bank Ore.
1385	" . . .	66.200	. .	3.907	0.030	0.430	0.345	0.130	0.182	11.730	16.530	0.633	46.340	0.057	0.072	13.860	Yellow Kidney Ore, Mt. Savage Furnace.
1411	Edmonson .	76.284	. .	2.361	0.030	0.180	0.008	1.055	0.151	12.000	7.951	. .	53.399	0.460	0.059	7.660	Proctor Ore Bank.
1509	Greenup . . .	80.040	. .	2.680	. .	trace	0.425	0.115	0.264	10.000	6.560	. .	56.280	0.050	0.107	. .	Limestone Ore, Tygert's Creek.
1516	" . . .	72.957	. .	1.660	0.640	0.380	0.083	0.500	0.178	9.344	15.160	. .	51.070	0.218	0.070	. .	Limestone Ore, Shover Drift.
1521	" . . .	68.928	. .	2.768	0.290	0.680	0.641	0.249	0.748	11.100	15.240	. .	48.249	0.098	0.299	13.600	Main Block, L. Morton Bank.
1598	Lyon . . .	70.518	. .	0.045	0.090	0.090	trace	0.275	0.113	9.850	18.910	0.009	49.363	0.120	0.045	18.160	Suwannee Furnace Bank.
1600	" . . .	69.392	. .	trace	0.170	0.140	"	0.303	trace	9.550	20.500	. .	48.574	0.144	. .	19.660	Suwannee Iron Mt. Bank.
1605	Muhlenburg	93.048	. .	5.290	0.090	0.680	0.930	0.147	0.112	12.430	17.250	. .	44.133	0.064	0.044	10.500	Airdrie Furnace Ore, near No. 4 entry.
1606	"	60.492	. .	7.075	0.360	1.980	1.550	0.083	0.185	12.530	15.560	0.185	42.344	0.035	0.074	13.660	Jerry Hope's Land, Muddy River.
1608	"	69.546	. .	3.914	0.230	0.480	0.921	0.115	0.216	11.250	12.730	0.598	48.822	0.050	0.086	11.300	Martin Ore.

Red Hematite Ores of the Clinton Group.

Page in L. B.	No. in Report.	County.	Specific Gravity.	Iron Peroxide.	Alumina.	Manganese Brown Oxide.	Lime Carbonate.	Magnesia.	Phosphoric Acid.	Sulphuric Acid.	Combined Water.	Silica and Silicates.	Moisture and Loss.	Per cent. of Iron.	Per cent. of Phosphorus.	Per cent. of Sulphur.	Per cent. of Silica.	Remarks.
	533	Nr. Cumb. Gap, Ten.	n. e.	80.820			. .	. .	. not	deter	mined	. .	. .	56.574	. .	. .	11.260	Dyestone Ore, Clinton Furnace.
	540	" "	3.942	77.380	3.941		0.420	trace	0.330	trace	2.500	15.900	. .	54.166	0.144	trace	. .	Poor Valley Ridge, Upper Bed.
	541	" "	3.914	73.935	5.776		4.510	0.200	0.310	"	3.850	11.730	. .	51.754	0.140	"	11.760	Foot of Poor Valley Ridge, Upper Bed.
	542	" "	3.190	47.965	2.130		1.230	0.194	0.575	"	4.000	43.090	. .	33.575	0.251	"	42.76	Foot of Poor Valley Ridge, Middle Bed, 26 in. thick.

COALS.

The following analyses of coals from the James River district was made by Mr. William Wallace, of Glasgow, Scotland, and is given in Jed. Hotchkiss' Virginia. It represents the results of several analyses.

Volatile matter, 14.26 to 34.57 per cent.

Coke { Fixed Carbon, 56.23 to 81.61 per cent.
Coke { Sulphur, 0.04 to 1.10 per cent.
Coke { Ash, 2.24 to 8.88 per cent.

Water (at 212° Fahr.), 0.82 to 1.80 per cent.

Dry Coke, per ton of Coal, 12 cwt. 3 qrs. 13 lbs. to 16 cwt. 3 qrs. 10 lbs.

Coke, per cent, 64.33 to 84.18.

Sulphur in volatile matter, 1.14 to 0.78, or 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 cubit foot, 77.6 to 82.3 pounds.

Weight per inch per acre, 123 to 133 tons.

THE FOLLOWING ANALYSES OF COALS GIVE THE RESULTS OF A PART OF THE WORK OF THE KENTUCKY SURVEY, BY DR. ROBERT PETER, BY CHEMICAL ASSISTANT.

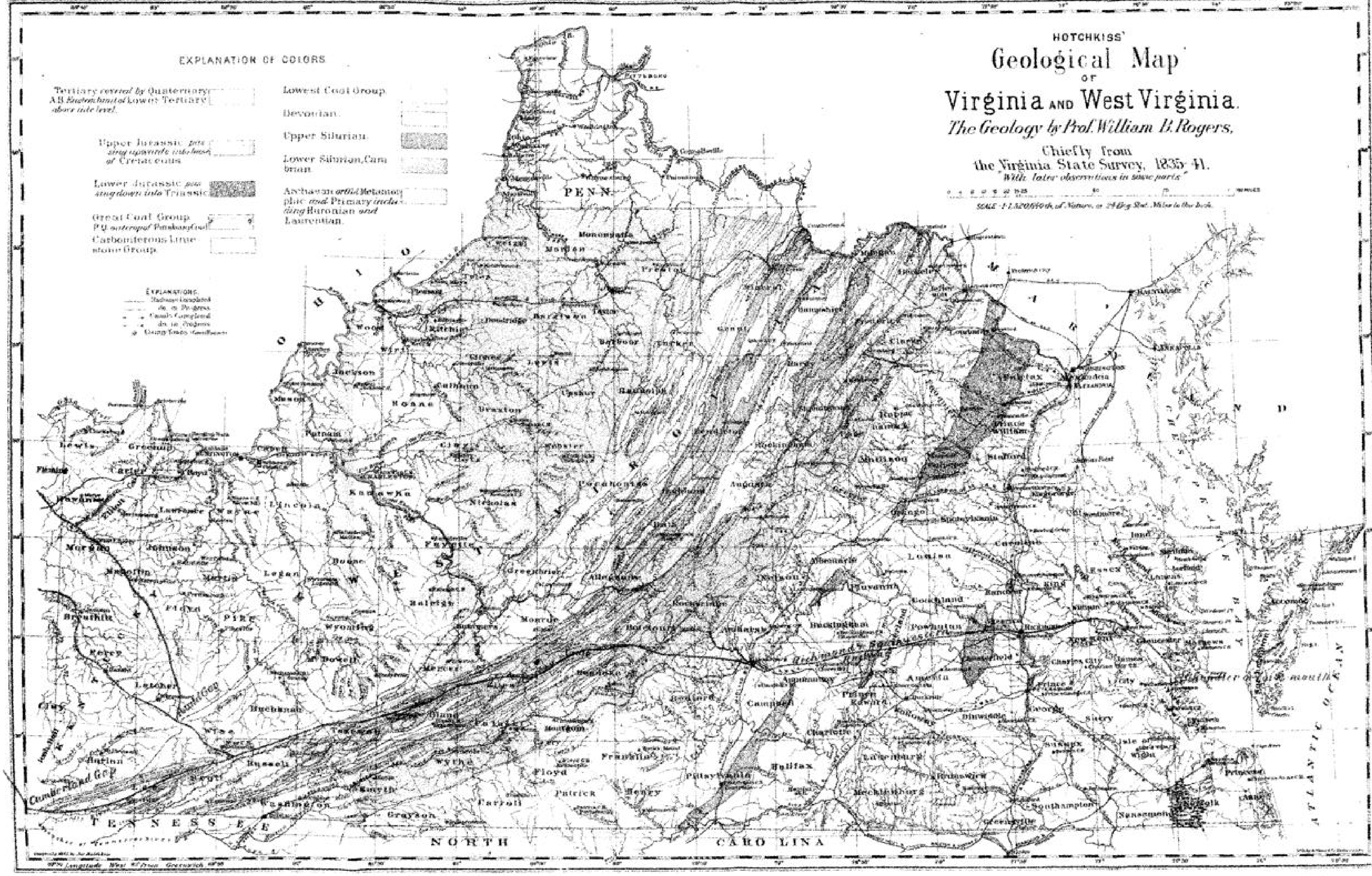
Number in the Report	County.	Specific Gravity.	Hygroscopic Moisture.	Volatile Combustible Matters.	Coke.	Total Volatile Matters.	Carbon in the Coke.	Ashes.	Character of the Coke.	Color of the Ash.	Per cent. of Sulphur.	Remarks.
1280(*a*)	Boyd	1.358	3.40	32.30	64.30	37.70	55.40	8.90	Dense	Light purple-gray.	1.230	Turkey-pen Hollow, Raccoon furnace (Coal No. 6).
1280(*b*)	" . . .	n. e.	4.70	34.30	61.00	39.00	59.04	1.96	"	" " "	0.982	Turkey-pen Hollow (a selected sample, Coal No. 6).
1285	" . . .	1.315	2.70	36.70	60.60	39.40	52.60	8.00	Spongy	Dark lilac-gray .	1.711	Horse-Run Coal (Coal No. 6).
1286	" . . .	1.308	3.30	33.30	63.40	36.60	57.60	5.80	Moderately Dense	Light lilac-gray .	2.480	Coalton Coal, Ashland Co. Mine (4 entry, Coal 7).
1289	" . . .	1.320	5.00	34.50	60.50	39.50	55.40	5.10	Spongy	Light brown-gray.	1.285	Coalton Coal, Ash'd Co. (250 yds. from W. end, Coal 7).
835	Breathitt . .	1.219	0.30	56.70	38.10	57.00	43.00	4.90	Dense	Light purple-gray.	0.452	Cannel Coal (South's), near Jackson.
871	Carter . . .	1.200	.60	66.30	33.10	66.90	28.30	4.80	"	Tawny yellow . .	1.320	Cannel Coal, Stinson Bank.
1348(*a*)	" . . .	1.435	5.40	32.70	61.90	38.10	52.52	9.38	Moderately Dense	Lilac-gray	2.356	W. Pritchard's Bank (Coal 7).
1348(*b*)	" . . .	n. e.	4.50	37.10	58.40	41.60	56.40	2.00	" "	Yellowish	0.571	W. Pritchard's Bank (selected sample, Coal 7).
1350	" . . .	1.340	6.40	31.40	62.20	37.80	57.66	4.54	Porous	Purplish-gray . .	1.670	Drift on Gum Branch of Straight Creek (Coal 7).
1353	" . . .	1.274	3.80	34.50	61.70	38.30	58.50	3.20	Dense porous . .	Brownish-gray .	2.164	Graham Bank, near Willard (Coal 1).
1356	" . . .	1.289	4.10	34.60	61.30	38.70	56.525	7.775	" " . .	Lilac-gray	1.414	Kibby drift, Everman's Creek (Coal 2).
1357	" . . .	1.208	4.60	33.50	61.90	38.10	51.00	10.30	" " . .	Yellowish-gray .	1.200	Stone-Coal branch of Tygert's Creek (Coal 1).
1413	Edmonson .	1.282	2.30	32.10	65.60	35.40	56.30	9.30	Cellular	Light lilac-gray .	1 059	Tar-Lick Coal, 5½ feet thick.
1418	" . . .	1.336	3.66	35.14	61.20	38.80	54.25	6.94	Light Cellular .	Lilac-gray	2.706	Shoal Branch, Main, Nolin Coal.
1448	Grayson . .	1.305	4.70	31.40	63.90	36.10	52.20	11.70	Spongy	Lt. Brownish-gray	1.945	Tar-Lick Coal, Dismal Creek.
1484	Greenup . .	1.316	4.82	32.90	62.28	37.72	55.18	7.10	Friable	Chocolate	1.469	Coal used at Kenton furnace (Coal 1).
1486	" . .	1.250	4.80	34.64	60.56	39.44	52.58	7.98	Dense	Lilac-gray	1.331	Main Coal at Raccoon furnace (Coal 3).
1493	" . .	1.289	4.10	34.96	60.94	39.06	55.54	5.40	Spongy	Dark brick	1.590	Below the Kidney Ore, Laurel furnace Coal 3).
1496	" . .	1.300	3.20	36.60	62.20	39.80	53.14	7.06	Dense Spongy .	Lilac-gray	2.264	From a drift near Pennsylvania furnace (Coal 3).
1649	" . .	1.306	1.50	52.20	46.30	53.70	40.60	5.70	Very Friable . .	Lt. Yellowish gray	0.782	Cannel Coal, Hunnewell Mines.
1579	Hopkins . .	1.322	3.20	35.90	60.90	39.10	54.00	6.90	Light Spongy . .	Light lilac-gray .	2.759	St. Charle's Mines.
1588	Lawrence .	1.316	4.00	35.70	59.70	40.30	52.28	6.42	Spongy	" " " .	1.080	McHenry Bank, near Louisa (Coal 3).
1589	" . .	1.281	5.10	35.30	59.60	40.40	57.80	1.80	Light Spongy . .	Light gray-buff .	0.736	F. Swetman's Bank, Brushy Creek (Coal 1).
1591	" . .	1.349	2.10	33.90	64.00	36.00	56.00	8.00	Friable	Yellowish-white .	0.736	Holbrook's Coal, Brushy Creek (Coal 3).
1601	Menifee . .	1.319	2.94	33.06	64.00	36.00	56.60	7.40	Dense	Lt. Brownish-gray	0.997	Subconglomerate Coal, Hawkin's Creek.
1618	Muhlenburg	1.278	3.60	31.40	65.00	35.00	58 50	6.50	Dense Spongy .	Lilac-gray	1.438	Airdrie furnace Coal (Coal 12).
1623	" . .	1.221	3.80	32.70	63.50	36.50	58.00	4.90	" " .	Br'sh Salmon-gray	1.923	Muddy River Coal Mine.
185	Union .	1.308	3.50	36.00	60.50	39.50	57.50	3.00	. . . . .	. . . . .	1.746	Mulford's Main, or five-foot Coal.

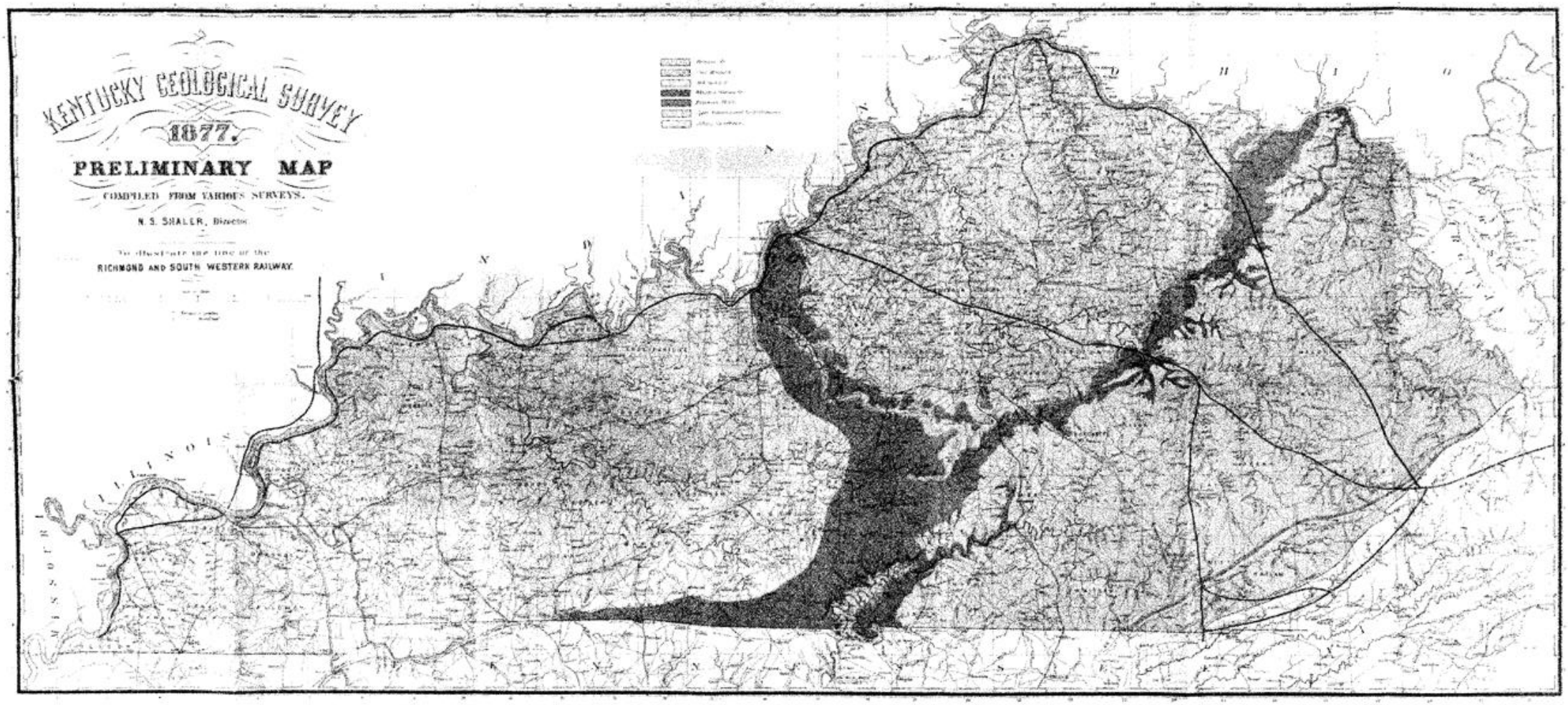
HYDRAULIC CEMENT LIMESTONES.

THE FOLLOWING ANALYSES ARE BY DR. PETER OF THE KENTUCKY GEOLOGICAL SURVEY.

No. in Report.	Page in Laboratory Book.	County.	Specific Gravity.	Lime Carbonate.	Magnesia Carbonate.	Alumina.	Iron Oxide.	Manganese Oxide.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand and Silicates.	Per cent. of Lime.	Per cent. of Magnesia.	Total Silica.	Remarks.
456	. .	Grayson . .	2.651	46.830	26.840	0.380	2.380	trace	0.120	0.330	0.500	0.370	20.780	26.280	12.960	n. e.	From near Grayson Springs.
521	. .	Jefferson . .	n. e.	50.430	18.670		2.930		0.060	0.158	0.320	0.130	25.780	28.290	8.890	22.520	" Falls of the Ohio, Louisville.
1060	. .	" . .	n. e.	42.819	21.819		6.560		1.284	0.233	0.233	0.372	23.980	24.118	10.395	n. e.	" Chenowick Creek.
1137	. .	Meade . . .	n. e.	47.560	26.515			2.160		1.332	0.126	0.265	19.680	26.688	12.631	n. e.	" Mitchell's Spring.
1165	. .	Nelson . . .	n. e.	40.480	24.267		4.493		0.207	0.819	0.455	0.042	29.380	22.667	11.554	. .	" Bardstown.
1201	. .	Oldham . .	. .	41.580	24.030		5.860		0.374	0.303	0.455	0.204	23.580	23.284	11.443	. .	" near La Grange.
1202	. .	" . .	. .	41.980	21.400		6.860		0.310	0.386	0.370	0.379	24.680	23.508	10.190	. .	" Curry's Fork of Floyd's Creek.

Map showing Proposed Routes of the Richmond & Southwestern Railway




KENTUCKY GEOLOGICAL SURVEY
1877.
PRELIMINARY MAP
COMPILED FROM VARIOUS SURVEYS.
N. S. SHALER, Director.
To illustrate the line of the
RICHMOND AND SOUTH WESTERN RAILWAY.
ILLINOIS
MISSOURI