BRYAN (Patrick Walter)

THESIS

SUBMITTED FOR THE DEGREE

OF Ph.D.
An Enquiry into the Major Geographical Factors Conditioning the Production and Distribution of Coal and Iron in the United States of America.

By P.W. Bryan, B.Sc. (Econ.), F.R.S.G.S.

Lecturer in Geography at University College, Leicester.
CHAPTERS.


"  II  -  Coal - Producing Areas (Continued) Anthracite Regions of Pennsylvania, Minor Regions, Coal Reserves, pp. 47 - 63.


"  IV.  -  Iron and Steel Industry - Iron Ore Production, Movement and Reserves. Steel Centres. pp. 74 - 110

"  V.  -  Coal Movement to Lakes and Coast, pp. 111 - 129

Bibliographical Notes are given at the end, pp. 130 - 133.
List of Maps and Diagrams

in separate case.

---

Fig. 1. Coalfields of the U.S.A.

2. The Northern Appalachian Coalfield - Production.

3. Natural Regions of the Northern Appalachian Coalfield.

4. Sketch Map of the Pittsburg and West Virginia Coal Producing Districts.

5. Diagrams to illustrate structure, etc. of the Northern Appalachian Coalfield.

6. The Connellsville coking area.

7. New R. Coalfield.

8. Relief of Anthracite Field.

9. Production of " " .

10. Distribution of Anthracite.

11. Iron ore Deposits and Production, U.S.A.

12. Diagrams to shew mining conditions in the Lake Superior Country.

13. Iron ore Production and movement, Lake Superior Region.

14. Chief Steel Centres - Production.

15. Steel centres, Pittsburg and Atlantic Seaboard.

16. Railways Related to Ridges and Rivers, Northern Appalachian Coalfield.

17. Hampton Roads.


19. Sketch Map of Certain Mining Areas of the U.S.A.
CHAPTER I.

COAL - GENERAL POSITION.

PRODUCING AREAS - PITTSBURG

REGION, WEST VIRGINIA - ALABAMA.
GOAL.

Applied power is one of the basic facts of modern civilisation and the main source of this applied power is coal. By far the greatest producer of coal in the world to-day is the United States of America. In the following chapters the attempt is made to set out the principal natural factors conditioning the production and distribution of coal in the United States, in relation to the chief industries based on coal as a source of power. Before proceeding to examine the actual conditions of production let us endeavour to realise just what coal production in North America means as a part of the total world production. Let us consider the Table shown in diagram number 1 which gives us the coal production of the world for the years 1912 and 1913.

It will be seen from an examination of the figures that out of a world total of 1,400 million short tons 549 million short tons were produced in the United States, the Canadian production a matter of about 100 million short tons being almost negligible by comparison; 292 million short tons were the contribution of Great Britain; while Germany accounted for about 100 million short tons. If for convenience of realisation we regard 100 million short tons as a unit, it will be clear that out of a world total of 14 units, the United States was responsible for 5.5 units or rather better than one-third; Great Britain for just under three units or over one-fifth; and Germany for two units or about
one-seventh; while France occupied a rather bad fifth place in the list with a contribution of half a unit.

Now let us see from whence came these five and one-half units which made up the share of the United States to the common pool. If we consult the second table of figures on the first diagram we will see that nearly four of those units came from one great coalfield - the Appalachian - and almost two and a half of these came from a single state in that large field - the State of Pennsylvania. In other words three fourths of the total for the United States comes from one great field, and nearly half from the mines of a single state. The bulk of this coal as we shall see later comes from a relatively small area in the south-west of the state, an area which extends over the borders into the adjoining states of Ohio, West Virginia and Maryland. If we add in the amount raised to the surface in those parts of the States referred to, which may for practical purposes be regarded as an extension of the Pennsylvanian Field, we get a total for the northern part of the Appalachian Field which we may consider as a whole of three units, or rather more than the total coal production of the British Isles. (See Table 2). The output of the Appalachian Field is roughly comparable to that of Europe exclusive of Great Britain.

1. Figures for 1912 give similar results.
Apart from the Appalachian Field it will be seen that the remaining fields of the United States may be grouped regionally under roughly four heads, the Central, the West Central, the Rocky Mountain and adjoining areas, and the Pacific. Of these the most important from the point of view of output is the Central, which comprises parts of the States of Illinois and Indiana with an output of 81 million short tons, or roughly one-third of the output of the State of Pennsylvania. All the remaining areas added together have an output which is only about two-thirds of that of the Central Field and together with the Central Field these areas account for roughly one-fourth of the coal output of the United States.

Now with this general comparative idea of the output of the United States and its various parts in our minds, let us turn to a consideration of the actual fields and their locations before discussing the question of the various geographical conditions underlying production.

A glance at the map of the United States in fig. 1 will shew several areas indicated by shading which are called the coal measures.¹ Such an area is that commonly shown in many atlases as the coalfields. In such an atlas will be found a map showing the coalfields of the British Isles on

¹ Based on Map in U.S. Census 1920, Vol.XI, p.254
which is depicted a very extensive coalfield in the hills overlooking Tralee, in the southwest of Ireland. It is needless to say that from the standpoint of coal production no such coalfield exists, nor is it ever likely to exist, unless Mr. Ford's new process of low-temperature carbonisation proves capable of even greater things than is at present anticipated. In such cases it is not just a question of the area being undeveloped. That may or may not be so. The error generally arises because of the fact that the map-maker has taken as coal the area shown on geological maps as underlain by the coal measures, a class of rocks so called because they frequently but not necessarily contain coal, or because the area depicted as a coalfield contains, or is thought to contain, actual coal seams which have not yet been developed.

The map to which we have already referred, shews that in the United States there are three large areas and a number of small ones which are indicated as being underlain by coal. In these areas the coal varies very much in character, and to some extent in accessibility, and largely because of these two factors, only a relatively small portion of the total areas underlain by coal have been commercially developed. What we want to know, then, is not where coal is known or is thought to exist, but
where, and in what amounts coal is being actually raised to the surface. To answer this question what is needed is a map showing by counties the amount raised to the surface in a given year. Figure 2 shows these facts for the northern part of the Appalachian Coalfield. An examination of this map will show that in the northern part of this field there are three main producing areas, while a similar map not here reproduced shows that in the southern part of the field there are three much smaller areas (see sketch-map, Fig. 1). Of the northern three, two are in Pennsylvania — one in the north-east of the state producing anthracite, the other in the south-west and, as has already been pointed out, this latter area extends over the borders of the state into West Virginia, Ohio, and Maryland. The third producing area in the northern part of the field lies in the south of West Virginia. As has already been noted, the Pennsylvanian area produces nearly half of all the coal raised in the United States, and is by far the greatest single bituminous coal producing area in the world. As this latter area is

1. Based on Statistics - Mineral Resources 1912, Part 2, p. 201 etc. and also 1" Topographical Maps.
# COAL PRODUCTION - WORLD - 1912 and 1919.

<table>
<thead>
<tr>
<th>Country</th>
<th>1912 Million Short Tons</th>
<th>1919 Million Short Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>534</td>
<td>549</td>
</tr>
<tr>
<td>Canada</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Great Britain</td>
<td>292</td>
<td>263</td>
</tr>
<tr>
<td>Germany</td>
<td>170</td>
<td>131</td>
</tr>
<tr>
<td>Austria Hungary</td>
<td>55</td>
<td>-</td>
</tr>
<tr>
<td>France</td>
<td>43</td>
<td>24</td>
</tr>
<tr>
<td>All others</td>
<td>263</td>
<td>336</td>
</tr>
<tr>
<td></td>
<td>1,368</td>
<td>1,314</td>
</tr>
</tbody>
</table>
also to a large extent typical of the conditions in the chief areas of the United States it is considered in some detail in what follows.

The general relief and structure of the eastern half of the United States have been discussed already in another part of this book, but it will help us to fix more clearly the actual location of the chief producing areas and also the conditions underlying production, if we just briefly recall some of the more salient facts.

The eastern part of the United States is occupied by a series of parallel belts of country running from the northeast into the southwest. These belts are not only parallel to each other but also to the Atlantic Seaboard. Close to the Atlantic lies the long narrow strip of the Coastal Plain of which the western boundary is formed by the belt of broken country which is sometimes misleadingly called the Fall Line. Beyond the Fall Line we come to the Piedmont Belt, which, formed as it is of old crystalline rocks that at one time made up the ancient continent now known to geologists as Appalachia, offers a marked contrast, well expressed in its somewhat uneven relief, to the young, undisturbed and almost horizontal strata of the Coastal Plain. The western edge of the Piedmont is marked by a very definite ridge, to which the term Blue Ridge is rather loosely applied. Westward of this ridge lies the belt of country commonly spoken of as the Greater Appalachian Valley.
It consists for the most part of a well defined series of parallel ridges with intervening valleys, and is itself bounded to westward by a marked feature - the Allegheny Front as it has been called. It consists of a great escarpment formed by the outcrop of the strata of which the country to westward is composed. This westward country is a great plateau sloping away south-west and west to the Mississippi Valley.

The structure of this plateau and of the rolling plains country which stretch away westward to the Mississippi consists of a series of low broad anticlines and synclines running roughly parallel to the Allegheny Front. A principal anticline which forms a kind of backbone to the series runs southwestward from the Toledo end of Lake Erie through the position of Cincinnati, and crossing the Ohio passes through the Nashville Region. This upfold separates the Appalachian Coalfield from the Central Coalfield which lies southeastward of Lake Michigan. It is thought that in Carboniferous times when the coal measures were being laid down, this southwestward trending ridge formed dry land, separating two basins occupied by arms of the sea in which were deposited over very long periods of time, and probably under conditions of progressive depression, the massive sandstones, limestones and shales

1. See Section 3, fig. 5.
of the coalmeasures. The more easterly of these two basins which today carries the Appalachian Coalfield was limited in extent by the ancient continent of Appalachia to which reference has been made above.

Towards the close of the Carboniferous Epoch, the horizontal strata thus laid down in this basin were intensely folded and crushed by earth movements, acting at right angles to the present lie of this area against the old continent lying to the southeast. In this way were produced the ridges and furrows of the Greater Appalachian Valley, as also in this way was the heavy faulting brought about which along the westward edge of this area of intense folding has formed the escarpment - the Allegheny Front - separating the ridge and furrow structure of the Great Valley from the undulating structure of the plateau to the west. With the exception of the anthracite field of northeastern Pennsylvania which lies in the rock structure of the Great Valley between the Susquehanna and Delaware Rivers, the chief coal mining districts of eastern U.S.A. lie wholly on this plateau of almost horizontal rocks, to be found westward of the ridge and furrow zone forming the Appalachian Valley. This is a fact, which, as will be seen later, has a very direct bearing on the methods of mining in vogue in each area and therefore, on the cost of production.

Let us now examine in a little more detail the plateau

1. U.S. Geologic Atlas, folio No. 82, p. 2. Masontown -
   Uniontown.
2. See Fig 2 and Compare with Fig 3, and also with Fig 5.
to which the name Allegheny Plateau is often given.

Pittsburg is today situated in the river angle where two of those many streams draining eastward to the Mississippi unite to form the Ohio. Since its very genesis, these westward draining streams or their forbears, have been busy at the work of carving out the plateau surface. Ages of such erosion reduced it to a base level, the so-called peneplain of Professor Davis. Subsequent uplifts rejuvenated the rivers. They began again the work of modelling the surface. They dug out those deep trenches which are such a conspicuous feature of the relief to-day. They entrenched themselves within their old beds. The more powerful captured their weaker fellows, and thus was brought about that concentration of streamways on Pittsburg, which has played such a big role in determining Pittsburg as the great dominating centre of the iron and steel industry of the United States today. The shallow synclines and anticlines of the plateau structure close to the escarpment of the Allegheny Front have also played their part. The gentle downfolds have preserved the coal at no great depth below the surface. The low upfolds bring it still nearer to the surface or, where as in the Connellsville District their summits have


2. See fig. 14.
been planed off, the coal outcrops on either flank.\footnote{U.S. Geol. Atlas, folio 84, Connellsville, Geological Maps at end.}

Such, put very briefly, are some of the main structural facts to be borne in mind, in connection with the Appalachian Coalfield. Having then this broad and somewhat sketchy picture in our minds, let us get closer and examine in the first place the main producing area in more detail.

If we glance at a map of the country between the Great Lakes and the sea, we will notice that the Susquehanna sends long tentacles westward in the shape of its headstreams. The more southerly of these headstreams interlock with those of the Allegheny, which rise wholly on the plateau. A short distance south of the more southerly of these Susquehanna headstreams, the Potomac draining into the flats to the east of Chesapeake Bay, reaches back almost to the headwaters of the Monongahela. Both of these streamways have been lines of movement from very early times in the history of westward movement in the States, and both centre on Pittsburg at the angle where the Allegheny from the north, and the Monongahela from the south, unite to form the Ohio. It was doubtless this nodality of Pittsburg, combined with the fact that it lies just westward of the two passages through the ridges to the east, that undoubtedly led to
the early development of the area as a coal producing region, as it had already led to its settlement. This question of the eastward connection of the area with tidewater will be more fully dealt with later, when the question of coal movement is being discussed. For the moment it is useful to notice that two hundred miles to the southward of these passageways, there occur through river action two other routes through the ridges where the headwaters of the James and the Roanoke have cut back into the Great Valley, and that just to westward of these openings where the New and Big Sandy Rivers have trenches deeply the horizontal rocks of the plateau, we find the second largest of the bituminous coal producing regions of the coalfield - the New River, Kanawha, and Pocahontas Districts of West Virginia. The main producing area lies eastward and southward from Pittsburg. It is not confined to the state of Pennsylvania, but extends westward into Ohio and southward into West Virginia and Maryland. (Fig.1.) Considered very broadly apart from that portion of the field which is in Ohio, it is the country drained by the middle and lower Monongahela and its tributaries, and by the Conemaugh, a left-bank tributary of the lower Allegheny. All these river valleys focus on one point and that point is Pittsburg. For this reason the coal carrying railroads have a down grade to Pittsburg and an up grade out of
Pittsburg. Moving outward, the railways are only carrying for the most part supplies and manufactured goods to the mining areas, while the inward movement to Pittsburg of the bulky fuel needed for a manufacturing centre is largely facilitated by the downgrade. Hence within a short radius of Pittsburg on the northwestern edge of the coalfield, or to be more exact within the confines of Allegheny County, we are not surprised to find steelworks, the output of which in value was in 1909 nearly 25% of the total output of steel in the United States.\(^1\) Apart from the production of this small area in the immediate vicinity of Pittsburg, about 22\% more\(^2\) is produced in the adjoining counties, so that the steel producing region related to this coalfield round Pittsburg as a centre, really accounts for 47 per cent of the total production, or putting the position more broadly we are probably not far wrong in saying, that Pittsburg forms a centre in close proximity to which is produced roughly one half of all the steel manufactured in the United States.

---


2. Obtained by adding figures for counties close to Allegheny County.
Coal U.S.A. 1919

<table>
<thead>
<tr>
<th>Region</th>
<th>Million Short Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appalachian:</td>
<td></td>
</tr>
<tr>
<td>(Anthracite 88.1)</td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>238.3</td>
</tr>
<tr>
<td>(Bituminous 150.2)</td>
<td></td>
</tr>
<tr>
<td>West Virginia</td>
<td>77.6</td>
</tr>
<tr>
<td>Ohio</td>
<td>35.1</td>
</tr>
<tr>
<td>Kentucky</td>
<td>29.4</td>
</tr>
<tr>
<td>Alabama</td>
<td>15.4</td>
</tr>
<tr>
<td>Virginia</td>
<td>9.3</td>
</tr>
<tr>
<td>Tennessee</td>
<td>5.1</td>
</tr>
<tr>
<td>Maryland</td>
<td>3.0</td>
</tr>
<tr>
<td>Michigan Field</td>
<td>413.2</td>
</tr>
<tr>
<td>Michigan</td>
<td>1.0</td>
</tr>
<tr>
<td>Eastern Interior</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>60.3</td>
</tr>
<tr>
<td>Indiana</td>
<td>20.5</td>
</tr>
<tr>
<td>Western Interior</td>
<td></td>
</tr>
<tr>
<td>Iowa</td>
<td>5.5</td>
</tr>
<tr>
<td>Kansas</td>
<td>5.2</td>
</tr>
<tr>
<td>Missouri</td>
<td>3.8</td>
</tr>
<tr>
<td>Southern Interior</td>
<td></td>
</tr>
<tr>
<td>Oklahoma</td>
<td>3.8</td>
</tr>
<tr>
<td>Arkansas</td>
<td>1.4</td>
</tr>
<tr>
<td>Texas</td>
<td>1.6</td>
</tr>
<tr>
<td>Northern Gt. Plains &amp; Rockies</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>10.2</td>
</tr>
<tr>
<td>Wyoming</td>
<td>7.2</td>
</tr>
<tr>
<td>Utah</td>
<td>4.6</td>
</tr>
<tr>
<td>New Mexico</td>
<td>3.2</td>
</tr>
<tr>
<td>Montana</td>
<td>3.2</td>
</tr>
<tr>
<td>North Dakota</td>
<td>29.2</td>
</tr>
<tr>
<td>Pacific</td>
<td></td>
</tr>
<tr>
<td>Washington</td>
<td>3.0</td>
</tr>
<tr>
<td>All Others</td>
<td>0.09</td>
</tr>
<tr>
<td>Total</td>
<td>548.59</td>
</tr>
</tbody>
</table>

Let us see then what other natural conditions beyond nodality have placed Pittsburg in this dominating position in the coal and steel industries. From the name of the chief seam worked and the position of Pittsburg, this district area lying south and east of the city has been sometimes called the Pittsburg District. The name has the merit of simplicity and also that of close relationship to the natural features of the region. The rocks of the district, as we have seen, consist chiefly of massive sandstones and limestones of Carboniferous Age. They contain a large number of seams, but by far the most productive of these is that known as the famous Pittsburg Bed.1 This seam lies at the base of a series of massive limestones, and is underlain by massive sandstones and shales. The overlying limestones and the coal seam itself, are known as the Monongahela formation, from the name of the river valley where the formation is most fully developed (Fig. 5). This seam possesses many outstanding advantages, some of which mark it off sharply from its fellows, and have led to its greater exploitation. Of these advantages three from the point of view of coal production are of outstanding importance. The seam lies almost horizontal over very large areas. It is of a fairly

1 U.S. Geol. Atlas, Brownsville, Connellsville, folio No. 94, p. 11. See also fig. 94 in above folio and the Geologic and Top maps for what follows. (No other seam is commercially worked on a large scale).
uniform thickness. Its depth below the surface varies to some extent with the relief, but it is seldom found below 400 feet. It lies mostly either at, or slightly below, or slightly above waterlevel in the main valleys of the region. It is extensively mined where the seams are exposed at the surface. We will therefore expect to find the mines chiefly where the streams of the region have cut down to or below the level of the bed, or along the surface outcrops of the seam at the sides of downfolds. A glance at a detailed map of the area (fig. ) shows us that that is so for we see the mines strung out in long lines along the streams and the outcrop. This detailed map to which we shall have occasion to refer again in connection with the coking areas, shows us one of those very gentle downfolds near the edge of the coalfield, in which the coal has been preserved from erosion. They are separated from each other by regions from which the coal is absent, it having been removed during the erosion and disappearance of the intervening anticline.

This map is based on a series published by the United States Geological Survey on a scale of one inch to the mile, and may be taken as fairly typical of the coal-

2. U.S. Geol. maps, 1:62,500, for the following Quadrangles:- Brownsville, Connellsville, Masontown, Uniontown.
field as a whole, in so far as the position of the chief seam is concerned, though as one goes westward in the field one finds that the rocks are more horizontal, and that therefore the only outcrop of coal is that along the river valleys. The coal found in this bed is chiefly of a high grade type suitable for the manufacture of coke and gas. The most suitable coking coal is found in the extreme south-east of the district. As one moves in a north westerly direction towards Pittsburg, the character of the coal changes broadly speaking through a high class steam fuel to a rich gas coal. With the possible exception of the famous steam coals from the Pocahontas region of West Virginia, the whole of this Pittsburg District contains the very highest grade of bituminous coal found in the United States.

It will be helpful perhaps at this point to describe briefly the area shown in the sketch-map of the Connellsville District as it will enable us to realise better the actual nature of much of this coal mining country. We have seen that Pittsburg stands at the junction of the Allegheny from the north, and the Monongahela from the south. Some ten miles above the city, the Monongahela is joined by its main tributary which flows from the south-east, and is known by the name of the Youghiogheny. Situated on the

right bank of this stream some forty miles from its mouth is the town of Connellsville, the greatest coking centre in the United States, and the natural centre of the region shown in the sketch-map in Fig. 6. In the southeast of the district we notice that there is a long narrow belt of country shown by the shading as being underlain by the Pittsburg coal bed, and that parallel to this belt but in the north-western part of the district there is a similar area, but one which covers a very much greater extent of ground. Separating these two regions there lies a long narrow belt of country where no coal is found. These three areas correspond to the gentle hill and furrow structure found at the edge of the Appalachian Plateau and to which reference has been already made above. The belt of coal country lying to the southeast is a shallow syncline in which the coal has been preserved from erosion, while the district from which the coal has been removed is occupied by a low anticline, beyond which in a northwesterly direction the strata become almost horizontal thus giving us


the wide area in this direction which is underlain by coal. So much then for the structure in general of this area which is fairly typical of the whole region, and which is very simple in type. The rocks consist for the most part of the massive sandstones, limestones, and shales to which reference has already been made. The surface rocks are limestones or limestones barely capped by sandstones. At the base of these limestones lies the Pittsburg coal bed resting on sandstones and shales (Fig. 3). These limestones have been deeply trenched by the numerous rivers of this well watered area. The drainage originally was probably of a very simple type flowing northwestward in accordance with the slope. Subsequently river capture, as in the case of the Pittsburg Region, has led to the present well defined river basins which have largely determined the main coal producing areas. This trenching of the plateau surface has been usually carried sufficiently far to expose the coal bed. This is more especially so.

2 U.S. Geol., fol. 174, 110 etc.
3 See various U.S. Geol. Atlas folios, e.g. Nos. 94, 82, 174, 110, 133, 180, 178, 178.
in the case of the main rivers and their tributaries, while in the case of the smaller streams the coal bed is only a short distance below the floor of the valleys, and can be easily reached either by slopes or by short shafts. In the actual district we have been considering, the eastern part of the area has been much dissected by the main stream of the Monongahela and some of its lesser tributaries, while the remainder of the area has been similarly treated by the Youghiogheny, the largest of the Monongahela tributaries. It will be seen that as a result of this arrangement of the streams, the shallow syncline to the southeast is bisected by the Youghiogheny, which has here cut below the level of the seam as have also its north bank tributaries at this point. In contrast to this, those of the south bank have not quite reached the coal. Nevertheless it will be noticed that in both cases the mines are shewn located along the valleys. From this it is clear that mining operations are not confined to the actual coal exposures, but are carried on wherever the coal is fairly easily get-at-able.

---

1 Those facts are very well shewn on U.S. Geol. folio No. 94.

2 The fact is well shewn on U.S. Geol. folio No. 94.
along the two principal rivers and the outcrop, horizontal adits and upslopes are driven in from the river bank, the coal being run out by gravity planes to the waterside or to the railway track, which follows the stream. In the case of the canalised Monongahela, this coal is loaded into barges which are floated to the blast furnaces and to the factories situated by the waterside in the vicinity of Pittsburg. One of the commonest sights on the river, are these barges with their cargoes of fuel for the Pittsburg industrial region. To facilitate this traffic an elaborate system of locks, thirteen in all, has been constructed on the Monongahela. In this fashion two of the chief obstacles to navigation on the Pennsylvanian rivers are brought under control. These obstacles are low water during late summer and autumn, and floods in spring caused by the melting of the winter snows. Fog which causes at times much delay in traffic, can now be mastered if foreseen in time, by spraying the river with a very fine oil spray. Ice thus remains as the only large scale natural obstacle to water traffic as yet uncontrolled by man.\(^1\) These locks on the river make it

---


easily navigable for barges as far as Morgantown in northern West Virginia, where the southern extension of the Pittsburg coal area is found. The advantage of this system of navigation in facilitating the development of the coal industry is clearly brought out, when we realise that water transport is, other things being equal, very much cheaper than rail, and this advantage is reflected in the fact that out of a total of some 18 million short tons of coal used in 1909 in the Pittsburg Metropolitan District, no less than ten million short tons were water borne on the Monongahela.¹

We have said that where the coal is exposed on the surface it can be readily mined by adits and upslopes. It helps us to realise the extent to which this is done, when we observe that fifty-one per cent of all the coal won in Pennsylvania is won by drift which is the local name for upslope; twenty per cent by downslope requiring some slight mechanical power to raise the coal to the

¹ Mineral Resources, U.S.A., 1915, Part 2, p. 568; See also Kidd, 1903
surface, while rather more than twenty per cent is won by means of short shafts. The deep shafts which are so common in Great Britain and other mining areas, and which add so greatly to the cost of the coal by reason of the expense of getting it to the surface, are unknown in this region. Seldom is the plateau surface more than 400 feet above the level of the seam, and at these extreme heights for this area an examination of the geologic folios of the region reveals no mines. As has been pointed out above the mines are in the valleys and along the outcrops, and even where they do not reach the seam the valleys greatly reduce the depth to which the shafts must be sunk.

As a more or less direct result of the horizontal strata and the great area of the plateau structure in which the seams of the Appalachian Coalfield are found, the seams of the coalfield are very persistent over great areas, and they are also over great areas of a very uniform thickness.

1 U.S. Census, vol XI, p. 213.
3 See also Chisholm, p. 42. Note on high temperature at great depth.
4 See page 17, reference to folios
5 On all these points see fig. 5 which is based on the U.S. Geol. Atlas folios.
This fact is emphasised in the numerous sections of the seams to be found in the geologic folios published by the United States Geological Survey, and is also clearly brought out by a Table published for the first time for the year 1917,2 shewing the percentage of coal mined from seams of certain thicknesses. Thus for the year 1917, 63% of all the coal mined in Pennsylvania came from seams of thickness between 4 and 7 feet, and it has been estimated that a thickness of about 6 feet is a fair average for the famous Pittsburg bed.3 That these conditions are by no means confined to the Pittsburg region but are also the ruling conditions throughout the greater part of the Appalachian Coalfield is shewn by the fact that of the coal mined in West Virginia, 64 per cent, and of the coal mined in Virginia 70 per cent came from seams ranging in thickness from 4 to 7 feet.3 A seam six feet thick is one that is very economical to work.1 Where much thicker seams are found they are expensive to roof, and where thinner seams are worked the cost of raising the coal is proportionately higher, as practically the same amount of work has to be put in as would


be needed in the case of a six foot seam, and a much smaller quantity of coal would be won per unit of expenditure.

The uniformity and horizontality of these seams, render possible the use of coal cutting machinery on a large scale. Here again, we have a marked contrast with the British coalfields where narrow seams, far from uniform in thickness, and frequently far out of the horizontal, are often met with. These facts are clearly reflected in the percentages of coal machine mined in the various areas. In 1919 the percentage of coal machine-mined in Pennsylvania in the bituminous fields was 57, while in Great Britain the percentage was about twelve.

In Ohio the machine mined percentage was eighty-seven. Here the seams are exceptionally horizontal and very uniform in thickness. In the anthracite fields machines are little used, the seams being largely unsuitable for their use, as they are often narrow, frequently heavily faulted, and not merely out of the horizontal, but quite commonly nearly vertical. Here we have the contrast between the horizontal

---

1 See sections and descriptive matter in Walcot Gibson's "Coal in Great Britain."


3 Second Annual Report of the Secy. for Mines, London, 1922, Chart X and Table 41
though in parts slightly undulating structure of the Appalachian Plateau and the crushed, folded and heavily faulted structure of the Greater Appalachian Valley expressed in terms of coal mining; while the advantages accruing from the favourable geographic conditions on the plateau are clearly reflected in terms of cost of coal at the pits-mouth. This in 1919 in spite of the high wages paid in the States averaged $2.49 in the bituminous fields of Pennsylvania, whereas in Great Britain in 1918 it was 19/-.

In the anthracite fields of Pennsylvania the pitmouth cost was slightly less than double that of raising to the surface the bituminous coal won in the same state, but as we have partly seen under wholly different conditions. The actual conditions in the anthracite fields will be more fully considered later.

Before leaving this question of the lie of the Pittsburg Bed there is one other advantage accruing from that lie to which reference may perhaps usefully be made here. In all coal mining operations there is a considerable amount of unproductive time spent by the miners in getting to their work after they reach the surface opening of the

---


2 Colliery Text Book and Coal Traders Directory, 1923, p. 552.
mine. Although in many areas this time is not a very great amount it mounts up to a very appreciable matter in many of the British fields where the miner has not only to go deep but has also to travel some distance, which may even be a matter of some miles under ground, before getting to the working face of the seam. This latter situation more particularly arises in connection with mines such as those of Nova Scotia, where owing to the fact that they run out directly under the sea, there is no opportunity of tapping the seam further along by sinking a new shaft. In the Pennsylvania fields which we are considering this difficulty does not arise. As the seam lies near the surface and is thus readily get-atable from almost any point, the miner has rarely, if ever, to travel far to the working face from the mouth of the mine. Hence other things being equal he can either get out a larger quantity of coal in the same time as is worked in other areas, or he can afford to work shorter hours for the same output. As a matter of fact he does not work shorter hours and it has been estimated by the United States Bureau of Mines that on the average the American miner works seven and a half hours at the coal face as against the British miner's six and a half hours. This reason, coupled

with the facility for machine mining on a large scale, accounts largely for the fact that he has a much higher individual output than his British cousin, the average individual output of the American miner per annum for the period 1911-1918 being 843 tons per annum as against the 333 tons per annum of his British competitor. It is also of interest to notice that during the period for which the above averages were taken the average for the United States almost doubled while that of the United Kingdom decreased by one-fifth. This would seem to reflect two facts, the first being that conditions in Great Britain are becoming more difficult because of deeper shafts, etc., and the second being that the more favourable natural conditions in the United States have enabled her to avail herself more fully of the development of machine cutting.

It has been already pointed out that the rivers of the coalfield have dug out deep trenches in the horizontal rocks of the plateau, and we have already seen something of the importance of these trenches in the way in which they have laid bare the coal seam. There remain however accruing from these features of the relief certain other advantages, which although of minor importance in comparison with that to which we have referred, are nevertheless worthy of mention. The walls of these river trenches are frequently in the case of the larger streams,
as much as one hundred to two hundred feet in height, and may be almost vertical, as it is quite common for a material such as limestone, of which they are mostly composed, to weather into almost perpendicular walls or precipices. In early days the development of this region was somewhat retarded, because these trenches, deeply sunk in the surface of the plateau and with their almost vertical sides, offered considerable obstacles to movement. These trenches are often as much as one mile in width hence they would add greatly to the cost of railway construction on the plateau. The existence, however, of a bench or terrace alongside the water in these trenches, combined with the arrangement of these valleys all centering on Pittsburg, which is in consequence the natural focus of all movement, has obviated the construction of railways on the plateau surface at all. These terraces are usually found varying in width from a few feet, up to half a mile or more and from ten to twenty feet above water level. The rivers are thus entrenched within their old beds. During the first uplift of the

1. Geological Atlas folios, e.g. Folios 82 and 94.
3. With the very minor exception of occasional lumbering lines.
country after it had been reduced to a peneplain, the increased slope rejuvenated the rivers which then cut out the present trenches as their beds. A subsequent uplift still further increased the slope and gave the rivers new cutting power. They then cut out their present beds within the old trenches, thus forming the bench or terrace to which we have referred, and which forms such a suitable site for the roadbeds of the railways of the plateau. Between Connellsville and Pittsburg, the Baltimore and Ohio Railroad on the east bank, and the Pennsylvanian Railroad on the west bank of the Youghiogheny make use of such terraces for their roadbeds; while the Pennsylvanian Railroad in carrying coke from Uniontown in the Connellsville District, makes use of a series of these terraces, first alongside Redstone Creek, a tributary of the Monongahela, and later alongside the Monongahela itself. Many other examples could be given from the large scale maps of the region, but these will perhaps serve to illustrate the matter as they are but typical of many others. In summing up this aspect of the area, we

2. Ibid.  " "  
3. Ibid. folio 94, maps at back.
may say that because of the facts discussed above as to the plateau structure of the country and the nature of the material of which it is composed, many if not all of the railways of the coalfields in the plateau region tend to be confined to the river trenches, and that where terraces are absent in these trenches, heavy expenditure has to be incurred in carrying the roadbed alongside the water.

These terraces greatly facilitate the work of coal-getting in still another fashion, located as they are alongside the water and on the same level in the majority of cases as the outcrop of the coal seam in the river bank, they form excellent sites for mining villages and other communities such as those connected with the coke ovens of the south-eastern part of the district. On such a bench on the east bank of the Youghiogheny, where the river as it enters the shallow syncline containing the famous coking coal has exposed the coalbed, stands Connellsville the centre of the coking industry. Stockdale and Bellevernon occupy somewhat similar positions, the one on a right bank terrace and the other on a left bank terrace of the Monongahela. These locations are no exceptions, as most of the smaller towns and mining communities of the coalfield are similarly

---

2. " " " " 82, " " 
situated. It is not necessary to elaborate here the many advantages flowing from this location in close proximity to the seam and on natural route ways, as they will be readily appreciated from what has been said above as to the general effect of the dissected plateau structure of the whole area under consideration on coal getting.

In summing up the natural factors at work in this region in relation to coal getting, it may perhaps be suggested that from what has been said above it is clear that the dominating geographic factor at work is that of structure, if we include under that head all those geologic conditions and processes which have resulted in the rock structure of which the region is composed. Closely allied to this factor comes that of climate, which chiefly in the form of rainfall and frost action has so interacted with that of structure as to lay bare the coal seam, to provide numerous natural route ways focusing on Pittsburg, and to provide convenient sites for the mining communities. The result of the interaction of these two factors is of course the relief of the country as it is to-day.

Before leaving the region to consider other areas, it may be well to point out that the Pittsburg mining district may be conveniently sub-divided into three fairly distinct

---
fields on a regional basis of river valley, types of coal produced and distribution of coal raised. These districts are as follows:

1. **The Connellsville Coking District.**
   It consists of the counties of Fayette and Westmoreland, which roughly correspond to the middle Youghiogheny and some of the right bank tributaries of the Monongahela. In shape this area is a long and narrow belt running from southwest to northeast until close to the Conemaugh River it merges into the second of the areas, that of Cambria.

2. **The Cambria District.**
   This district includes the county of Cambria and parts of the counties of Clearfield, Jefferson, and Indiana. It corresponds roughly to the upper basin of the Conemaugh River, a left bank tributary of the Allegheny.

3. **The Allegheny-Washington District.**
   This district consists of the counties named, and is approximately the area drained by the lower Monongahela.

The outputs of these three districts for 1912 are given in the following table:
1. **Connellsville District:**
   - Fayette .................................. 32.4
   - Westmoreland ............................ 30.6 63.0

2. **Cambria District:**
   - Cambria .................................. 17.6
   - Clearfield ............................... 7.9
   - Indiana .................................. 9.2
   - Jefferson ................................. 5.4 40.1

3. **Allegheny-Washington District:**
   - Allegheny ................................. 16.9
   - Washington ............................... 16.6 35.5
   - **Total** .................................. 138.6

The Connellsville Coking District produces about one-half of the total coal raised in these districts, the output of which taken together is about five-sixths of the total bituminous coal raised in Pennsylvania. The balance comes from a number of minor areas of which the county of Somerset just to the southeastward of the Connellsville District is the chief.

As the Connellsville District will have to be dealt with separately when the problem of the character and distribution of coke comes up for consideration later on it will, for the moment, be left on one side. The other sub-divisions of the area offer no very outstanding characteristics. The Allegheny-Washington District may be connected in one's mind with the production of an excellent steam and rich gas coal.

---
which is largely used in the vicinity where it is mined, that is in close proximity to Pittsburg, while the Cambria District produces mainly steam and domestic fuels a considerable proportion of which finds its way eastward through the Appalachian Ridges to the tidewater ports of New York, Baltimore and Philadelphia on the Atlantic Seaboard, chiefly for coastwise shipment to New England.

Leaving a consideration of this coastwise and tidewater movement until we can more conveniently consider it as a whole, we will pass on to examine in the order of their respective outputs of coal those other areas of large importance from the standpoint of bituminous coal output in the Appalachian Coalfield. These are two in number, namely the region of southern West Virginia and that of the Birmingham District of Alabama.

Some 150 miles southward of the Pittsburg District we find the second largest producing area in the Appalachian Coalfield and we find it located as in the case of the Pittsburg District where a series of large streams have deeply trenched the plateau surface opposite to where a series of the Piedmont and Coastal Plain streams have cut their headstreams well back into the furrows of the Great Valley. The plateau

---

   U.S. Geologic Atlas Folio, 72 e.g.
is here identical in many respects with that portion of it which we have been considering further to the north. The general slope and therefore the drainage is still to the northwest, the rocks are still almost horizontal over great areas, and are composed of massive sandstones, limestones and shales of Carboniferous Age. The altitude is however greater. We are here at the highest portion of the Appalachian system, and are just at the northern edge of that rather extraordinary area where the general tilt of the valley region changes from the southeast to the northwest, with the consequent result that the rivers of the Great Valley instead of draining away eastward to the Atlantic rise on the westward slopes of the Blue Ridge to the east of the Great Valley and after cutting their way westward in great gorges through the northeast and southwest ridges of the valley, proceed to cut their way into the face of the escarpment forming the eastward boundary of the plateau. \(^1\). In this fashion they cut very deep trenches in the surface of the plateau itself on their way to join the Mississippi system. \(^2\). Of these westward flowing rivers we are concerned here mainly with three, which drain the southern half of the State of West Virginia. These three are the New River and its tributaries which occupy the south

---

1. U.S. Geological Folios. See also article by Bayley Willis in "Physiographical Monographs of the U.S.A.
2. See fig. based on U.S. Top.: Map 1:62,500.
centre of the State, the Big Sandy which forms the southern boundary of the State, and lying between the two, the Guyandotte. Of these the New River is by far the largest system and the one which is most intimately related to the coal-mining area. It is the most northerly of those westward flowing streams which rise in the Blue Ridge and which have been referred to above. It has cut a great gorge across the valley ridges which has a significance in connection with coal distribution which will be discussed later. For the moment we are concerned with the allied fact, that on entering the plateau to eastward and in crossing the plateau it has carved out a trench which is in parts over a thousand feet in depth. In the walls of this trench the coal seam is exposed\(^1\) (fig. 7). The actual exposure of the seam lies some hundreds of feet above water level, the exact elevation varying according to the locality. Towards the eastern edge of the field the seam lies about 1,000 feet above the water level, but as one follows the river westward across the plateau one finds this elevation decreasing fairly rapidly, until in the vicinity of Fayetteville, nearly half-way to the Ohio from the point at which the New River enters West Virginia the main seam lies only some 500 feet above the river. Here then we have a rather

\(^1\) U.S. Geological Atlas, Folio 72.
striking contrast to the conditions existing in the Pittsburg District and one which has given rise to an important difference in the methods of handling the coal to those in vogue in the former district. In this field the coal when brought to the surface will be as we have seen some hundreds of feet above water and therefore above railway level. To solve the problem of handling thus presented gravity inclines are employed to run the coal by its own weight down to the route level, and the weight of these loaded trucks on the down journey haul up the empty trucks together with such supplies as are actually required in the mines. A study of the map (fig. 1) of part of the New River field will make clear both this method of handling and also the nature of the gorge in which the river flows and which makes necessary the gravity planes. 1. Here as in the Pittsburg region the villages are found on the benches or terraces which lie alongside the water in the valleys. 2. Movement over the plateau surface here is much more difficult than in the Pittsburg District, hence we find that the railways are entirely determined as to location and almost wholly as to direction by the plateau trenches. The bulk of the coal

2. " " " "
3. See also note at foot of p. 2.
movement is in directions parallel to the lie of the plateau trenches, being either northwestward to the Ohio and the Great Lakes, or southeastward through the Appalachian Ridges to tidewater on Chesapeake Bay at Hampton Roads.

The conditions which we have been examining above apply mainly to the New River Region of West Virginia, which produces some fifteen million tons per annum, or more than the coal output of the whole of Canada in a normal year, or about 1/3 of the coal output. The region is found in the counties of Fayette and Raleigh and extends for some 25 miles or so up the New River above its junction with the Gauley. An extension of the area lies to the south of the main area near the headwaters of the Coal River, a tributary of the New River. To the south of the New River region is the main producing area of West Virginia, that of Pocahontas and McDowell. It consists of the counties of McDowell and Mercer in West Virginia and that of Tazewell in Virginia. It lies for the most part on the headstreams of the Tug Fork of the Big Sandy. Its total output\(^1\) for the year 1912 was some 19 million tons or some two-fifths of

---

1. Mineral Resources U.S.A. 1912, Part 2, p. 223. I have grouped County statistics to get this result. See also U.S.A. Reconnaissance map on scale 1:2,500,000 for county boundaries.

2. See later under distribution of Coal, p. 122.
the total for the West Virginia fields. In this connection it should be noted, however, that out of a total coal production for the state of West Virginia of 67 million tons, about one-fourth comes from the Fairmont area in the north of the state, and really counts as an extension of the Pittsburg Region, and thus not considered to be a part of what are generally thought to be the West Virginia fields. The Pocahontas McDowell Region is especially famous for the production of a very high grade steam fuel which is said by the United States Geological Survey\(^1\) to come within five per cent of the best Welsh. In this area the conditions as to mining are more nearly comparable with those of the Pittsburg District than those of the New River area, as here the Big Sandy rises on the plateau to westward of the escarpment. For this reason we do not find those great gorges which leave the coal seam far above water level. The streams are smaller and younger, hence they have neither had the time nor the cutting power needed to etch out deep valleys. It is easier, therefore, to handle the coal. With this exception the geographical conditions in all this area are very similar to those of the New River area further to the north.

In addition to the producing areas already described as lying high up on the New River and the Big Sandy, there are also some fairly large producing areas on the lower courses of both these rivers before they join the Ohio, as will be seen from a glance at the map [page 14].

The coal in these latter areas is not of such a high grade type as the excellent steam and coking fuels which are found in the fields on the upper courses of these two rivers. It is none the less extensively mined and the total production of these scattered areas which may conveniently be grouped as the Kanawha Region is about equivalent to 2/3rds that of the Pocahontas Region which, as has already been pointed out is the largest in the state.2

In summing up the conditions in the region of the West Virginia fields, one may say that with the exceptions noted above, they are very similar to those of the Pittsburg Region. We find all those advantages of horizontal seams of an economical thickness and fairly uniform character over great areas which we have already studied in the northern region. We have here also those deeply trenched and terraced river valleys which have exposed the coal on the surface and

### Producing Regions West Virginia, 1912

<table>
<thead>
<tr>
<th>Region</th>
<th>Million Short Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pocahontas District</strong></td>
<td></td>
</tr>
<tr>
<td>McDowell</td>
<td>15.8</td>
</tr>
<tr>
<td>Mercer</td>
<td>3.1</td>
</tr>
<tr>
<td>**</td>
<td>18.9</td>
</tr>
<tr>
<td><strong>New River District</strong></td>
<td></td>
</tr>
<tr>
<td>Fayette</td>
<td>9.6</td>
</tr>
<tr>
<td>Raleigh</td>
<td>5.1</td>
</tr>
<tr>
<td>**</td>
<td>14.7</td>
</tr>
<tr>
<td><strong>Kanawha District</strong></td>
<td></td>
</tr>
<tr>
<td>Kanawha</td>
<td>5.1</td>
</tr>
<tr>
<td>Logan</td>
<td>4.2</td>
</tr>
<tr>
<td>Mingo</td>
<td>2.6</td>
</tr>
<tr>
<td>Pittman</td>
<td>.6</td>
</tr>
<tr>
<td>Boone</td>
<td>.4</td>
</tr>
<tr>
<td>**</td>
<td>12.9</td>
</tr>
<tr>
<td><strong>Other Regions of State</strong></td>
<td></td>
</tr>
<tr>
<td>**</td>
<td>20.3</td>
</tr>
<tr>
<td>**</td>
<td>66.8</td>
</tr>
</tbody>
</table>
have thus made it easily get-at-able, and which have also provided easy routes for movement and convenient sites for settlement. A marked contrast which we will have to consider later is that fact that there are here no manufacturing areas, hence all the coal produced is either converted into coke for shipment out of the area, or is shipped directly out either northward and westward to the shores of the Great Lakes, or eastward through the Appalachian Ridges to tidewater on the Atlantic coast at Hampton Roads.

Alabama Field.

Some 400 miles south of the Pocahontas area we come to the last coal field of major importance in the Appalachian Region if we exempt for the moment the anthracite area of the extreme northeast. This field is the Birmingham field of Alabama. We have already seen that towards the southwest the Appalachian Ridges begin to peter out and finally to vanish beneath the younger rocks of the Coastal Plain. In this southwestern area the streams which rise in the depressions of the Great Valley instead of cutting their way eastward or westward through the ridges as is done by their fellows to the north, here follow the furrows between the great ridges and thus flow out in a southwesterly direction to the Gulf of Mexico. This general direction is not only followed by the valley streams, but also by the streams rising on the southward continuation of the Cumberland Plateau, the portion of the plateau which we
find in this area to the west of the Great Valley, and which corresponds to the Allegheny Plateau in the north. This drainage arrangement probably depends on the fact that here the plateau is composed of a series of detached blocks whose longer axes lie parallel to the ridge and furrow structure of the valley. So we find that in the valley we have among others the parallel streams of the Coosa and the more westerly Cahaba, while on the plateau flowing in a southwesterly direction is the Warrior, and its main tributary, the Mulberry. The escarpment which as we have seen elsewhere forms such a prominent feature in the Appalachian country is here found to eastward of and parallel to the Warrior River.¹

At or near to its foot lies Birmingham, the centre of the steel industry. As in the Pittsburg country there is here one seam which dominates the field to the almost complete neglect of any other for the time being.² This seam runs away westward beneath the plateau and forms the Warrior Coalfield. The seam is known as the Pratt seam. On the average it is about four feet thick, but it is not quite so uniform throughout the area as is the Pittsburg seam in the more northerly part of the field. Close to


² Ibid. pp. 15, 18.
this coal but further to the west and therefore lying in
the Great Valley Region there are two other fields, the
Cahaba and the Coosa, named respectively from the chief
streams in their respective neighbourhoods. Neither of
these areas has so far been worked to a great extent, and
they thus serve as a useful reserve for future exploitation.
Such advantages as we have already seen arising in other
areas from the horizontal arrangement of the strata and the
trenching of the rocks by the rivers, are found to a lesser
extent in this area, the difference where it exists being due
to the fact that we are here getting to the edge of the
Appalachian system, and thus into country where the more
marked characteristics of that region are beginning to break
down and disappear.

As we shall see more clearly in a later part of
our study, only certain coals form good coking coals. The
Pratt seam contains one of those coals which form an excellent
coking coal,\(^2\) hence if iron ore of a suitable character is
available in the vicinity, we will expect an iron and steel
industry. Close to the foot of the escarpment there out­
crops in the same formation as that in which the Pratt seam
is found, a band of excellent iron ore - the Clinton ore -
which, from the standpoint of quality and content of metal,

---

2 Ibid pp. 18, 20.
is comparable to the Lake Superior ores. This ore is a high class hematite and on the basis of it and the coking coal from the Pratt seam has been built up the iron and steel industry of Birmingham, Alabama, where it is stated that iron and steel are more cheaply produced than anywhere else in the world. In close proximity to these two main raw materials there are to be found abundant supplies of limestone, while much timber for use as pitprops is available here, as indeed in all other parts of the Appalachian area not far from the regions where it is needed for use. The coal can everywhere be readily mined by slopes, drifts or short shafts, its bed being readily accessible from the surface.

From four to seven million tons are used annually in the production of coke out of a total production for the states of from sixteen to twenty millions.

2. Ibid. p. 22.
3. Ibid. Maps in appendix.

In 1915 total used was 4.5 million short tons and in 1917 it was 7.2 million short tons.
Although possessing all the advantages set out above, the Birmingham area, in common with all the other bituminous regions of the United States, labours under the very great drawback of lying a long way from tide-water. To the Gulf Coast in the vicinity of Mobile is a distance of about 200 miles, and there is no nearer sea. None of the rivers draining towards the Gulf are sufficiently large to be navigable in an unimproved condition. Within quite recent years, however, to overcome this difficulty a series of locks have been constructed on the Black Warrior and on the Tombigbee, the river into which the Warrior drains. The Tombigbee flows into the Gulf at Mobile Bay a few miles eastward of the site of Mobile. A navigable waterway is thus available from the coalfield to the Gulf, and from here for some time past small barges have carried coal to New Orleans, utilising the sheltered Mississippi Sound along the south coast of the state of Mississippi to the mouth of the Mississippi River. Quite recently a government barge line using 2000 ton barges has been established on the river, and this service has greatly reduced the cost of conveying coal and steel products to the Gulf. These boats draw four feet, and are 280 feet long by 42 feet in width. For handling bunker coal there

is a lighter in the harbor of New Orleans equipped with an endless chain system of buckets, which load coal direct to ship's bunkers from the barges, and thus effect a saving of from $1.50 to $2.00 per ton on bunker coal to ships.¹

In addition to the Pittsburg, West Virginia, and Alabama Regions, there are minor regions of production in the Appalachian bituminous area. These are chiefly found in the eastern parts of the states of Kentucky and Tennessee. The total production of these minor regions is some fifteen or twenty million short tons annually, or about the equivalent of the Canadian output. The conditions of production are very similar to those of the West Virginian fields.

¹ Ibíd.
Anthracite Field.

Let us turn now to a consideration of the anthracite coalfield of Eastern Pennsylvania, which as we shall see, offers a marked contrast to the various bituminous fields which we have been examining heretofore. The eastern part of the state of Pennsylvania is occupied by three of the physiographic divisions into which eastern North America is divided. These regions lie roughly northeast and southwest in three belts parallel to each other. Beginning in the northern part of the state they are the Allegheny Plateau, which with its deeply trenched valleys we have already examined elsewhere, the Great Appalachian Valley consisting of the highly folded and contorted rock structure expressed in alternate ridges and furrows which is characteristic of this region wherever found, and lastly, in the extreme southeast of the state we find a small portion of the old crystalline area which forms the Appalachian foothill country throughout the eastern edge, but which here has almost the character of a low plain with gentle relief. Rising well back on the Plateau and crossing the other two divisions of the region on their way to the Atlantic, are two of the main rivers of the area,
right angle the longer limb of which lies parallel to the Blue Ridge but some thirty miles to the northwest, while the short limb cuts directly across the ridges. In the rough rectangle thus formed the northeastern end consists of the Delaware River. In contrast to the course followed by the Susquehanna this river cuts straight across the ridges and furrows of the valley region, and does not turn southeast until forced to do so by the Blue Ridge, the northern foot of which it follows for a distance of some forty miles before turning sharply eastward through the great water gap which it has cut in the Blue Ridge on its way seaward. It is within the limits of this rough rectangle which lies as we have seen wholly within the region of highly contorted, faulted and twisted strata lying between the Piedmont and the Plateau that we find the great anthracite coalfield of the United States - a region which measures only some 120 miles in length by about one third of that distance in breadth.¹

Before we proceed to examine the details of the conditions governing production and the various subdivisions of the area, let us try to form some concept of what this coalfield means to the economy of the States. In 1919

¹ All the above facts are clearly shewn on the U.S. topographical maps covering this area.
the Susquehanna with its great network of headstreams and tributaries, and the lesser but still fairly large Delaware. The Great Valley is here separated from the lower Piedmont country by the sharply defined barrier of the Blue Ridge (fig. ). Immediately in rear of this ridge lies a valley between five and ten miles in width which is divided into two longitudinally by a lower ridge. Hence just in rear of the Blue Ridge we find two very clearly marked parallel valleys.

The next subdivision of the Great Valley is an area of lesser ridges and basins which occupies the great bulk of the region and is bounded to the north by a more marked ridge of which the best defined part is called the Pocono Mountains. Beyond these mountains and lying between them and the edge of the Allegheny Plateau, we find a second large and clearly marked valley comparable to that already referred to as being just behind the Blue Ridge.

On leaving the plateau country, the Susquehanna enters this valley and receives a tributary from the northeast, the Lackawanna. It then turns sharply to the southwest and follows the valley for a distance of about seventy miles, until it receives a tributary coming this time from the plateau. Thereupon it turns southward and then south-eastward cutting deep water gaps through the parallel ridges of the Great Valley before crossing the Piedmont country beyond. In this fashion the Susquehanna forms a rough
some 88 million tons of anthracite were mined¹ which represented roughly one-sixth of the total coal production of the United States or about twice the total coal production of France or one third of that of Great Britain. Anthracite possesses two outstanding advantages over bituminous coal. It is almost smokeless and it possesses a much greater heating capacity per unit of bulk than does bituminous. For this reason it is mostly used to-day for heating purposes particularly in large blocks of buildings where central heating is employed, such as offices and apartment houses.² It is also excellent for smelting purposes, and therefore it was used in the early blast furnaces³ of the States which, as we shall see more fully later, were established close to the anthracite coalfield in the thirties and forties of last century. Prior to this period the coal was floated down the Lehigh and Susquehanna rivers in crude barges, but so great was the inertia of the human mind to adopting anything new, that at first people refused to have anything to do with it as they did not consider it possible that "black stones", as

they called the anthracite, could be made to burn. It steadily replaced charcoal as a blast furnace fuel during the first half of the 19th century, and during the second half of the century it was itself steadily replaced by coke, mainly, but not wholly, because coke is so much cheaper. Coke also is more efficient from the draught creating point of view. Its higher price is partly due to the fact that the natural conditions as we shall see in a moment, render mining operations much more difficult here than in the bituminous fields, and partly because the organisations engaged in exploiting this natural resource have taken advantage of the fact that it is such a definitely limited natural resource to maintain the price at an artificially high level. With such minor exceptions as to be negligible in any large view, there is no other anthracite producing region in the United States.

We have seen that anthracite is almost smokeless

1 U.S. Fuel Administration, Rept. of Distrib., Part I, p.11.
2 Senate Doc.50, 63 com, 1st Sess., Vol.3. (Question is here considered in full). The Anthracite industry is here described as exhibiting"a high degree of concentration of ownership of a limited natural resource located in a restricted area."
3 See 22nd Annual Report, U.S. Geol. Survey. Also Coal Resources of the World, Canada 1913, p.531.
and that it has greater heating value per unit of bulk than bituminous coal. These characteristics are mainly due to the fact that it is composed of a very high per cent of carbon and a low per cent of volatile constituents, and this composition in turn depends, as has been suggested and also denied, on the conditions to which it was subjected subsequent to its original deposition. We have seen that it is found wholly within the Great Valley Region and therefore within the region where great folding, faulting and compressions have taken place in past ages. In this fashion it is probable that the volatile materials normally present in coal, have been driven out and the residue has been converted into the substance which is marketed to-day as anthracite.¹

¹Footnote on next page.
we have then here a very remarkable contrast with the conditions in the bituminous fields. Here the seams are mostly far out of the horizontal. They may also be very irregular, and may be as much as a couple of thousand feet below sea level, (fig. 5). All these facts practically prohibit the use of machines, so that only some 2% of the coal mined (Ully) is machine mined. Hence, as we have already pointed out the cost of anthracite is very much higher than that of bituminous, quite apart from any monopoly or semi-monopoly which may exist.

We have seen that the coalfield is wholly within the rectangle between the Blue Ridge and the Susquehanna Valley, but within this general area there are a number of clearly marked divisions which can be related to very definite relief features, (fig. 9). The main producing area is that known as the Northern Basin from which comes roughly half of the total output. This basin consists of the Lackawanna and Wyoming Valleys, the latter being part of the longitudinal Susquehanna Valley after the main river receives the


Lackawanna as a tributary. It is shut in to the south by the Pocono Range a fact of some importance in connection with the problem of distribution by rail. The basin is some 55 miles long by about six in breadth. The chief mining centres are Carbondale, Scranton, Nocosic, Pittston, Wilkesbarre and Nanticoke. In this basin the dip of the beds is less than in any of the others, nevertheless it ranges from 10 degrees to as much as 70 degrees. In addition to the difficulties already referred to in the way of general structure, this basin is still further handicapped by the fact that from Pittston to Nanticoke there is a former valley of the Susquehanna now buried in sand. This gives much trouble in the mining, as it causes breaks in the shafts.

South of the Northern basin lie two others, known as the Eastern and Western Middle Basins, which produce between them rather more than one fourth of the total output. Both of these basins are occupied by streams draining into the Susquehanna. The Eastern Middle is a very shallow basin on a high plateau to south of the Pocono Range. Hazleton the chief mining centre is near

2. Ibid. p. 68.
the headwaters of a small stream which drains eastward from the plateau to the Lehigh, a tributary of the Delaware. Mining is relatively easier here than in the other areas as the dip is slight. The Western Middle is really a series of basins within a main basin, the two chief subdivisions of which are the basin surrounding Shenandoah and Mahanoy City and that around Shamokin on the Creek of that name, some miles further to the west. Here the coal has been very much fractured and mixed with slate, the dips are great and mining is difficult.

The last of the major subdivisions of the anthracite field is that known as the Southern Basin. It lies in the great valley already described as lying in rear of the Blue Ridge which we saw was subdivided by Sharp Mountain into two parallel furrows. The most northerly of these is that containing the coal. The valley is occupied by many minor headstreams of the Schuylkill, which cuts its way out through the Blue Ridge and crosses the Piedmont to join the Delaware at Philadelphia. In this basin the dips are greater as a rule than in any of the others, hence the mining difficulties are greater. The output of the basin is rather less than

one quarter of the anthracite raised to the surface in
the field. Although there are a large number of mining
centres as in all the other basins, the main one is
Pottsville.

In the early days of the development of the
area, much coal was moved by water on both river and
canal. To-day practically the whole movement takes
place by rail. Relief control is clearly reflected
in the concentration of rails on the water gaps of the
Blue Ridge, also in the northeast-southwest movement
along the valleys, and the use made of minor headstreams
to facilitate approach to suitable tunnelling points. Thus we see from the map the double line of rail using
the Lehigh Valley and its water gap on the way to New
Jersey and Philadelphia, and the similar concentration
of lines on the Schuylkill water gap to reach Reading
and Philadelphia. The bulk of the anthracite is used
in territory fairly close to the coalfields, certainly
within the region of the northeastern manufacturing area.
Within this region, roughly one third moves to the great
centre of business administration represented by New York,

2. Ibid. Map forming Plate No.6.
CHAPTER II.

COAL - PRODUCING AREAS (CONTD.)

ANTHRACITE REGIONS OF PENNSYLVANIA,
MINOR REGIONS, COAL RESERVES.
New Jersey and related areas. Nearly one sixth goes to New England while one fourth is used in Pennsylvania. One tenth moves to the states adjoining the Great Lakes, and less than one twentieth to Canada, moving mostly by rail through Buffalo. The concentration of the consumption on the great centres of business organisation for use in the offices and in the apartment houses which fringe such centres, is very marked. It is the rapid growth of such centres and the consequent demand for anthracite as a cleanly and highly efficient domestic fuel that has much more than offset the decrease in the demand for it as a blast furnace fuel through the introduction and rapid extension of the use of coke.

Of the remaining coalfields of the United States by far the most important is the Central Field which is found in the states of Illinois, Indiana and Western Kentucky, the total output of which is roughly of the same order as the output of the anthracite field which we have been considering above. The coal produced is not, however, anthracite, it is not even a high grade

bituminous such as that of the Pittsburg Region, but it is an inferior bituminous much less valuable than the bulk of the coal found in the Appalachian Field. Some 40% of the output comes from the Belleville-Springfield area, from what is known as Bed No. 6, by far the most important seam in the state. As far as depth is concerned the coal is readily accessible, and is usually mined at some 50 or 60 feet below the surface. The coal area forms a shallow basin with the coal outcropping along the edges, and for this reason the bulk of the mining is confined to the edges of the field. As in the Pittsburg District the chief seam mined averages about 6 feet in thickness and is therefore a very economical seam to work as far as thickness is concerned.

1. On all this area see U.S. Geol. Atlas, folio 195 particularly p.12. 

"Most of the coal is used for miscellaneous heating and for making steam. For such use this coal is not inherently so valuable as that of the best coals of the Appalachian field, owing to its relatively high content of oxygen, sulphur, ash and moisture..... It is essentially a non coking coal, as attempts to produce a good blast furnace coke from it, have not been successful." And also 22nd Annual Report, U.S. Geol. Survey, Vol. 3, p.

Mining is mostly carried on by means of short shafts.
As the whole of the area has been glaciated the shafts have to be sunk through varying depths of glacial drift.
This renders the sinking of the shafts more difficult as it is always more difficult to sink a shaft through more or less unconsolidated material than it is through the solid. 1.
Trouble also arises because of the frequent presence of water in this looser matter. 1. As has already been pointed out the quality of the coal is inferior to that of the Pittsburg Region, and the large quantities of sulphur present make it very unsuitable for coking purposes hence except for domestic consumption it is unable to compete with that from the Appalachian Field except during the period when the Lakes are closed by ice and traffic becomes impossible. Were it of better quality it would find a ready market in the great steel centres which, as we shall see later, have sprung up in the vicinity of the head of Lake Michigan.

As all the remaining fields of the United States including the Western Interior, the South Western, the Northern Great Plains, the Rocky Mountains, and the Pacific Coast Fields of Washington, only produce taken together a total of some sixty or seventy millions, a detailed examination

1. These difficulties are very fully discussed in Coal Resources of Dist. 4, State of Ill. Geol. Sur., Bull.26, 1921.
would not be justified. The further west one goes in the direction of the Rockies the poorer the quality of the coal. In the Rocky Mountain area there are many detached fields which have been mainly developed either in connection with the transcontinental railways or in connection with the numerous mining camps. In these fields the coal varies much in quality and other characteristics from field to field, and a detailed examination of these differences would be quite out of the question in a study of this character.

On the Pacific Coast the Washington coal is mostly used either locally or moves southward along the coast to California. This movement is however very largely controlled by the price of fuel oil in Southern California. As it rises coal movement slacks off while as it falls the movement increases. For the moment there does not appear to be much prospect of future development in competition with oil, as far from shewing signs of decrease the present prospects for oil development in California are steadily moving on the upgrade. In considering this question of

1. See Ries, Econ. Geology p.27 et seq.

2. In this connection see map of the chief mining areas of the U.S.A. prepared on a percentage basis for the non-ferrous metals.

competition it has also to be borne in mind that an apparatus suitable for oil burning is not necessarily adapted for coal, hence the substitution of the one fuel for the other for industrial purposes cannot take place instantly. As the price of oil rises the increased coal export will tend to lag somewhat behind as rather than incur the expense required to substitute coal burners for oil the tendency will be for certain firms up to a point to pay the higher price for oil.

Before we conclude our survey of the coal production of the United States it may be helpful if we just examine briefly the possibilities of future production. The United States Fuel Administration in a report published during the war, when reviewing the coal resources of the country, estimated that the United States possessed a coal reserve of some fourteen hundred billion short tons (1,446,000,000,000) or a sufficient quantity to keep the whole world going at the present rate of consumption for over 1,000 years, or about eleven times the estimated total reserve of the British Isles down to a depth of 4,000 ft. This total applies only to coal within three thousand feet of the surface and excludes


2. See Second Royal Commission on the Coal Supplies of the U.K. Below 4,000 ft. very difficult to work because of high temperature: see in connection with working under high temperature - Chisholm, p.42.
1.

On this point one cannot do better than quote from Walcott Gibson's excellent book on "Coal in Great Britain," pp. 126, 127 as follows:—

"The restriction of anthracite to definite areas has led to much discussion. Four explanations have been put forward; (1) that the anthracitized seams were originally bituminous coal which have been exposed to a high temperature under a great thickness of sediments; (2) that they were bituminous seams subsequently altered by the neighbourhood of plutonic rocks; (3) that they have been affected by slip cleavage in the disturbed areas; (4) that the differences in composition between the bituminous and anthracitic coals are due to original composition. Objections to the views expressed above are obvious. The coals are bituminous in the Southwest (of South Wales), where the overlying strata is thickest; the igneous rocks of South Wales are of pre-Carboniferous age; the anthracites are not cleaved. Though the Pennsylvanian anthracites are in a highly disturbed region, the seams of coal in the structurally complex regions in the North of France are not more anthracitized than those in less disturbed areas."

See also p. 27, where it is pointed out that "it is even conceivable that ................. alignitic, a bituminous, or even an anthracitic coal, may result, according to the stage at which the decomposition of the vegetable debris was arrested, though this is generally denied."

However these facts may be, there is no doubt that structure here adds greatly to the cost of mining operations. See in this connection 22nd Annual Report, U.S. Geol. Survey, Vol. 3., pp. 68, 70, and 80, where sections are given of the main areas in the anthracite fields.
lignite and sub-bituminous coal of each of which the United States possesses about one thousand billion tons. There is little doubt that suitable methods of utilising this coal for industrial purposes will result from the many experiments in this direction which are being carried on both in the United States and in Canada, a country which possesses an even larger reserve of the lower grade coals than does the United States. The Lignite region of the United States lies mostly in the Northern Great Plains Region in the States of North and South Dakota and Montana, all of which are in close relationship to the Canadian frontier. As against the total U.S.A. reserve of some fourteen hundred billion tons only some sixteen billion tons in all have been raised to the surface in the United States to date.

1. See also Coal Resources of the World, Inter. Geol. Cong. Canada 1913.
CHAPTER III.

IRON AND STEEL INDUSTRY.

COKE.

--------------------------
We have now completed our study of the main facts underlying the production of coal. We have seen where the main producing areas are, and the geographical conditions which assist or retard the bringing of the coal to the surface. We have now to pass on to discuss three aspects of the matter, which with their many subsidiaries may be conveniently summarised as consisting of the answers to the three questions: What is it doing? Where is it going to do it? And how does it get there?

Taking then the first of these questions and confining ourselves to bituminous coal we have available for the year 1915 the admirable figures prepared by the United States Fuel Administration.\(^1\) Grouping these figures conveniently for our purpose we find that out of a total of 445 million short tons, 232 million, or rather more than half the total was used for industrial purposes other than transport. Of the remainder, almost two-thirds if we put together coal used on rails and for bunkering ships, was used for transport in the proportion of rails 122 millions and bunker 12 million, while one-third was accounted for by domestic use plus a relatively small fraction which was exported. Turning in the first instance to that very large percentage which was


\(^2\) See Table compiled from above report appended.
used for the various industries of the country, other than the transport industry, we find that 62 million tons or rather better than one-fourth was converted into coke. Now the chief use of coke is for fuel in the blast furnace to produce pig iron, the latter being the primary product in the iron and steel industry, from which all the other products of that industry are produced. Coke is coal which has been heated in an oven until all the volatile constituents have been driven off. All coals are not suitable for the production of a high class coke. The coal for preference should be soft and friable and of such a character generally that when converted into coke it will form a coherent yet porous mass of a nature which will break into large blocks capable of bearing a fair weight in the blast furnace. Because of this fact and the enormous importance of an abundance of high class coke for war purposes and also to eliminate, as far as possible all unnecessary transport, one of the first acts of the United States Fuel Administration was to prepare a table shewing the value of the various fields from the standpoint of the possibilities of coke production. Judging from the table prepared by them it would appear that in

1. The essential points in a coke for furnace use are hardness of body, well-developed cell structure, purity, and uniform quality. Campbell, U.S. Geol. Atlas folio 94, p.17. See also Ibid for Analysis of Connelsville Coke.

all parts of the Appalachian Field there is to be found coal of quality suitable for the production of commercial coke but that the quality appears to vary very much within each locality. Thus of the coal used in Alabama in the year 1917, over 25% was suitable for this purpose, while almost the whole of the New River and Pocahontas coals were suitable. Of the Pennsylvanian coals over 50 per cent were found to be of the right type, but the great bulk of this coal came from the extreme southeast corner of the field. Out of a total of 66 million tons of coal consumed within the State in the year 1915, 38 million tons, or between one half and two-thirds of the total was used in the manufacture of coke. Part of the coal thus used came from the neighbouring State of West Virginia and moved down the canalised Monongahela, from the Fairmont District in the northern part of the State. In the same year roughly two-thirds of all the coke made in the United States was made in Pennsylvania, and rather more than half of all the coke ovens were in that State, while at least half of all the United States coke came from one small district - that of Connellsville.

1. Mineral Resources, U.S.A., 1915, Part 2, p.524. Here there is an excellent article dealing with the whole question of coke and emphasizing the importance of the change over to by-product ovens.


3. There is an excellent map shewing the distribution of the coke ovens of the U.S. in Mineral Resources 1915, U.S.A., Part 2, p.532.
This small district which occupies such a dominating position in the iron and steel trade of the United States has already been described on pages . As we have seen it is only some sixty miles long by six or so in breadth, and is really a detached outlier of the main Pittsburg Region extending from Latrobe in the northeast to Fairchance in the southwest, (fig. ). We have also seen that the central part of this outlier has been much cut up by the Youghiogheny and its tributaries notably by Jacob's Creek and Sewickley Creek lying north of the main river, and by the headwaters of Redstone Creek and George Creek, tributaries of the Monongahela. The area dissected by these streams is the heart of the Connellsville Coking District, and Connellsville situated on a river terrace where the Youghiogheny enters the coalfield, is the centre of the industry and has given its name not only to the district but to the coke produced.

Connellsville coke made in the old fashioned beehive ovens on the coalfield was, in 1912, the standard blast furnace fuel in the United States, and commanded the highest price.  

1. "The Coal is soft and easily mined. It breaks up into fine particles and is thus in the best condition for thorough coking." White & Campbell, 22nd Annl. Rept. U.S. Geol. Sur. Vol.3, p.177. See also Mineral Resources, U.S.A., Part 2, 1912, p.234 and 279. This paper also includes a careful analysis of the various coking areas of Pennsylvania giving the number of coke ovens, the coal used, the coke produced, and the value per ton of the coke at the oven for each of the areas discussed.
The process of manufacturing coke consists, as we have already seen in heating suitable coal in an oven until all the volatile materials have been driven off. In the method employed in Connellsville to bring about the desired result the coal is heated in open ovens which on account of their shape are spoken of as "beehive" ovens. This process is a most wasteful one as all the very valuable by-products are dissipated into the air. Modern practice tends steadily to replace the wasteful "beehive" coke with coke produced in what are called retort or by-product ovens, names both of which are self-explanatory.¹ In these ovens the by-products are saved and converted into many useful products. Benzol derivatives, gas, ammonia, and coal tar are the more valuable products thus obtained and in the year 1916 the value of these four sets of products alone came to some sixty-two million dollars while in the same year the coke produced at the same time was valued at seventy-five million dollars.² Prior to the introduction of the by-product oven all these products were lost. It is true that in that year

¹ On Coke generally see "Products and by-products of Coal," Canada, Dept. of Mines Bulletin 323.

² Mineral Resources, U.S.A. 1916, Part 2, p.1089. In 1920 the value of the by-products was not less than ninety-four million dollars; see Coal Catalog 1922.
some half of the sixty-two millions was represented by benzol products such as toluol which was in great demand for war purposes and it is also true that by-product coke is much more expensive to produce than beehive coke because of the greater working and overhead expenses of the by-product oven. None the less the rapid increase in numbers of the later indicates their more profitable nature. In this connection it is interesting to notice that while in the year 1900 only one million tons of coke or 5 per cent of the total was manufactured in by-product ovens by 1918 some twenty-six million tons or 46 per cent of the total was so made. 1

As a result of the rapid spread of the process one finds a steady shift of the coking Industry from the coalfield to large manufacturing centres such as Pittsburg and Youngstown, and to the lake shore smelting centres, as at Cleveland and Buffalo, where the by-products can be profitably used on the spot. Many cities on the shores of the Great Lakes and in large manufacturing centres now get almost their whole supply of gas for heating, lighting and power purposes from retort ovens. Indianapolis, Hamilton, South Chicago, Milwaukee and


Duluth may be cited as examples, which get their gas in this way much more cheaply than would otherwise be possible, a fact which has been brought clearly home to them during recent steel strikes, when they were forced to depend on the much more expensive water gas. This shifting of the industry to the shores of the Great Lakes is clearly illustrated in the establishment of many steel works in the Lake country of recent years, such as that of the United States Steel Corporation's great plant at Gary at the southern end of Lake Michigan where great batteries of retort ovens have been constructed to which the coal is brought from the coalfield by rail.

Of the total amount of coke produced in the United States in 1912 three-fourths was made in beehive ovens, and of this "beehive" coke, two-thirds came from the Connellsville District. It perhaps gives some idea of the size of this industry if one bears in mind the fact that over 50,000 carloads of coke per month were shipped out of the district in that year. Because of the fact that the coal from which coke is made occupies a greater bulk than the resulting coke, should the practice of coking at the furnace instead of on the

2. Ibid.
3. In 1915 we took 15 tons of coal on the average to make 10 tons of coke for U.S.A., as a whole, and this average was also true for the State of Pennsylvania. In this connection see Table of figures on p.541 Mineral Resources, U.S.A. 1915, Part 2.
Table Shewing Distribution of Bituminous Coal
Compiled from Statistics on p.12 of Report of,
Distribution Division, U.S. Fuel Administration 1919.

<table>
<thead>
<tr>
<th></th>
<th>1915 Million Short Tons</th>
<th>1917 Million Short Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industries</td>
<td>160</td>
<td>175</td>
</tr>
<tr>
<td>Coke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beehive</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>By-Product</td>
<td>20</td>
<td>84</td>
</tr>
<tr>
<td>Coal Mines</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>232</td>
<td>271</td>
</tr>
<tr>
<td>Rails</td>
<td>122</td>
<td>154</td>
</tr>
<tr>
<td>Bunker</td>
<td>12</td>
<td>154</td>
</tr>
<tr>
<td>Domestic</td>
<td>55</td>
<td>57</td>
</tr>
<tr>
<td>Exports</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>Public Utilities -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity and Gas</td>
<td>5</td>
<td>37</td>
</tr>
</tbody>
</table>

In 1915 part of public utilities included under Industries.
Figures to nearest million short tons.
coalfieldd, become universal, this rail traffic will, quite apart from the normal growth of the iron and steel industry become still greater, but instead of carloads of coke we shall then have carloads of coal. Since the Pittsburg seam becomes less suitable for coking as we go westward, the change in the location of the ovens will not interfere with the great importance of the Connellsville District from the standpoint of the production of the finest coke. Its importance would then be of rather a different character, as, instead of being the source of the finest coke, it will then be the source of the raw material needed for the manufacture of the highest grade of coke. In this connection we have two points to bear in mind. In the first place the position of affairs foreshadowed above will come to an end when the coal of the district becomes exhausted, and a recent estimate by the United States Geological Survey puts the life of the coal reserve in the Connellsville District at about 25 years. If this estimate is anywhere near the truth, the end of this great coking field which for so long has dominated the pig iron industry of the United States

1. See page 15.

2. 22nd Annl. Rept. of U.S. Geol. Survey. Also Mineral Resources
is well within sight. Secondly we have to notice that coke can be made in retort ovens from coal which would not produce a good quality "beehive" coke. The West Virginia coals are on the whole poorer in coking qualities than are those of the Pittsburg Region, but they are excellent from the standpoint of the production of retort oven coke, hence they are being used to an increasing extent for this purpose more particularly in connection with the lake shore smelters, as there is a very small local demand and a down grade all the way on the whole from the West Virginia fields to the lake smelters. Thus we find these facts reflected in recent years in the steadily growing shipments of coal from the New River and Pocahontas Districts of West Virginia to the blast furnaces of Cleveland, Gary, South Chicago, and other smelting centres on the shores of the Great Lakes, where increasing numbers of retort ovens are being built almost yearly. This development it is obvious will have the very interesting effect of increasing the life of the Connellsville District. As reflecting and commenting on the facts described above it is useful to note that according to the "Mineral Resources of the United States for 1915", some 81 per cent of the beehive coke made in that year was made from Pennsylvania coal while only 5 per cent of it was made from West Virginian coal. On the other hand over

40 per cent of the by-product coke was made from West Virginian coal, thus reflecting the movement to the lakes, while only some 33 per cent was made from Pennsylvanian coal.¹

Of the total coke manufactured in the year 1915 rather less than half was consumed in the steel centres in the vicinity of Pittsburg and Eastern Pennsylvania, about one-fourth in the smelters of Ohio as at Youngstown, and the balance on the lake shores as at Gary and in Alabama.²

CHAPTER IV.

Iron and Steel Industry.
Iron Ore Production, Movement and Reserves.
Steel Centres.

-------------------
Having seen then something of the factors and conditions influencing the production of coke let us turn to a consideration of the factors underlying the production of the other two raw materials which play their part in the blast furnace and which together with coke are of fundamental importance in the iron and steel industry. There is very little to be usefully said about limestone as one of the most outstanding facts about it is its great abundance and its very wide distribution throughout all of the area where it is required. Being present in such accessible amounts nearly everywhere it has exercised a very limited control on the development and location of the industry. We will therefore pass on to examine the geographical problems which arise in connection with the location, production, and distribution of iron ore and the location of the chief centres of the blast furnace industry.

As we saw was the case with reference to coal a map showing merely the location of the chief deposits of iron ore in the United States gives a very misleading idea as to the chief centres of production (fig. 1). From the

1. In this connection see the numerous Geologic folios covering the area; also the 22nd Annl. Rept. of the U.S. Geol. Survey and the numerous articles on Coke in the Mineral Resources Volumes.

facts shown on this map, it would appear quite probable that
the main sources of iron ore were to be found along the western
edge of the Greater Appalachian Valley near the position of the
Allegheny Front. Some very small areas will be noticed towards
the western and southern shores of Lake Superior. Judging from
the map alone these would appear to be almost negligible sources
of supply, yet this is far indeed from representing the true
state of affairs, for in the year 1919 the total U.S.A. production,
or some fifty-two million tons, came from a relatively small district lying northwest and south
of the lake. Of this 86 per cent the bulk was mined in one
section of the district known as the Mesabi Range (fig. )
situated some seventy miles inland from the great grain shipping
port of Duluth. It will help us to realise the importance
of this range from the world point of view, if we compare it
from the standpoint of production with some of the chief
European producing areas.

According to the Census Reports of the United States
for the year 1909 the United States in that year produced
42 per cent of the total iron ore production of the world,
and her next nearest competitor was Germany which produced
only half that amount. Following Germany came the United

Kingdom with a production of 12 per cent, and after it came France with a slightly smaller amount, the percentage given being 10. The position to-day is very similar except that the passing of the whole of the Lorraine ore into French hands has put Germany out of her place in the list and her place has been taken by France. Spain, Sweden and Austria followed with smaller totals, and a number of other countries such as Newfoundland, Canada, Cuba, and Algeria had outputs which represented about one per cent of the world total. It will therefore be seen that the United States produced the very large proportion of something over one third and less than one half of the total world production and the great bulk of the remaining two-thirds came either from the United Kingdom, or from territory now in French hands plus smaller amounts from Spain, Sweden, Austria and Germany.

We have seen then that the United States is the greatest iron ore producer in the world and further that the bulk of her output comes from what, regarded from the areal point of view, is a relatively small region near the head of Lake Superior. And we have noted the still more striking fact that the bulk of the output of that small region can be narrowed down to one special mining area known as the Masabi Range, which alone produced in the year 1913 over 9 million long tons of ore. It will still further enable us to

realise the world importance of this range if we compare it with the greatest of the European iron ore deposits, namely that of Lorraine. This great field, which in pre-war days was shared between France and Germany, is known as the Minette ore field of Lorraine and Luxembourg. In 1913 the total output of this field including the French, German, and Luxembourg areas under one head, as they all formed parts of the one field, was 43 million tons. From this fact it looks at first sight as if these two fields, the one in America and the other in Central Europe, were very nearly comparable from the standpoint of sources of raw material for the iron and steel industry. We do not perceive that this is not so until we begin to consider not merely the output of ore from each field but also the amount of metallic iron present in the ores obtained from each of these fields. While the American ore yields about 52 to 64 per cent of metallic iron that from the Lorraine field yields only from 33 to 40 per cent on the average. In other words the European ore is a very low grade ore and, other things being equal, will not therefore stand as

2. Rastall's Geol. of Metalliferous Deposits, p.328.

See also 21st Annl Report of U.S. Geological Survey Vol.3. p.371. This article contains an elaborate description of the iron-ore districts of Lake Superior, by Van Hise, and Leith. In this article the Mesabi ores are estimated to range from 39% to 69% with an average of 63%.
heavy transportation costs as will the American ore. This
fact throws an interesting sidelight, a study of which is
however beyond the scope of our present purpose, on the
dependence of the French ore on the Ruhr Coalfield for its
sales of ore and supplies of coke. The contrast between the
two fields is perhaps made even more vivid if we realise that
to obtain one hundred tons of metal from the American ore it
would be necessary to shift at a maximum something less than
200 tons of ore while to obtain the same quantity of metal
from the Lorraine ore, one would have to move some 300 tons
of ore.¹

A further contrast between the conditions in the two
fields becomes clear when we begin to consider them from the
point of view of location of the ore beds with reference to the
adjoining strata, and thus from the standpoint of accessibility.
The Lorraine deposits form a definite stratum underground in a
series of limestone rocks which are comparable to the oolitic
limestone series of the British Isles.² These rocks form,
owing to the trenching of the river, a marked escarpment over­
looking the Moselle. Where the ore outcrops on the face of
this escarpment, it can be mined fairly readily by adits driven

¹. It should also be remembered that not only will transport
costs be greatly increased but also costs in connection with
smelting the bulkier Lorraine ore will be higher.

into the outcrop on the cliff. Being closely associated with the limestone in which it is found it requires no flux and this is of course of considerable advantage from the point of view of the smelter. Apart from the outcrop however it must be mined by shafts from the plateau surface overlying the deposits. The average thickness of the deposits is in the neighbourhood of 80 to 100 feet. The depth below the surface varies from the surface outcrop in face of the escarpment to some 1,900 feet below the surface at Verdun.

When we turn to a consideration of the conditions on the Mesabi Range we find a very different state of affairs. Here we do not find the ore lying in relatively thin beds some distance under ground, but close to the surface in vast masses which may be as much as 2,000 feet long by 1,500 feet broad and 500 feet in thickness. These deposits are covered only by a thin mantle of drift or boulder clay. Both the boulder clay and the underlying masses of ore are soft and friable and this fact makes it

---

1. Geol. of Metalliferous Deposits, Rastall, 1923, p.354.
possible to depart entirely from the normal methods of mining by means of tunnels and shafts and to adopt the much simpler and cheaper methods of mining by steam shovel on the lines adopted when excavating for foundations in building operations. In this method of procedure the cover of drift is first dug off by steam shovel and in this fashion the underlying ore body is exposed. When this has been done, the ore is removed by cutting it away in a series of great terraces which give the ore fields at a superficial glance very much the appearance of those hillsides in the Far East, which are terraced for rice cultivation in mountain regions. The great steam shovels used in the ore fields dig nine feet at a time and lift some four and one half tons. Because of the exceptionally favourable geographical conditions described above with reference to the Mesabi Range and which are present to a lesser degree in the other producing districts of the Lake Superior Region, ore can be obtained here much more cheaply than at any other centre in the United States with the possible exception of the Birmingham District of Alabama. In the Cuyuna Range which lies westward of the Mesabi the conditions are identical, though this latter range

3. For a full discussion of the advantages and disadvantages of the glaciation of this district in its effect on iron ores, see Amer. Bull., Vol. 43, p. 564.
has as yet only been developed to a limited extent. None of the ranges of the Lake Superior country are more than one hundred miles from navigable water, the bulk of them are less than half that distance, while the Mesabi Range which we have been considering lies from seventy to eighty miles from the lake shore.

Of the six ranges of the Lake Superior country we have touched on two. There remain four to be located and considered. One of these is the Vermilion which lies in echelon with the Mesabi about ten miles farther inland towards the northwest and therefore close to the Canadian frontier. It is entirely owned by the United States Steel Corporation, which through its subsidiary the Oliver Iron Mining Company\(^1\) holds three-fourths of the total ore reserves in the State of Minnesota in which are situated the Mesabi, the Cuyuna and the Vermilion deposits. The reserves in the United States if we consider ore of a metallic content of over 50 per cent have been estimated to be over seventy thousand million tons or an amount which at present rates of consumption would be sufficient to maintain the output for nearly fifteen hundred years. In addition to these enormous supplies of high grade

\(1.\) Les Annales, Mar. 15, 1913, p.123.

ores, there are very much larger supplies of lower grade ores which are quite equal in many respects to the European ores, but which cannot be worked to-day in competition with the high grade American ores. Estimates of these supplies are largely in the nature of guess work. It is interesting to notice in passing that the supplies of ore in Lorraine, all a low grade ore, are only estimated to be about seven to eight thousand million tons or less than one-tenth of the high grade ore reserves of the Lake Superior Region, and this offers a still further contrast between the two chief iron ore producing areas of the world.

The remaining three ranges all lie to the south of the lake in the northern part of the peninsula portion of Wisconsin. They lie, as can be best seen from the map, fairly close to the water, and are in order from left to right, the Penokee-Gogebic, the Marquette, and the Menominee. As in the case of the regions already dealt with the ore is present here in vast bodies, but the position of these bodies with reference to the surface and surrounding rock masses offers a marked contrast. The ore bodies being further underground and being enclosed in hard rock strata which are either steeply inclined or in some cases even vertical have to be mined by shaft, and for this reason the cost of winning the

ore is higher. The quality of the metal and the percentage of metallic contents in the ore is just as high and situated as they are much closer to navigable water, these districts are in a more favourable position for marketing their ore, (fig. 2). As the following figures of the actual output of the various ranges for the year 1918 shew, they were not being exploited to anything like the same extent as was the Mesabi:

<table>
<thead>
<tr>
<th>Range</th>
<th>Output (million long tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Mesabi</td>
<td>39.1</td>
</tr>
<tr>
<td>Penokee-Gogebic</td>
<td>7.8</td>
</tr>
<tr>
<td>Menominee</td>
<td>6.0</td>
</tr>
<tr>
<td>Marquette</td>
<td>3.9</td>
</tr>
<tr>
<td>Cuyuna</td>
<td>1.7</td>
</tr>
<tr>
<td>Vermilion</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Having thus seen the location of the chief Lake Superior deposits together with the local factors conditioning production, let us turn to a consideration of the outside factors at work in influencing production in this region. At the outset, it will help us to realise more clearly the position, if we study for a few moments the contrast between the development of the iron and steel industry in the United

States with that of Great Britain. In the latter country the fundamental raw materials needed for the industry were side by side and near the sea. Thus in the Tyne, Wear, and Tees country of north eastern England there was the coal of the Northumberland and Durham Coalfield, the large iron ore deposits of the Cleveland Hills, and the magnesian and carboniferous limestone deposits. All of these were in close proximity not merely to each other but to the sea. At Barrow the valuable hematite ores used in conjunction with the coal of the Cumberland Field on the coast to the north form the basis of the large shipbuilding and engineering industries of the Furness District. Even where as is the case in South Wales, local supplies of ore are largely worked out, foreign ore from the north coast of Spain can be easily and cheaply brought in by sea to the furnaces in close proximity to the coal mines on the South Wales seaboard.

When we turn from this picture of conveniently located raw materials to that of the industry in the United States we see a very different state of affairs. In the early forties the primitive forges of the Appalachian Valleys based on the charcoal of the forests and the scattered local supplies of ore from the limestone outcrops of the ridges and escarpments of the Alleghenies had been largely replaced by a concentration of the youthful industry in the Piedmont country lying

---

between the Blue Ridge in southeastern Pennsylvania and the Delaware River, where, passing Philadelphia on its way to the sea it flows parallel to the Blue Ridge. Lying just back of the Blue Ridge in the Appalachian Valleys as we have already seen, is the anthracite coalfield, and on this supply of coal, highly suitable for smelting purposes plus the scattered local supplies of ore were based the iron industries of those days. Coke was not then used as a raw material for smelting the ore nor had the vast ore deposits of the Lake Superior country been discovered.

Fur traders moving easily by canoe over the almost unexplored north country were the first to uncover these vast stores of future wealth, but it was long before there was any realisation of the great part which these ores were to play in bringing about the dominating position now occupied by the United States, in the iron and steel industry of the world. That this should be so is not surprising when one grasps the enormous distance lying between the coal country and these ore fields. The modern industry demands coke as a blast furnace fuel. Connellsville, the centre as we have seen of the coking industry lies a distance of about one thousand miles from the Lake Superior ore deposits. Had it not been

for the fact that for the greater part of this distance a line of natural water communication in the shape of the Great Lakes and their connecting streams offers an easy route between the two areas, the double movement of iron to coal and coal to iron which takes place along this route to-day and which forms such an outstanding feature of the industry, would have been impossible, and the American iron and steel industry would have been compelled to follow quite different lines in its development. As it was, although this great waterway existed, in its natural state it was of little use. The connecting streams between the lakes were interrupted by rapids and obstructions in the channels, which effectively prevented them from being used by anything but canoes. The most important of these obstructions existed where the St. Mary's River, through which Lake Superior drains into Lake Huron, falls a height of twenty feet in a series of rapids and cataracts in a distance of about one mile on its way to the lower lake. To overcome this obstruction canals have been from time to time constructed and deepened to meet traffic demands. Of these canals the first was constructed in the forties and it was a twelve foot canal.\(^1\)

\(^1\) On the obstructions to navigation and the canals by which they are avoided see two useful articles in the Times Trade Supplement for 15/1/21 and 22/1/21 by the Canadian Secy. to the Joint International Waterways Commission; and see also the Great Lakes Pilots, Vols. I & II (1921) Nos. H. O. 108A and 108B, and see also Amer. Bull. Vol. 43, 1914, p. 658 et seq. See also Bull. Amer. Geog. Soc. Vol. 43, 1911, p. 568. It is interesting to note that as the writer of this article says, "The efforts to induce the American Government to build a canal at this point (the Soo) were at first unsuccessful, largely through the opposition of Henry Clay, it is said, who could think of no resources of the Lake Superior Region the transportation of which would ever warrant the enormous
Footnote (Contd.)

expense of the canal." For a full description of the projects for improving the Great Lake Navigation and also the present position see Report of the International Joint Commission submitted to the U.S. Senate and issued as Senate Docs. 114 and 179, 67th Con. 2nd Sess. 1921-22.
After the Civil War this canal was deepened to sixteen feet. To-day there are no less than five parallel locks, one of which is on the Canadian side and is 22 feet deep, while of the four remaining on the American side, two are twenty-four feet deep. The ruling depth of the route however is here 22 feet, as that is the depth of the approaches to the canals in the St. Mary's River. These canals constitute the famous "Soo" canals, which, as we shall see have played and are playing a very big role in the American iron and steel industry.

Other barriers to free movement along the lakes were the obstructions in the channel linking Lake Huron with Lake Erie. This channel consists of the St. Clair River, Lake St. Clair, and the Detroit River which empties Lake St. Clair into Lake Erie. A depth of 21 feet now exists at low water in this channel and this is sufficient to take the great whale-back boats used in the Lake trade. The size of these boats has steadily increased, until to-day we have boats such as the Grant Morden, which is no less than 625 feet in length with a tonnage of 12,000 and is capable of carrying half a million bushels of wheat. With this channel made practical, a through waterway was provided from the head of Lake Superior to the southern shores of Lake Erie. Based largely on this development and the introduction of coke as the standard blast furnace fuel, by the early or middle

---

1. Times Tr. Sup: 22/1/21. Article by Canadian Secy. of Joint International Com: for investigating the proposed deep waterway from the Great Lakes to the Atlantic.
seventies, the centre of the iron industry had largely shifted to the district around the city of Pittsburg at the forks of the Ohio. To this point the coke moved from Connellsville, and met there the ore brought by water and rail from the head of the Great Lakes. We have not here the space available to consider the many other developments which were needed before the Lake Superior ores could move in this fashion and become the dominating factor in the industry which they are to-day. It must suffice for us to say that these improvements were mainly related to the invention and application of machinery on a large scale to the efficient handling of the ore, so as to reduce to a minimum that most expensive item in the cost of modern transport - the transferring of commodities from one system of transport to another, and the putting of commodities on and off carriers.

As a general result of these developments, the Mesabi Range with its enormous deposits of ore readily handled by machinery, began to come into play in the early nineties of last century and to-day is in the dominating position of

supplying over seventy per cent of the output of the Lake Superior country.

This great movement of ore from the head of Lake Superior to the shores of Lake Erie has led to the growth of two groups of highly specialised ports on the Lakes,¹ the one group relating to the iron fields engaged in despatching ore and the other group related to the blast furnace centres in or near the lakes, and engaged in receiving and forwarding the ore to its final destination. Of the first group we will expect that those having the largest traffic in ore will be those connected with the Mesabi Range at the extreme head of Lake Superior. These are Two Harbours, Duluth, and Superior which as will be seen from a glance at the map, are in close relationship both to the Mesabi and also to the Vermilion Range. Of the rest Ashland towards the southwest end of the lake is the port of the Penoke-Gogebic, Marquette on the south shore handles the ore from the Marquette Range, while Escanaba on the northwest coast of Lake Michigan serves as an outlet for the Menominee Range.² All these ports have plenty of deep water for the large lake boats.

The significance of this fact is rooted in the past. A slight depression\(^1\) of the region during late glacial times resulted in the drowning of the lower parts of the river valleys which thus form excellent deep water harbours. For this reason the depth available in Duluth and Superior for example, compares very favourably with that of many ports on the Atlantic Seaboard. As will be seen from the Table (\(^{2}\)) Duluth handles the greatest quantity of ore nearly one-third of the total and is fairly closely followed by Superior and Two Harbours. These three ports are of course most intimately related to the Great Mesabi Range. Of the three remaining shipment ports each serves as the outlet for one of the smaller producing regions south of the lake, and handles as we should expect smaller quantities of ore.

Of the second group of ports engaged in this traffic, those on the south shore of Lake Erie are by far the most important from the standpoint of quantity of ore handled, the Lake Michigan ports being chiefly the two neighbouring ports of South Chicago and Gary at the extreme head of the lake. Gary is controlled by the United States Steel Corporation and contains the Corporation's new plant which is said to be the

---

\(^1\) Amer. Bull: Vol. 43 (1911) p. 564.
largest steel manufacturing plant in the world. Of the Lake Erie ports Cleveland, Ashtabula, Conneaut, Buffalo and Lorain are the chief handlers of the ore. We may regard these Lake Erie ports as being of two distinct types. The first of these types is the port which merely receives the ore and forwards it inland by rail to the Pittsburgh District the Youngstown District, or some other steel district on or near to the coalfield. Of the ports of this type, the best examples are Ashtabula, Conneaut and Fairport. These ports practically do nothing else but receive iron ore and ship coal. Thus according to the U.S. Geological Survey Report in the Mineral Resources of the United States for 1912, of Ashtabula's total receipts, over 99 per cent consisted of iron ore, and of her water shipments over 90 per cent was coal. The second type of port is the one which receives the ore both to forward it inland and also to use it in the blast furnaces set up in the port itself. This latter class of port as we have already seen has been increasing since the introduction of the by-product oven. Two of the best known examples of this type of port are Cleveland on the Cuyahoga River in the middle of the south shore of Erie, and Buffalo on Buffalo Creek at the eastern


end of the lake.

The following table gives for the years 1912 and 1918 the shipments of Lake Superior ore and the receipts at lake ports:

<table>
<thead>
<tr>
<th></th>
<th>Shipments</th>
<th></th>
<th>Receipts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Million tons</td>
<td></td>
<td>Million tons</td>
</tr>
<tr>
<td></td>
<td>1912</td>
<td>1918</td>
<td>1912</td>
</tr>
<tr>
<td>Superior</td>
<td>14.2</td>
<td>14.1</td>
<td></td>
</tr>
<tr>
<td>Duluth</td>
<td>10.5</td>
<td>20.6</td>
<td></td>
</tr>
<tr>
<td>Two Harbours</td>
<td>9.4</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>Ashland</td>
<td>4.8</td>
<td>7.6</td>
<td></td>
</tr>
<tr>
<td>Marquette</td>
<td>3.3</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Escanaba</td>
<td>5.2</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>Total Lake</td>
<td>47.4</td>
<td>51.3</td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>.8</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>48.2</td>
<td>63.0</td>
<td></td>
</tr>
</tbody>
</table>

As will be seen from the above table the shipments are in excess of the receipts. The difference mainly goes to certain furnaces located on the shores of the Great Lakes in Canada, to which reference has been made in the section dealing with that country.

Since all traffic must pass from Lake Superior it will

---

be seen that the really critical point in connection with this great traffic movement regarded as a whole, is the St. Mary's River with its system of canals commonly spoken of as the "Soo." It may be helpful if we compare the bulk traffic of the "Soo" canal system with that of the Suez, which, prior to the opening of the Panama Canal, was the greatest of the world's ship canals. In doing so it is necessary to bear in mind the very different character of the traffic in each case, and also the fact that because of the closing of the Great Lakes by ice, the "Soo" canals are only open for a period of about eight months of the year, which period usually begins about the first of May, and ends about the first of December. Under favourable conditions the ore boats may start during the last week of April, and traffic may continue well into December. For this reason comparative figures of the "Soo" traffic from year to year are rather misleading, as the open period may vary to the extent of a month in extreme cases. This fact also introduces a special set of problems in connection with the storing of the ore in sufficient quantities at lower lake ports during the open period, to tide the industry over the time when the waterway is closed to traffic by the ice.

As to the nature of the traffic on the "Soo" it may be

said that approximately 90% of that moving eastward is iron ore, and that about the same percentage of that moving to the west is coal. Of the remainder the bulk moving eastward is grain, flour and copper, while the westward movement consists chiefly of manufactured goods. Offering a marked contrast to this traffic in character is that of the Suez. Here we have moving to the east mainly manufactured goods, and to the west very mixed cargoes of tropical and semi-tropical eastern products, of a type which contrast strongly with the bulky raw materials of the "Soo."  

We still have (our) marked contrast when we consider the tonnage passing through each of these great critical traffic points. In the year 1906 the total traffic on the Suez was 13 million tons, while that of the "Soo" canals was over 41 millions net tons, or just over three times as great. By the year 1913 the Suez tonnage had risen to about 20 million tons, while that of the "Soo" in 1916 had reached 92 million tons, or nearly 5 times that of the great

2. Chisholm, pp. 474, 475.
4. The Suez tonnage decreased after 1913.
5. This was of course partly under the stimulus of the increasing demand for munitions for Europe. For tonnage see article on Great Lakes waterway in T. Tr. Supplement 22.1, 21. noted on F. ☑.
world canal linking the West to the East. And this traffic it needs to be remembered was moved during a working season, the length of which is only two-thirds of that during which the great waterway to the Far East is operating.

We have now seen briefly the chief sources of the iron ore, and the geographical facts in connection with its production and movement eastward to the blast furnaces for conversion into pig iron which forms the basic raw material for the rest of the industry. We need now to consider in a little more detail where the great centres of the iron and steel industry are located and the factors conditioning that location. This process will consist largely of pulling together and emphasising a number of points which have already been touched on in various parts of the subject.

Apart from the scattered charcoal furnaces to which we have already referred the beginnings of the industry were in the narrow Piedmont Belt lying between the anthracite coalfield and the Atlantic Seaboard. This industry depended largely on local iron ore supplies from the Adirondacks and on anthracite as fuel. The chief centres of the industry on the Atlantic Seaboard Region are Chester, near Philadelphia, situated on tidewater on the northeast southwest stretch of the Delaware, where it forms the boundary
of New Jersey before spreading out in the waters of Delaware Bay; Camden in New Jersey on the opposite shore of the Delaware facing Philadelphia; South Bethlehem and Allentown on the Lackawanna just before it joins the Delaware; Reading on the Schuylkill located on the stretch of Piedmont between the Blue Ridge and Philadelphia; the towns of Lebanon and Steelton (Harrisburg) which lie near the foot of the Blue Ridge not far from the great water gap out in the ridge by the Susquehanna, on its way out of the valley region to cross the Piedmont to the sea.

(Fig. 3). To this list may be added the great batteries of retort ovens at Sparrow Point near Baltimore at the head of Chesapeake Bay, excellently situated for importing foreign ore and despatching the finished products. With the opening up of the Pittsburg Coalfield and the application of coke to the smelting of the ore a new centre sprang up beyond the mountains under such favourable conditions that the Atlantic Seaboard Region was forced to turn largely to coke from the Connellsville Region for fuel and to abandon the much more expensive and no more effective anthracite. Close proximity to tidewater is one of the advantages which this region still possesses as compared with that of Pittsburg. It thus possesses from the point of view of the world market one of the great advantages possessed by Great Britain, the one which

---

perhaps more than any other made her in the middle of the last century the workshop of the world. In view of this fact it is interesting to notice in passing that it is stated that two recent shipments of an experimental nature have been made of steel products from Pittsburg down the Ohio by water to the Mississippi country by one of the largest of the independent firms, the Jones and Laughlin Company. ¹

This shipment has been made to develop this route for the

¹ C.S. Monitor, 2/12/21. W.T. Mossman of the Jones and Laughlin Company said: "The load now about to start will be nearly twice as large as the initial shipment, as the attention attracted to the latter has resulted in numerous steel consumers asking to be included in the next river delivery. The Company is contemplating extending the service ............... is studying various types of ocean-going steel barges with a view to undertaking to lay down its products to customers in Gulf ports and possibly in time to delivery to Pacific coast ports...... The project to load steel products on ocean-going barges in the Pittsburg harbour and unload them in the harbours of Houston, Galverston, Los Angeles, San Francisco and other Gulf and Pacific ports appeals to the Pittsburg Steel manufacturer who now has to compete with Atlantic Seaboard rivals who are able to ship steel products at the low all-water rate by intercoast lines through the Panama Canal."
despatch of steel goods to the Gulf ports of Texas, and Mexico, in competition with the Atlantic seaboard firms for the market offered in equipping the oil-fields of the Gulf Region. Apart from this competition, firms on the eastern seaboard possess a distinct advantage, other things being equal, in tendering for oil or other equipment work in the Gulf Region, an advantage the measure of which is the difference between the all-water route to the Gulf ports, and the rail and water route from Pittsburg. The promoters of the new route have also in view the despatching of goods by this route and by way of the Panama Canal to the western seaboard at San Francisco. Since the opening of the Panama Canal the Atlantic seaboard has possessed a marked advantage in connection with the canal since it gave to it an all-water route to the west the cost of transport by which was so much less than by rail across the continent, as to render it impossible for rail borne goods to compete with those carried by steamer through the Panama Canal. Although possessing this distinct advantage from the standpoint of foreign trade the Atlantic Seaboard area is very far removed from the great markets of the middle and far west, and it is further handicapped by the distance which separates it from the main coking coal regions and also from the Lake Superior iron ore deposits.

As we have already seen, what has been somewhat loosely termed the Pittsburg Region grew up based mostly
on the coking coal of the Connells ville district. Its
growth was rapid and its chief centre became and is to-day
for the steel industry, what Chicago is for the wheat
industry, the great market and organisation centre of the
industry for the United States. Pittsburg at the forks
of the Ohio dominates the whole region. Second to it
stands Youngstown in the famous Mahoning Valley, which,
lying northwest of the position of Pittsburg is about half
way to the south shore of Lake Erie. Close to these centres
there is a great series of satellite towns such as Allegheny,
Warren, Akron and Sharon. In these towns almost all branches
of the heavy steel trade is carried on not to mention the vast
number of subsidiary industries which such centres bring into
being. As has already been pointed out these centres lie for
the most part lower than the actual producing area of the coal-
field, so that all coal moving to them follows the river
valleys, and therefore has a down grade to the manufacturing
centres, a fact which must have a very definite bearing on cost
of transport as an item in total production cost. To-day this
area is a much heavier steel producer than is the Atlantic
Seaboard, although this impression is not conveyed by superficial

1. Measured by the ore which it receives.
examination of a map published in the United States Census Atlas 1910 shewing the distribution of blast furnaces in the United States for the year 1909. A glance at this map leaves the impression that there are quite as many blast furnaces in the eastern area as in the Pittsburg District. To correct this false impression as to the output of the respective areas it becomes necessary to examine the actual figure shewing the output for each area of pig iron, and on doing so we find that something over fifty per cent of all the pig iron produced in the United States comes from the area we are now considering, and only about ten per cent from the Atlantic area. The explanation is, of course, that the furnaces in eastern Pennsylvania, are as compared with those of the west, small and many of them are merely small charcoal furnaces, while those of the Pittsburg country being much more recently built are of much greater capacity. There are still in this eastern area some smelters working on anthracite, but they may be regarded as the dwindling remnant of the former industry of this area. Whereas in 1870 over fifty per cent of the pig iron was produced with anthracite as the fuel used, in the year of the Census 1909, only two per cent of the pig iron was so produced.


To the east of the main Pittsburg area but forming really an eastern extension of it, lies the steel producing district surrounding the town of Johnstown on the Conemaugh, which as we have already seen is one of those left bank tributaries of the Allegheny which have deeply trenched the plateau, and in doing so have exposed the coal. Here is located the Cambria Steel Works and to this district comes annually about two million tons of ore from the Lake Ports. 1. Lying to the southwest of the main district is the steel town of Wheeling on the Ohio, and still farther to the southwest is the town of Ironton not far from the junction of the Ohio with the Big Sandy, as this river comes out of the West Virginian Coal Region. All these districts may be regarded as minor extensions of the Pittsburg District and are quite distinct from the next, the most recent of the great steel areas which we have to consider, that is the district which has grown up fringing the shores of the Great Lakes, and which as we have already seen is based largely on that very prominent feature of the modern development of the industry, the change over from beehive to retort ovens.

Before leaving the Pittsburg District we may point out that the city stands in Allegheny County which comprises quite a small area in the vicinity of the city, and that for this area statistics are available as to the production within the county of iron, and steel goods. An examination of a few of these figures may help us to realise to some extent what this small area means to the industry. In the year 1910, as shewn by the American Census 1910, 1. twenty per cent of the pig iron of the United States was produced within this small area in close proximity to Pittsburg and there is little doubt that if we had figures available for the whole of the district dependent on Pittsburg as a centre we would find that over half of all the pig iron produced in the United States came from this area. Within the county there was also produced over thirty per cent of all the steel ingots, castings, plates, sheets and rolled iron and steel, and over forty per cent of all the structural shapes made in the country. A consideration of these figures serves to underline heavily the statement commonly made, that Pittsburg dominates the heavy steel trade of the United States.

Turning now to discuss the rather scattered area which is somewhat loosely spoken of as the Lake Shore Region we find that it falls naturally into two easily distinguishable districts, the region along the southern shore of Lake Erie, and the region

on the southwestern and southern coasts of Lake Michigan. That of the Lake Erie country is by far the larger of the two. This is what one would expect if one recollects its position at the meeting point, where if one may so express it, the ore from the head of the lakes comes ashore and the coal from the northern Appalachian Region goes afloat. The position here to-day is thus comparable in many respects with that of the industry in South Wales where the coal coming from the hill country beyond the Vale of Glamorgan meets the iron ore at ports such as Cardiff and Newport coming from Spain by an all-water route. In both cases the coal is moving mainly downhill to the coast while the iron ore is moving by an all-water route for the bulk of its journey. Here too, the various satellite steel industries which depend on the smelter for their raw materials, are largely engaged in the different branches of the heavy steel industry such as the manufacture of structural shapes, plates and parts of large castings.

On the other hand the steel industry which we find located on the shores of Lake Michigan mainly at South Chicago and Gary, was primarily developed at those points, not because of local deposits of coal and iron as in the case of the Pittsburg or eastern areas, nor because it was the meeting point of the raw materials as in the case of the south shore of Erie, but because of the large western market available for
steel products. Of these perhaps the most important are all kinds of farm and other labour saving machinery ranging from the simplest of farm implements to the most elaborate combined thresher and harvester, and also steel products used in connection with transport in the vast extents of the west ranging from automobiles to steel rails. Hence we find at Chicago such plants as that of the International Harvester Trust Corporation which specialises in farming machinery, and also to be connected in our minds with the vast prairie and plains environment of the city, we find some of the greatest railway works in the world.

Of the centres on Lake Erie, by far the most important from the standpoint of production, are Cleveland in the centre of the south shore of the lake on the Cuyohoga River,\(^1\). Buffalo or rather its northern suburb Tonawanda at the extreme end of the lake at the mouth of the Erie Canal, and Toledo at the west end of the lake on one of the old portage routes to the west by way of the Maumee River. It is unnecessary to dwell at greater length on the development of this lake region as a steel producing area as the more outstanding facts have already been emphasised when considering the question of the relative advantages of retort ovens versus beehive, and

---

the allied question of the gradual change over from the one type of oven to the other. This change over together with the convenience of the location as a meeting point for the fundamental raw materials plus the influence of the development of the west and therefore of a new market rapidly extending, are the more important points to be borne in mind.

In passing, attention may be called to a minor development of the industry at the head of Lake Superior at Duluth,\(^1\) where coal can be obtained at a lower freight rate than at Chicago. This is based on the fact that coal moving to Duluth does so as a fill-up cargo on the return run of iron and wheat ships moving from the head of Lake Superior to the Erie ports, a position comparable in its effect on the price of coal, to that of the coal which moved in pre-war days to Italy in ships going to the Black Sea to load wheat from South Russia and Rumania. Coal moving from Lake Erie ports to Chicago may or may not get a profitable return cargo there being no ore to move and much of the wheat from that centre moving east by rail. Hence the freight rate on coal must be high enough to safeguard the shipper against loss. The smelting industry at Duluth has therefore been built

up partly on the basis of this return cargo coal, partly on
the basis of the large local supplies of ore, and partly,
and perhaps primarily on the basis of the rapidly growing
western demand for iron and steel goods, it being found
cheaper under the conditions explained above to move coal to
the iron, rather than to move the iron to the lower lake
ports, and then move the manufactured goods back over the
same ground. Of a similar type to this last named area are a
number of minor areas on the Canadian shores of the lakes, which
depend almost entirely for their raw materials on the ore from
the head of the lakes and coke made in retort ovens from
Pittsburgh coal.

Since the Alabama Region as a steel producer was
discussed under the head of the Alabama Coalfield there remains
but one large iron and steel area with which we have not dealt.
That is the region of Southern New England. With this region
it is not proposed to deal here as it carries on its numerous
metal working industries largely on the basis of pig iron,
which it imports from other areas and does not therefore form
one of the great basic units of the industry such as those
which we have already discussed.

We have now considered the main steel producing
areas of the United States in relation to the chief supplies of

1. See Annu. Repts. of the Mineral Resources of Canada,
Dept. of Mines, Canada.
the needed raw materials. It remains for us if possible to obtain some more accurate indication than we have so far given, as to the relative importance as producing centres of the various areas. Pig iron being the basic material produced no matter whether it is to be made subsequently into steel or iron, bridges or pokers, we can perhaps get some idea of the relative importance of the respective areas by considering the output of pig iron in each. As complete county statistics were not issued with the last available Census, there exists no basis for determining with absolute accuracy the exact production of each area, but by carefully considering the incomplete figures, the following estimated percentages of pig iron production for each area have been prepared for the years 1890 and 1908 respectively.  

<table>
<thead>
<tr>
<th></th>
<th>Atlantic Seaboard</th>
<th>Allegheny County</th>
<th>Pittsburg District</th>
<th>Lake Shore</th>
<th>Alabama</th>
</tr>
</thead>
<tbody>
<tr>
<td>1890</td>
<td>23</td>
<td>(15)</td>
<td>51</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>1908</td>
<td>10</td>
<td>(25)</td>
<td>54</td>
<td>25</td>
<td>11</td>
</tr>
</tbody>
</table>


2. These figures are included in those for the Pittsburg District.
It has to be borne in mind in connection with the foregoing figures that they are very largely estimates. It will be noticed that the Pittsburg District produced over one half, and the Lake Shore District one quarter of the 1903 output, while the share of the Atlantic seaboard decreased to 10 per cent of the total and the percentage for Alabama remained about stationary. In this connection it has to be borne in mind that these figures are percentages and that in the period under review there was a very large increase in the total production of pig iron in the United States, therefore in the case for example of Alabama although a relative decline is shown there has really been a large increase in the output of the Birmingham district smelters. So also we have to bear in mind that the decline in the output of the Atlantic seaboard area from 23 per cent to 10 per cent is a much larger decline than the proportion would indicate, and that the increase of the Lake Shore area to 25 per cent of the total is a much larger increase than the figure indicates. A further interesting point to notice is the great increase in the production of Allegheny County as compared with that of the whole Pittsburg Region. This would seem to indicate that while the whole region has increased its output in a slightly greater proportion than the increase in the total pig iron production of the United States for the period under review, the increase in the immediate vicinity was in much greater proportion, thus shewing increasing concentration of the
industry in this neighbourhood, a fact which is possible explainable on the ground that new furnaces would tend to install batteries of ovens of the retort type which are best erected in the vicinity of a large manufacturing centre where a ready market is available for the by-products after coking.

Summarising the facts elucidated by these estimates we may say that the Pittsburg area probably produces over half of all the pig iron produced in the United States and that it has increased its output largely in the period under review but has not appreciably increased its share of the total production of the United States; that the Atlantic Seaboard Region has steadily decreased, its place being mainly taken by the largely increased production of the Lake Shore Region, based on the increased use of the retort oven and superior position from the raw materials point of view. While the Alabama Region while increasing its total production has barely held its percentage position in view of the greater increases elsewhere.

It will help us perhaps to realise what the pig iron production of the United States means, if we consider for a few moments the world production of this basic raw material of the iron and steel industry. In the year 1913 the total world production was about 76 million long tons and of this the

1. Iron Trade Review Annual 1921.
   See also Times Trade Sup: 14/1/22.
   See also Political & Coml. Geology, Spurr.
United States produced 31 million tons or about 40 per cent. Of the remainder Germany produced 19 millions or 24 per cent. Great Britain 10½ millions or 14 per cent, France and Russia about 5 millions each or 7 per cent, Belgium and Austria-Hungary 2-1/3rd or 3 per cent, Canada 1 million or 1 per cent, while Sweden, Spain, Italy and Japan produced about half a million each. We have seen above that the Pittsburg District produces over half of the total U.S.A. production, or say 18 million tons which is very nearly the equivalent of the total German production, or over 1½ times the production of all the steel areas in Great Britain; while the Lake Shore area alone produces over three-quarters of the British output. Further we may regard the outputs of the Atlantic Seaboard and Alabama areas as being independently greater than that of Belgium, while combined they exceed the output of the whole of France.

A recent development of the iron and steel industry in the United States has taken place in the Rocky Mountain Region where there are available excellent supplies of coal and iron. From this point of vantage more than half way across the Continent a determined effort is being made to capture the Pacific Coast market.

CHAPTER V. 

Coal Movement to Lakes and Coast. 

-----------------------------
We have already seen in the previous chapter that about one-third of all the coal used in the United States for industrial purposes other than for transport by rail, was used in the manufacture of coke, and we have considered briefly the factors at work in connection with the great industry based on this fact, and have also considered briefly the location of the great steel manufacturing centres in relation to geographical factors. It now remains for us to discuss broadly the movement of coal as a whole from the two main coalfields - the Pittsburg District and the Coalfield of West Virginia. Regarded in the mass the bulk of this movement will obviously be from the coalfields to the great centres of industrial activity. We have already seen where those centres are if expressed in terms of the iron and steel industry which is the most fundamental of the industrial activities of any modern manufacturing country. We have but to add to those centres the textile and metal working region of New England to cover all the major industrial regions of the States. If we further add to the above the great commercial centre of New York, the administrative centre of Washington, the region of lesser industrial activity stretching westward from Ohio across the prairie lands to south of the Great Lakes, the cotton manufacturing belt on
the Piedmont in the Carolinas and the flour milling regions of the northwest, we have covered the greater part of the minor manufacturing regions. Bearing these facts in mind we shall be able to form a clear concept of coal movement in the mass. Thus we shall expect a large movement of Pennsylvanian coal to the great steel centres of Pittsburg and Youngstown and their satellite towns; to the blast furnaces of Buffalo, Cleveland, Gary, South Chicago and other places on the shores of the Great Lakes; to the steel region of Southeast Pennsylvania lying between the Blue Ridge and the sea; and to the textile and metal working regions of New England. In addition to the above we will have minor movements to all the lesser regions with certain complications due to movement of coal in transit from one area to another. In addition to this movement to industrial centres there is a movement to the ports for export and for bunkering ships. If we examine the statistics of consumption already referred to we will see that some thirty million tons were so shipped in 1915.

From a study of a map it will be clear that of the four major regions to which coal will move, two, the Atlantic Seaboard Region and the New England Region lie to the east of the Appalachian Ridges, while the other two, the Pittsburg-Youngstown Region and the Region of the Great
Lakes lie to the west. Of the minor regions, three are to the east, and two to the west. The significance of these facts will appear when we examine the geographical factors conditioning the actual movement. Before doing so let us see how far we can analyse the actual movement of coal from the Pittsburg Region. As we have already seen the Pittsburg District extends beyond the state of Pennsylvania westward into Ohio and southward into West Virginia. Statistics of coal consumption are only available by states, hence we are not in a position to give consumption and distribution figures for the district as a whole. It is fairly certain however that the figures for that portion of the district, by far the greatest part of it, which lies within the boundaries of the state of Pennsylvania give a very fair idea of the district as a whole and we certainly will not be far out if we regard them as typical of the whole area. Taking then as our basis the figures for the bituminous areas of Pennsylvania we find that in the year 1915\(^1\) out of a total production of 158 million short tons something between one third and one half (60 millions) remained within the state, and one half of this amount was converted into coke. Of the amount not so retained for consumption in the state,

about one third was shipped for use as railroad fuel; another third moved northward and westward to the ports on the southern shores of Lake Erie partly for shipment to the upper lakes and partly for use in the blast furnaces of Cleveland, Buffalo and other lower lake centres; while the remaining third moved eastward through or north of the Appalachian Ridges to the northern tidewater ports on the Atlantic Seaboard. Of these the chief are New York, Philadelphia, and Baltimore. The analysis of this eastward moving coal is complicated by the fact that the state of New York extends from the Great Lakes to the Atlantic Coast. Hence coal billed as moving to the state of New York may be going either to the Lakes or to tidewater. There is however little doubt that the great bulk of this coal is moving eastward.

It will be clear then that the bulk of the coal moving from the Pittsburg Field may be divided into two main streams, one of which moves northward and westward of the Appalachian Ridges while the other moves eastward through those ridges. We have then to consider how far geographic conditions assist or hamper these great movements. We have already seen that the coalfield is situated high up on the Allegheny Plateau. This fact other things being equal would give a downgrade in every direction to sea level. Between the coalfields and the lakes the grade is mainly down hill, with a slight rise to cross the low
water parting which separates the Ohio system of drainage from that of the series of small streams which drain northward to the Lakes. As has already been explained the dissected nature of the plateau surface offers some obstacle to movement, but this is offset by the fact that the river trenches, the chief cause of the obstruction, themselves provide excellent lines of movement which more than counterbalance the disadvantages of the relief.¹

A marked contrast is presented when we analyse the factors conditioning eastward movement. Between the coalfields and the sea lies that great maze of ridges and valleys, which from the point of view of movement east and west, bears the somewhat misleading title of the Greater Appalachian Valley. Looking eastward from the summit of the escarpment known as the Allegheny Front one sees ridge after ridge and furrow after furrow lying between the point of observation and the Piedmont country adjoining the Atlantic Coastal Plain. This maze of hill and valley forms a very definite barrier to all eastward movement. Hence the critical points from the standpoint of coal movement will be found where nature assisted by man has provided relatively easy ways through. Of these the largest, best known and best defined is the famous Hudson-Mohawk Gap which links the eastern part of the lakes and the northern portion of the coal-bearing plateau with the

¹ See the numerous folios of the U.S. Geologic Atlas of this area and also the topographical maps of the area.
Atlantic Seaboard at New York. In this gap are found the main lines of the New York Central Railroad which according to the U.S. Geological Survey\(^1\) stands third in importance as a coal carrying road being only exceeded by the Pennsylvanian and the Baltimore and Ohio. It carries about one fourth of the coal moving by rail, but this fact does not indicate that one-fourth of the eastward moving coal goes through the Hudson-Mohawk Gap as the New York Central system includes a number of subsidiary lines which operate to the west. There is no doubt however that a large amount of coal from the northern part of the coalfield moves by this route and the tunnels through the Berkshires into New England, and also via the Hudson Valley to tidewater at New York.

South of this point there are no passages through the ridges at all comparable in size to that which we have just considered, but the chief geographic control is still exercised from the point of view of movement by the river valleys which cut across the ridges. (See sketch map, fig. \(\_\_\_\_\_\_\_\) ). Contrary to what one might expect at first sight, the very marked feature of the Allegheny Front does not exercise much influence on movement, except locally. The main valleys to notice

\(^1\)\textit{Mineral Resources, U.S.A. Part 2, 1912, p. 74.}
\textit{See also do. do. do. do. 1915, p. 443.}
are those of the Potomac, the Susquehanna, and the New River. A study of a detailed railway map will make the position clear. From the northern part of the producing districts a number of lines cross the Allegheny Front into the Great Valley, and then concentrate on a point just south of the junction of the two main branches of the Susquehanna, near the position of Sunbury. Beyond this point the lines fan out to the northern tidewater ports, - New York, Philadelphia and Baltimore. Some eighty miles to the southwest of this point another group of lines concentrate near Altoona on the Juniata branch of the Susquehanna and thence go eastward through the great water gap which the Susquehanna has here cut in the Blue Ridge at Harrisburg, to Philadelphia and Baltimore. The principal railroad operating along this route is the Pennsylvanian, which is the heaviest carrier of Pennsylvanian coal.\(^1\) Here again one has to remember that although it is probable that the Pennsylvanian Railroad does carry the largest share of the eastward moving coal, one cannot substantiate this fact statistically


Ibid U.S.A. 1915, Part 2, pp. 443-446.


In this year statistics shew that the bulk of the coal carried on the Pennsylvanian system moved eastward (9/8 of total). Some 52 million tons were carried eastward as against 31 million tons carried westward.
from the figures available, since the Pennsylvanian system also operates to the west of the ridges and is therefore also engaged in the Lake shore movement.

Some further eighty miles to the southwest we find a great network of lines from the Connellsville and Pittsburg country all concentrating after crossing the Allegheny Front, on the position of Cumberland at the great angle of the Potomac. From this point two great main lines run eastward to tidewater, following the north and south banks respectively of the Potomac, through the deep water gaps which this river has cut in the parallel ridges of the Great Valley. By this route the Baltimore and Ohio Railroad carries coal both from the southern part of the district within the state of Pennsylvania and more particularly from that part of the district which extends southward into northern West Virginia.  

Southwest of the position of Cumberland on the Potomac, in a distance of 150 miles, no line crosses the sea of ridges, and it is not until a point is reached where the James River, by means of one of its headstreams, has cut back close to the lower Greenbriar, a tributary

1 Mineral Resources, U.S.A. 1912, Part 2, p. 74. See also later follow years.

of the New River, that a line is found crossing from
the plateau to the Piedmont. This line, the Chesapeake
and Ohio, uses for its roadbed the valleys of the lower
Greenbrier and the Upper James. It serves as an outlet
to Newport News for the coal of the New River Field, and
it stands second in importance as a carrier of West
Virginian coal, being only surpassed by the Norfolk and
Western.¹

Some forty miles south of the route followed by the
Chesapeake and Ohio Railroad, the New River which has its
source in rear of the Blue Ridge, and as we have seen
cuts its way westward in a great trench through the ridges
and into the plateau, forms a definite line of movement in
conjunction with the more southerly of the head streams
of the James. Here the Norfolk and Western, and the
Virginian Railroads make use of the great gorge of the
New River for their roadbeds, and carry through it the
famous Pocahontas steam coals to tidewater at Norfolk on
the south side of Hampton Roads opposite Newport News.
The distribution of coal from the West Virginian Fields
forms a marked contrast to that from the Pittsburg Region,
because of the fewness of the industries found in the
former area.² Whereas nearly one half of the coal raised
in the northern field is used either at, or in close

proximity to the field, over 90% of the coal brought to the surface in West Virginia moves either northward and westward to the shores of the Great Lakes and their fringing states, or moves eastward through the ridges by way of the Greenbrier or the gorge of the New River to tidewater at Hampton Roads. Of the total moving out of the state, some two-fifths moves east through the ridges, and the remainder moves to the Great Lakes and the neighbouring states in the proportions of one third direct to the Lakes, and two-thirds to Illinois, Indiana, Ohio and Michigan. About 12% of the total production of the state was used in 1915 as railroad fuel.  

Two groups of ports handle the bulk of this tidewater shipment, - a northern group consisting of New York, Philadelphia and Baltimore, related to the Pittsburg District, and a southern group made up of the Hampton Roads ports, which handle all the tidewater coal moving eastward from the New River and Kanawha Fields of West Virginia. According to the reports of the United States Geological Survey the northern group handle some two-thirds of the

---

1 On Export of Coal from the U.S.A. see useful articles by Wadleigh, Chief of Fuel Division, Dept. of Commerce, U.S.A. in the "Coal Catalog" for 1921, published by Keystone Co., New York, which is a standard reference book for the American Coal Trade.

total traffic coastwise while the southern group handles the remainder. Of the northern group New York is much the most important port, handling rather more than half the total for this group. To it Philadelphia is a rather bad second with Baltimore a close third. The bulk of the coal traffic of the port of New York is handled at Jersey City and Amboy on the New Jersey shore. Traffic intended for New England is ferried across the harbour and this traffic is very large. In addition to its large trade in bituminous coal, New York has a very large cross harbour trade in anthracite based on its vast numbers of business offices and apartment houses, where central heating is so much in vogue. Philadelphia's trade is mostly anthracite for the local trade and bituminous for the coastwise trade, while Baltimore is mostly connected with the coastwise traffic in bituminous.

The two southern ports of Newport News and Norfolk form a highly specialised group connected with the West Virginia Field; Newport News forms the terminus of the Chesapeake and Ohio Railroad and stands on the north bank of the estuary of the James River. From the open roadstead

1 U.S. Geological Survey, Weekly Reports on production and movement of bituminous Coal, Anthracite, and Beehive Coke. See, e.g. issue for Dec. 1, 1923, No. 333

2 Atlas, Mineral Resources.

3 Admiralty Chart of Hampton Roads.
leading to Chesapeake Bay, a thirty-five foot channel has been dredged to the coal piers. Some ten miles away to the south-east, on the opposite side of the roadstead is situated Sewall Point, which is the shipping point for the Virginian Railroad while some miles further to the south lies Lambert Point, carrying the loading piers of the Norfolk and Western which as we have already seen is the chief railroad handling West Virginian coal. Both of these latter sets of piers are served by a forty foot channel from the roadstead. (Fig. 17)

Granted a sufficient demand for export coal the ability of these ports to ship it is only limited by the equipment available at present. These two shipping points on the south side of the estuary are usually referred to statistically¹ as Norfolk, from the town of Norfolk which lies just to southward of Lambert Point. The combined ports of Newport News and Norfolk are generally known as Hampton Roads, from the roadstead and small town of Hampton to the north of the estuary of the James.² (Fig. 17)

Having thus brought our coal to tidewater we are in a position to conclude our study by asking ourselves


² On these ports and their trade in coal, see also Mineral Resources, U.S.A. 1913, Part 2, pp. 1322-1323.
what becomes of this tidewater coal. We should in passing just notice that all the coal moving eastward through the ridges does not reach tidewater. Some of it is used in the Piedmont and Coastal Plain. Further, of the coal which does reach tidewater some will remain for consumption in the tidewater ports. The bulk however is dumped at some tidewater port for shipment to some more distant point. In 1915 according to the United States Geological Survey such coal totalled some forty million tons in round figures. Over one third of this total was for coastwise shipment to other points in the United States, almost all of it being for the textile and metal working centres of southern New England which as we have already seen obtains also large quantities of coal direct by rail from the northern part of the Pittsburg District. This water borne coal moved along the coast chiefly from Hampton Roads ports but also from the northern ports. Rather better than one quarter of the total tidewater movement was used for bunkering ships, the great centre of this trade being, as might be expected from its large cargo and passenger traffic and its position at the entrance to the Hudson-Mohawk passage-way to the west, the port of New York. For foreign shipment rather less than one quarter of the total tidewater movement was used.


2 For an interesting account of the Coal Trade of New York see The Port of New York Annual, 1920, with article on Movement of Coal to Tidewater.
In this total the export to Canada is not included as it moved either by rail across the Canadian frontier through Buffalo or by water via the Great Lakes. The quantity so moving varies from year to year, but is approximately something of the order of nine or ten million tons together with two or three million tons of anthracite. Of the coal moving to Canada via the Lakes the bulk is despatched from southern Lake Erie ports, though a small quantity also moves via the south shore of Lake Ontario through ports such as Oswego and the mouth of the Genesee River. About three-fourths of the total export to Canada is handled by Cleveland at the mouth of the Cuyahoga River near the centre of the south shore of Lake Erie and by Buffalo at the eastern end of the same lake. ¹ Canada from the point of view of population consists of a long narrow east and west strip lying just north of the United States border. Canada has coalfields of her own. What part therefore of this strip will be supplied with United States coal? Roughly a belt of country extending from a point between Montreal and Ottawa and a point west of Winnipeg about one-third of the way

across the prairies of the Canadian west is so supplied. On the eastern and western margins of this belt the United States export coal comes into competition with coal moving inward from the Canadian Fields which, in the case of most of the chief producing districts, lie at or near the Atlantic or Pacific Seaboards. This territory thus dominated by coal from Canada's great southern neighbour has by no means fixed margins. These margins advance outward towards the eastern and western seaboards or retreat inward towards the Great Lakes in sympathy with the varying prices of the coals of each of the countries concerned. Thus during the year 1921 for example, the area supplied by the United States was much restricted because of the adverse rate of exchange, which made it profitable for coal from Sydney (Nova Scotia) Field to move up the St. Lawrence and Lake Ontario, and compete thus in a territory hitherto dominated by coal from the Appalachian Field. In that year the rate of exchange added about 15% to the cost of American goods in Canada. There is of course never a hard and fast line between the areas served by the two kinds of coal. Always on the margins

---


2 C.S. Monitor, 9 August, 1921.
there is a belt where both coals sell freely in competition with each other. Having thus seen something of the part played by the United States in supplying Canada with coal, let us return to our analysis of the tidewater movement.

Of the nine million tons shipped abroad in 1915 roughly half went to Europe and of this half Italy took the bulk. The remainder was divided up between the West Indies, Central America, and South America. Among these countries Cuba, the Argentine, and Brazil were the best customers of the United States for coal. We would expect that countries in the New World would be the best customers of the States and were it not for the war conditions existing that year Italy would not have been nearly so prominent in the list although even in pre-war days she received almost the whole of the very small amount of American coal which was then shipped to Europe.

As a coal exporting country the United States labours under two great natural disadvantages. The first of these is the distance of her coalfields from tidewater. Baltimore at the head of Chesapeake Bay is over one hundred and fifty miles from Connellsville in the south-east of the Pittsburg

2 " " " 1912, " 2, p. 570.
District, while New York is nearly three hundred miles from Johnstown on the Conemaugh in the northeast of the District, and Hampton Roads is nearly the same distance from the nearest point of the West Virginian Fields to tidewater. If we compare the position of the United States Coalfields with those of Great Britain, where the chief exporting fields are right on the coast, we have in part a measure of what this question of distance means from the standpoint of coal export. In the year 1913 the total coal export of Great Britain including bunker coal was just over seventy three million tons, or roughly four times that of the United States, and as we have already seen half of the United States export merely crosses the international frontier into Canada and is thus hardly comparable with the British export. Those coalfields in Great Britain which are chiefly concerned with the foreign trade and the bunkering of ships lie close to the water. Only a short, and therefore, relatively speaking, inexpensive railhaul is needed to put the coal alongside ship. This fact among others is reflected in the cost of coal alongside ship and therefore in the large export as compared with that of the United

---

1 Colliery Year Book and Coal Trades Directory for 1923, p. 559.
States. In this latter country, the expensive rail haul made necessary both by distance and by heavier outlays for upkeep largely caused by the more difficult physical conditions increases from two and one half to three times the cost of coal alongside ship.  

In the second place the United States is handicapped because she is to a considerable extent a self-contained country. She possesses within her own borders the bulk of the food and raw materials which her manufacturing districts require. She is also a heavy exporter of bulky raw materials such as cotton and wheat. She does not therefore need as does Great Britain, a bulky article such as coal to freight her ships on the outward run. Her outward bound coal ships must return empty or nearly empty, hence her freights for this reason alone would need to be heavier than those of Great Britain whose outward laden colliers can fill up with raw materials or food on the homeward run, thus having paying cargoes both ways instead of one way only. A typical example of that has already been referred to above where it was pointed out that ships going to the Black Sea to load wheat carried coal to run the industries of Northern Italy.

1. See among others Sargent: Coal on International Trade pp.46-47.

We have seen then that the coal dumped at tidewater from the Appalachian Fields moves on to farther destines in three great streams, of which the most important is that which moves coastwise to New England, the next is that which goes into ships' bunkers chiefly in New York Harbour, and the third is that which supplies foreign countries other than Canada, the movement to which country has been separately analysed. We have thus completed our analysis of the factors conditioning the production and distribution of coal and iron in the United States, and have seen something of the very large part played in the industries connected therewith by the geographical factors which may be conveniently grouped under the broad heads of structure, relief, and climate. We have seen the factor of structure mainly at work in determining the actual conditions under which both coal and iron are mined the depth of these minerals below the surface, and the facility with which mining operations can be carried on, while the two factors of relief and climate have been mainly in evidence in determining both the lines of movement to be followed by these minerals, and also the conditions under which such movement takes place.
Although fairly complete references have been given in the form of footnotes it may be helpful to append some general notes on the chief sources of material available and which have been used by the writer of the foregoing thesis.

The material used for the study may be broadly grouped under four main heads. They are as follows:-

1. The various folios of the U.S. Geologic Atlas of which some hundreds are now available have formed the basis for the study of the factor of structure in relation to relief and economic products. These folios are mostly on a scale of 1:125,000 and are very elaborately prepared, frequently illustrated with photographs, and always accompanied with excellent geologic and topographical maps. In addition to these Atlas folios much use has been made of the Topographical maps issued separately by the U.S. Geological Survey, chiefly on scales of 1:62,500 and 1:125,000. The study of the relief factor in relation to production and distribution has been mainly based on these maps. A useful general map of this type is the Contoured Map of the U.S.A. in two sheets on a scale of 1:2,500,000 in 1914. There are also numerous maps scattered throughout
the publications of the U.S. Geological Survey which have proved suggestive and helpful.

2. Descriptive material, i.e. material descriptive of the actual conditions of production and distribution in the coal and iron fields cover a very wide ground and ranges from the highly technical account of conditions to be found in the publications of the U.S. Geological Survey, of which the account of the coalfields in the 22nd Annual Report Vol.3 of the survey dealing with coal and that of iron in the 21st Annual Report, and the excellent monograph No.28, 1897, on the Marquette Range, by Van Hese, published by U.S. Geological Survey, form examples, through works such as Economic Geology by Heinrich Ries, Professor of Econ. Geology at Connellsville, and "Economic Aspects of Geology" by C. K. Leith, to articles in the various publications of the Geographical Societies. Of these latter I would call attention to "Some Geographic Influences of the Lake Superior Iron Ores," in the Bulletin of the American Geographical Society, Vol.46; "The Progressive Development of Resources in the Lake Superior Region," in the Bulletin of the American Geographical Society, Vol.43; "Coal in the United States," in the Scottish Geographical Magazine, Vol.33; and my own article in the Scottish Geographical Magazine, Vol.36 entitled, "Some Geographical Factors in the Northern Appalachian Coalfield."
3. Statistical Material. Three main sources have been used for statistical matter. These are the various Mineral Resources Reports for the U.S.A. published by the U.S. Geological Survey annually; the volumes of the Thirteenth (1910) and Fourteenth (1920) Census Reports of the U.S.A., of which the former gives more useful detail from the geographical point of view than the latter, partly because the latter is not yet fully available and partly because some useful tables have been dropped; and the volumes published by the International Geological Congresses, the one for 1910 dealing with Iron Ore Reserves, while that for 1913 deals with Coal Reserves.

Statistics for 1912 or 1913 have been largely used as giving pre-war conditions to which from the point of view of coal and iron production the U.S. has been returning, with minor exceptions; statistics for the war years tend to be misleading and have mostly not been used where similar statistics were available for pre-war conditions. Very recent statistics are not yet fully available.

4. Current Trade Papers and Newspapers. This material is of course of least weight and has been mostly used to illustrate tendencies where other material was lacking. It covers such papers as "The Black Diamond," "The Iron Trade Review," "The Times Trade Supplement,"
Fig. 14 — Sketch map of the Pittsburgh and West Virginia coal producing districts. The Appalachian ridges are only shown diagrammatically. C.D., Cumberland; Ch., Charleston; P.M., Pittsburgh; J.J., Johnstown; P.B., Beaver, W.Va., Wheeling.
FIG. 5. Diagram to illustrate structure in Eastern Northern Appalachian Coalfield.
A. Sketch section to show position of Pittsburgh Seam.
B. Diagram to show method of mining.
C. Position of Seam in Pittsburgh and anthracite areas compared.
Fig. 6. - THE CONNELLSVILLE CORING AREA, MAP AND SECTION ACROSS THE AREA.
Fig. 7 - Sketch map and sketch section of part of New R. Coalfield.
Fig. 9. Sketch map to show the relief of the anthracite coalfield of Pennsylvania. Based on U.S.A. topographical map 1:62,500. (Dated and reduced.)
Fig. 9: Sketch map to show the production of anthracite in Pennsylvania. For names of towns see relief sketch map of Anthracite Field.
Fig. 10. Diagram to shew distribution of anthracite, U.S.A. 1915.
Fig. 11. — Iron Ore Deposits and Production, U.S.A.

A, Lake Superior Region; B, Birmingham Region; C, Adirondack Region;
D, Birmingham Region; E, New Jersey and New York Region; F, All Other Areas.
Fig. 12.—Diagram to show mining conditions in the Lake Superior Country.

Fig. 14. Sketch map to show location of chief steel centers.

Toom: A. Allegheny; B. Pittsburgh; C. Johnstown; D. McKeesport; E. Youngwood; F. East Pittsburgh; G. Connellsville; H. Altoona; I. Johnstown; J. Scranton; K. Wilkes Barre; L.Hazleton; M. Steelton; N. Shadyside; O. State College; P. Reading; Q. Scranton; S. B. South Philadelphia; T. Warren.
Fig. 15 Steel Centers. Pittsburgh and Atlantic Sea Board Areas. Note contrast between location of works and production.
Fig. 16 - Sketch map of the Coalfields of the Northern Appalachian Region. Reconnaissance work has been made in the coal areas. For key to terms see Sketch map of Great Basin, U.S. Geological Survey of Washington which is indexed by the W.