1888

Report on the Sloss Co. Properties Contents of B - Valuable Minerals

William Ruffner

Contents of B

B

Valuable Minerals of the region.

Mineral Contents.

Nearly all of the rock groups described under the previous head carry valuable minerals. These minerals I shall name in the order of their importance, and then indicate their respective places in the geologic column, accompanied by remarks as to their commercial value.

1. Iron Ore
2. Coal
3. Gold
4. Limestone
5. Sandstone
6. Clay.

1. Iron Ores.

There are numerous horizons of iron ore; in fact some sort of iron ore is found in each and every formation, iron having been an all pervading element in the original substance of the earth, from which all the sedimentary rocks have been derived.

a. Ores of the Drift.

The Drift formation is the newest, but I mention it here because in our field it is associated with the oldest of the formations. This drift as before

Origin of Drift Ore.

mentioned carries a sheet of iron ore now generally broken into fragments, which, as I suppose, was not deposited when the drift material was dropped from the water, but was subsequently formed, probably after the subsidense of the sea, by the percolation of acidulated waters through the ferruginous material of which the drift in Alabama was largely composed, and originally derived from

the waste of the ore bearing rocks of the higher lands. The water leached the iron from the top layers of the drift and sand, and again deposited it on some impervious clay stratum beneath the surface. We see the same thing in tide water Virginia where the iron ore sheet, about six inches in thickness, is seen protruding from the edges of abraded clay banks, or else lying in the fragments on the surface. The first iron making done in Virginia was done with this ore, but it was soon abandoned for better beds. The drift ore every where that I have seen it, with a few scattering local exceptions is thin, lean and sandy. There seem to have been certain basins which received and held an extra quantity of the ore, and in these places it became more compact, and better in quality.

Generally lean & sandy.

There seem also to have been a few places, where the ore belonging to underlying rocks

Good in a few places.

was transported in blocks and mixed more or less thickly through the drift material. I suspect that this was the fact with regard to the drift ore of Lamar County, Alabama, which seems to have originated in the ore beds of the Sub-Carboniferous formation, and this may also be true of the beds which are reported as being found in the drift further North toward the Tennessee River, and also in Hickman and other counties North of the Tennessee River in the State of Tennessee: on which the Florence people are basing their boom; as one or two towns have done on the South side in respect to the ore lying South of them. Some of this ore is certainly good, and is reported as existing in considerable quantity in a few places.

This drift ore as seen by me in Bibb, Tuscaloosa and Chilton Counties, is generally so lean and sandy as manifestly to be of no value, except in a very few spots

concerning which I will speak further on.

6. Huronian Ores.

I will now take up the rock groups in regular order beginning at the bottom of our column. It may be well to state that what I call Huronian is supposed by some geologists to be altered Silurian, but I here assume that it is Huronian, without meaning by that to express any opinion on the mooted question.

The Mineral belt of the Piedmont Country.

This Huronian formation runs in a belt, or rather a number of belts, East of the Blue Ridge all the way from Canada to middle Alabama. Another line of it goes Westward from New York along the line of the Great Lakes.

Every where it carries iron ore beds, and about Lake Superior it is associated with much of the noted ores of that region, though as to the exact age of these ores there is some discussion. These are the same rocks that hold the iron ore beds of Chester

County, Pennsylvania, Harford County, Maryland, Nelson, Amherst, Campbell, Franklin and Pittsylvania Counties, Virginia, and Guilford, Mecklenburg, Cabarras, Gaston, Lincoln, Catawba and other counties of North Carolina. They also hold the iron and gold ores ~~of Georgia, and~~ of the mineral belt of Alabama passes North East into Georgia, and which is now pressed upon public attention about the town of Tallapoosa, on the Georgia Pacific Railway. This belt stretches Southward, also and bends around the South end of the Mountain Country.

The iron ores belonging to this group of rocks are very varied, consisting of hematites of every variety including the gray & specular limonites, including turgite and göethite, also magnetites. The magnetic ores of Cranberry, North Carolina, belong to this group. Also the Valley River and other ores of Western North Carolina. In other words ores of the

best quality are to be found in the Huronian group.

Iron-hat. Besides these legitimate ores there is a delusive sort of brown ore, which forms the outcrop of copper veins, which were originally chalcopyrite, a sulphuret of copper and iron, and which retain their original character below water level. This outcrop ore is the "iron-hat" of the mines.

not usually abundant. There is however great inequality in respect to the abundance of all iron ores in the Huronian group. No large operations in these beds have been carried on permanently any where South of the Potomac River, and yet valuable deposits have been temporarily worked; and I doubt not that still larger and more valuable deposits will be found.

The ores in this formation belonging to the Sloss Company will be described hereafter.

c. Potsdam Sandstone Ores.

This is the bottom group belonging to the Silurian age, and is well known from Quebec to Anniston as containing limonites of good quality besides manganese etc. As this group is so feebly represented in our field I shall not dwell upon it.

d. Dolomite Ores.

This is the formation named by Prof. Safford of Tennessee the Knox group, because the city of Knoxville is built upon it. It consists of limestones, shales and in some places sandstones, but we are chiefly concerned with the limestone group whose thickness in Alabama I do not exactly know, but I call it 600'. I speak of it as the dolomitic limestone, not because the whole bed is magnesian in its character, but because along most of the line, dolomites or magnesian limestones constitute the dominant rocks. I may here remark that in this

group further North, notably in Rockbridge County, Virginia, lies the hydraulic bed from which a very fine quality of hydraulic lime is made.

How formed. The iron ores of this group have been formed by the decomposition of the limestone, which contains iron diffused throughout its mass. The lime and magnesia having been leached out, clay and the iron oxides are left in beds of greater or less depth, overlying the parent rocks, or else removed therefrom by washing, and either strewed on the surface, or collected in basins or pockets at lower levels.

Whilst these ores are thus formed in loose beds and pockets, I would not exclude wholly the idea of stratification, because there are no doubt cases in which the decomposition of certain strata has gone so deeply down from the outcrop that the resulting ferruginous residuum is in fact a substituted stra-

tion of rock.

It is possible that it is only in this sense that the Clinton ores are stratified.

These ore bearing strata are not confined to the top layers, but are found at intervals all the way through the bed to the bottom. In fact there are no doubt localities where the entire group of dolomitic limestones is so impregnated with iron that if the conditions were favorable it might be decomposed and leached into a vast bed of iron ore.

This decomposition is the result of conditions brought about by the geologic displacement of the rocks; and my observation leads me to think that the greater the disturbances the greater the decomposition. We see an analagous fact in the Clinton ore beds, where the changes from iron limestone to hard blue ore, and from hard blue ore to soft ore, are greatest where by reason of uplifts and fractures the decomposing elements

are allowed freer access.

It is sometimes the case in South West Virginia where there are famous beds of dolomitic iron ore that the deepest and most numerous beds are near faults and folds. It is also true that in the same region where the rocks have been upturned at a high angle the decomposition of the rocks has depended upon the condition of exposure, and ore beds have been formed on three and sometimes four different horizons.

It is not sufficient that the limestone strata should be exposed to the action of the weather, but they must lie in such relations that the percolating waters will will move somewhat slowly, or be retained temporarily in contact with them, and that whatever is carried off must be in solution, and not swept away mechanically.

Large beds very rare.

Generally speaking, the proportion of iron in the dolomites is so small that the ores are scant

in quantity. Frequently also the iron ores are washed away mechanically or carried off in solutions so that large and valueable ore beds along this line are rare. I know of none of much value in Virginia, North of New River, and in Alabama there are but few really large beds. Good beds are reported in Tennessee, but I have not seen them. Some of the ore beds in South West Virginia are more than 100' in depth, and long in proportion. Lump ore is of course exceptional when compared with the whole mass that may be called ore. The most of it consists of particles of ore scattered through clay beds. Of course these ferruginous clays vary greatly in richness, but in South West Virginia in the better beds the yield of the clay under the washer is about one half ore. The dolomitic ore is a rich limonite, low in phosphorus, sulphur and silica.

Of fine quality.

The South West Virginia dolomitic ores are usually spoken of as Bessemer or steel ores, but so far as I have observed the analyses they have fully .04 to 1.07, averaging perhaps something under .1 of one per cent phosphorus.

The Murphree's Valley brown ores may probably average as much as .3 phosphorus; the best Lake Superior ores run from .02 to .03, Iron Mountain, Missouri about .04. The specular ores of the Huronian group average somewhat lower in phosphorus than any of these, and also somewhat higher in metallic iron. I suppose the dolomite ores stand next in quality to the best Huronian specular.

e. Chazy Ore

The impure limestones of the chazy formation also carry a little iron; hence on the chazy or chert ridges we usually find a sprinkling of float ore which is sometimes of good quality,

and is rarely ~~of~~ sufficiently
In small abundant to justify mining.
pockets. I know a bed in Giles County,
Virginia, which is the largest I
have ever seen, but even this
was soon exhausted. This ore is
apt to enclose chips of quartz
which would unfit it for smelting.
In fact there are sometimes
masses of it made up chiefly of
pebbles and angular blocks of
quartz cemented by iron
ore. Thomas has such a bed as
this near Beaver Creek in St. Clair
County. There is however also good
ore in Thomas's bed.

As the chert and dolomite
ridges often coalesce so as to form
one ridge, the float ore of the two
formations becomes intermingled. And I know a place in Coosa
Valley (Frame's), where a hill side
is heavily strewed with float
which is derived almost equally from the chert and dolomite
rocks.

f. Trenton Ore.

What is now usually called the Trenton group of limestones has heretofore been divided into two or more groups, the name Trenton being applied only to the lower division. The upper division is variously known as Hudson River, Cincinnati, or Nashville shales. In Virginia this upper division of the Trenton occasionally bears workable beds of limonite, as is the case on Purgatory Mountain near Buchanan. But I have never observed any indications of iron ore in the Trenton group of Alabama.

Extremely rare

g. Clinton Ores.

The great deposits

This is the well known group which forms the Red Mountains of Alabama, and is an iron bearing formation along the whole length of the Appalachian range.

In other States.

In Pennsylvania the Clinton ores have been worked for gener-

ations. In Virginia they have never been largely worked, although a few furnaces have used them liberally; for example the Roaring Run furnace of Allegheny County, and the Shenandoah iron works of Page County. Low Moor and other furnaces have occasionally used this ore as a mixture with other ores. In Tennessee this ore is worked as part of its stock by the Jellico and other furnaces. But it is too thin to be depended on exclusively. The Alabama beds, especially in the Birmingham and contiguous valleys, far exceed those in any other State, in number, size and richness.

Inasmuch as these beds are the chief dependence of the Alabama furnaces now and in the future, I will dwell somewhat fully upon their characteristics relatively and absolutely.

In Pennsylvania the Juniata Valley seems to occupy the same

position relatively in respect to the Clinton ores that the Birmingham valley does in Alabama: and I think it worth while to take from the Pennsylvania Reports an account of the Clinton formations in the Juniata Valley including its ore beds, quality of the ore and the use made of them.

The Clinton Formation in Pennsylvania.

The total thickness of the Clinton rocks is 1250' or three to four times the thickness of the Alabama Clinton. Prof. Lesley gives the following as a typical section of the rocks.

Thick rocks & thin ore.

Descending.	Thick
1. Red Shale	150' to 250'.
2. The Upper lime shales.	40' " 160'
3. The Lower " "	20' " 150'
4. The Sand-vein ore bed	0' " 2'
5. The Sand-rock	2' " 3'
6. The Ore Sandstone, about	25'
7. The Danville Ore-rock, with 3 or 4 Danville ore beds	6' " 15'
8. The Upper olive shales, about	150'

9. The Block ore bed or
Iron Sandstone 1' to 12'
10. The Lower olive shales, about 500'

219' to 1267'

In some places these strata measure over 2000' in thickness.

The structure of the mountains carrying the Clinton ores in Pennsylvania is less favorable for mining, or for the formation of iron ore than that of the Red Mountains of Alabama, owing to the presence in Pennsylvania of the Medina Sandstone, which is wanting in Alabama. The Medina being a very hard and massive sandrock, holds the crest and body of the ridge, and the Clinton rides on its back. The ore bearing strata are found far down the side or back of the mountain, and sometimes a part at least in the lowlands beyond.

In Alabama the Clinton usually occupies the crest and constitutes the body of the mountain, the effect of which is to present the outcrops on the front face of

the mountain where the beds can be easier found and mined.

As to the lithology of the formation in Pennsylvania it differs chiefly in the larger proportion of lime: which shows that the conditions have not been so favorable for leaching out the lime, and hence not so favorable for the formation of ore beds as in Alabama. The calcareous beds and the red shales in Pennsylvania are ferriferous, and had they been acted upon by the elements as in Alabama, the ore beds would have been thicker and more numerous.

The Clinton Ore derived from limestone

Ore changed to limestone.

Concerning the origin of the iron ore beds, the doctrine of the Pennsylvania geologists is that they are derived from the decomposition of ferriferous lime stone beds: a doctrine which is fully justified by facts. The same strata are in some places ore and in others fossiliferous limestone: and in places the same strata are so made

up of both ore and limestone that it is doubtful whether it should be called ore or limestone. This mixture is sometimes a diffused intermingling of the two, and at other times the ore and limestone lie alternately in laminæ or thin leaves: showing in both cases an intermediate stage of progress from limestone to ore. Prof. Lesley, the able State Geologist, uses the following language concerning the principal iron ore bed: "It is sometimes a mere fossiliferous limestone, sometimes a lean ore, and sometimes a rich ore": also, "The bed is calcareous, hard and lean below the drainage level, and rich and soft above it." Again he says of the same bed, when its dip is low or moderate, "If the bed be then mined downwards to levels below the drainage level, it will turn to hard limestone ore". Again he says, "On Perryville Ridge a cross-cut meets hard, ferriferous limestone at the depth of 35 feet".

Mr. Dewees, Assistant Geologist,

says of the Block ore: "In low dip measures, when it passes under cover it changes back to its normal condition of fossiliferous limestone".

The indications of the same origin and tendency are abundant farther South. For example at Rockwood Mines, Roane County, Tennessee, the red ore holds no lime at the outcrop, but descending the slope the lime gradually comes in and increases, and finally the iron entirely runs out, and is replaced and succeeded by limestone. In Alabama I have seen enough to satisfy me that a similar condition of things exists.

These and similar facts settle this point as respects Pennsylvania at least, namely, that Clinton iron ore beds certainly in some cases and probably in all, do at some point underground pass into the limestone strata from which the ores were originally derived.

The Clinton Ores in Pennsylvania.

Though the Clinton group in Pennsylvania is about three times as thick as in Alabama, the iron ore beds are all included in about the same thickness of rocks, namely 200', and in rocks not unlike, though as before remarked the Pennsylvania rocks are more calcareous than those of Alabama.

5 ore beds in Pa. There are five ore beds in the Clinton series, and they are neither very thick, nor remarkably good. They are all well shown on Jack's Mountain, and are officially reported by Prof. Lesley as follows:

1. Sand Vein Ore bed: sometimes 2'; usually worked at 16" to 18": often found much less.

2. Danville Ore beds: three or four beds of 4" to 8", separated by partings of sandstone, giving an inclusive thickness of 6'. Rarely one of the beds has a maximum thickness of 3'.

3. Block Ore: in two beds near together, one of them uncertain:

inclusive measure 6': "some of it good ore".

4. Bird's Eye Fossil: 6" to 14": ore of superior quality.

5. Shot Ore: 6" to 8" though sometimes thicker. This is the bottom bed, and is supposed by some to occupy the place of the Southern Clinton ores.

Ore seams worked down to 8 inches in Pa.

All of these beds are worked more or less in Pennsylvania.

I have studied the reports on the mines of the Juniata Country. There are eighty six (86) mines reported on, and the average thickness of all the beds worked is fourteen and a half inches (14½").

The cost of mining these Clinton ores is given by Mr. Dewees one of the Assistant Geologists.

Cost of Mining the Clinton Ore in Pa.

(Pa. Reports. Vol. F. p. XLIII.)

(See next page)

"The cost of mining ore varies with the different conditions of the ore bed, its thickness, the dips, the quality of the ore, (hard & soft,) and the condition of the hanging wall or roof rock.

Soft or medium soft, fossil ore in beds from sixteen to twenty four inches thick, on dips steep enough to run the ore to the gangway without hindrance, thus avoiding the labor & expense of scraping & shovelling, can be mined at the small cost of forty cents & upwards per wagon containing from fourteen hundred to sixteen hundred pounds of ore. The soft ore will cut more readily than the medium soft, but with it the top wall is generally softer and therefore more expensive to hold in place, thus increasing the cost of mining the soft ore to about the same as that of medium soft ore.

When the dips flatten so much that scraping & shovelling become necessary, the cost of mining soft and medium fossil ore increases proportionally, until the dip becomes so low that it will admit of the running of wagons into the chambers. When the dips are as low as this, the bed can be mined more cheaply than where the dip is from twelve to fifteen degrees

which is too steep a slope for wagons to be run into the chambers, & not steep enough for the ore to slide down by its own weight. Still mining with wagons is more expensive than that upon the steep dips.

At a dip of thirty degrees, soft & medium fossil ore is mined at present at a cost of about fifty cents per wagon load.

When the beds are smaller the cost of mining is increased. In a bed twelve inches thick, the cost is sixty cents per wagon load. These prices are considered low when the iron trade is more active than at present.

The cost of driving the gangways must sometimes be added to the above figures, but generally this cost is paid by the ore obtained. An additional sum of five cents per wagon must also be added for propping.

Hard fossil ore beds require drilling and blasting, but do not require so much handling as the soft ore to get the ore to the gangways in the flatter dips, as it will run on medium dips, & is less likely to clog in its course. There is however, some expense in breaking the ore into pieces small enough for

the miner to handle.

At present, in a bed of hard ore from eighteen to twenty four inches in thickness, the price paid for an eighteen hundred pound wagon of ore is from $1.00 to $1.25; or where the ore is very hard, on a dip of from twenty to twenty five degrees, the price is $1.75.

In flat dips or on a level, the labor required for handling the ore makes it very expensive mining.

The cost of mining hard fossil ore at present is so great as to prevent the mining of it for shipment by rail, the price being from $2.00 to $3.00 per ton according to quality.

The only hard fossil ore mined is used in furnaces near by, within convenient hauling distance. The expense of hauling is about a dollar per ton where the distance is between four and six miles, and from sixty cents to a dollar per ton where the distance is from two to four miles. These prices are of course modified by the character & condition of the roads.

P Royalty for the ore where it is mined ranges from 25¢ to 50¢ per ton, in some instances running as high as 50¢.

Quality of the Pennsylvania Clinton Ores.

The Sand Vein bed varies from a ferriferous fossiliferous limestone through all grades of lean, hard calcareous ore below the drainage level, to a rich soft ore above drainage. Fossil impressions are numerous. Sometimes the ore is high in Silica, especially when sufficient care is not used in throwing out the inferior layers above and below. With proper care in mining the proportion of silica is low.

A description of the different seams is to be found in Vol. F of the Pa. Geol. Reports.

I however here give a complete table of analyses.

Analyses of Clinton Ores of Penna. Vol. M.M.

Kind of Ore.	Metallic Iron.	Manganese.	Sulphur.	Phosphorus.	Carbonate of Lime.	Insoluble residue	Page.	Remarks.
Soft fossil ore	48.500	.090	.030	.197		12.015	236	Silica is included
Hard fossil ore; reddish grey	20.350	.194	.029	.335		5.520	"	in Insoluble residue
Hard & tough; fossiliferous; deep red.	41.900	.280	.035	.257		4.800	"	Carbonate of Lime
Fossiliferous, calcareous, reddish brown.	21.600	.035	.024	.477		7.090	"	Lime Carbon
Compact. fossiliferous	13.500	.032	.034	.182		8.315	"	
Lump. Compact & tough; ochreous; spangles of specular	52.000	.050	.031	.331		11.115	237	"Jack"
Two thirds lump ore, One third fine ore.	47.100	.194	.033	.174		17.855	"	
Brittle; fossil pits filled with specular iron ore.	48.550	.010	.003	.327		17.230	"	"Color"
Compact, Calcareous.	46.500		.025	.475	17.550	6.880	237 & 238	
Sandy, Coarse grained.	34.800		.038	.132	None	40.680	"	
Hard fossil ore, calcareous	25.075		.012	.223	54.359	5.235	"	
Hard fossil. 14" thick	11.825		.019	.255	71.518	5.800	"	
Brittle, fossiliferous. Argillaceous odor.	50.050	.448	.028	.561		12.385	238	
Block ore, compact, oolitic	55.000		.005	.252		9.630	238 & 239	
Coarse grained, reddish brown.	55.750		.025	.120		10.700	239	
Soft, reddish brown, micaceous.	57.217		.020	.122		9.660	"	
Block ore, fine grained.	29.200		.048	.537		46.550	"	
Coarse grained, sandy; quartz spangles.	29.500		trace	.111		49.840	"	

Analyses of Clinton Ores of Penna. Vol. M.M.

Kind of Ore.	Metallic Iron.	Manganese.	Sulphur	Phosphorus.	Carbonate of Lime	Insoluble residue.	Page.	Remarks.
Block ore; compact, coarse grained.	44.600		.012	.496		18.080	239	
one half "Jack", one half ore. Soft reddish brown; numerous small pebbles micaceous.	41.273		.020	.348		25.775	"	
Sand rock ore. Hard, slaty structure; dark brown color.	46.000		.009	.299		24.220	239 + 240	
Shot block ore. Hard pebbles of phosphate of lime.	31.150		.009	1.643		37.110	"	
20" thick with 5" "Jack". Block ore; compact, intermingled slate.	47.900		.008	.279		17.760	240	
2' thick. Block ore; coarse grained; numerous specks of quartz + specular iron ore.	51.900		.005	.215		14.030	"	
Compact, slaty.	24.800		.005	.562		43.610	"	
Compact, altered fossil; dark brown + liver brown	50.000		.010	.338		14.330	"	
Sand rock ore. Hard Coarse grained, sandy.	45.100		.005	.168		25.310	"	
Hard fossil from "Sand Vein" Sparkles with calcareous matter.	29.775		.112	.351	38.375	9.340	241	
Block ore, compact Coarse grained.	42.100		trace	.338	—	23.050	"	
10" thick. Hard, sandy calcareous.	16.500		.249	.122	12.172	49.748	"	
14" thick. Hard, compact.	32.100		.010	.257	34.250	11.360	"	
Compact.	45.450		trace	.246	—	21.600	"	
Soft + fine grained	50.000		.005	.451		15.880	"	

Analyses of Clinton Ores of Penna. Vol. M.M.

Kind of Ore.	Metallic Iron.	Manganese.	Sulphur	Phosphorus.	Carbonate of Lime	Insoluble residue.	Page	Remarks.
Block ore, compact.	53.100		.008	.152		12.600	241	
Hard, fine grained	49.700		.038	.590		15.800	241 & 242	
Slaty.	30.800		.062	.457		36.240	"	
Hard, compact, coarse grained	26.100		.051	.544	47.018	9.610	242	
Fossil from "Sand Vein"; compact, earthy; sparkles with specular iron	46.900		.005	.310	—	22.880	"	
"Sand Vein"; compact; spangles of Quartz & Specular ore.	42.700		trace	.138	—	28.680	"	
Altered fossil; brittle, argillaceous.	32.700		.031	.415	—	32.560	"	
"Sand Vein", 24" thick; compact, coarse; spangles of quartz.	52.300		trace	.378		10.550	242 & 243	
Compact, coarse; spangles of quartz	52.900		.011	.514		9.070	"	
Compact, coarse; spangles of quartz	50.300		.006	.488		14.270	"	
Slaty, compact.	29.400		.056	.726		32.660	"	
"Sand Vein"; 26" thick with 6" Jack Compact, coarse.	54.400	.226	.026	.337	.740	8.315	243	
"Sand Vein"; compact, coarse.	43.100		.010	.243		21.800	243 & 244	
"Sand Vein". 24" thick 6" Jack. Compact, coarse.	52.600		.023	.521		11.560	"	
Block fossil. Spangles of Quartz & Specular iron ore.	49.900		.006	.196		15.100	"	
"Sand Vein". Soft, spotted with quartz.	52.100		.032	.396		12.960	244	
Soft, considerable specular	42.750		.021	.113		27.430	"	
"Sand Vein"; friable, argillaceous, Spangles of quartz.	48.800		.028	.326		15.230	"	

Analyses of Clinton Ores of Penna. Vol. M.M

Kind of Ore.	Metallic Iron.	Manganese	Sulphur	Phosphorus	Carbonate of Lime	Insoluble residue	Page	Remarks.
"Bird Eye" fossil ore. Compact, coarse, brittle	45.125		.015	.407	10.928	12.855	244 & 245	
Block ore; hard with shot like pebbles of impure phosphate of lime. Spotted with quartz.	32.455		.094	1.975	—	29.635	"	
"Bird Eye" fossil ore. Coarse, brittle	50.500		.024	.257	—	15.220	"	
Hard fossil ore. Danville ore bed - Small lenticular masses of slate.	33.800		.004	.358	39.142	3.851	245	

The Clinton Formation in Virginia.

This rock group varies in thickness from 250' to 700': the greatest thickness being in South West Virginia. White sandstones, variegated shales and occasionally thin limestones with one, ~~and~~ sometimes two & rarely three contiguous iron beds, constitute this group. The iron ore bed of this formation is the most protean of all the ore beds in the State. It is in rare cases, e.g. on Little North Mountain in Augusta County, and near Eagle Rock, Botetourt County, where a thick bed of good limonite is found in one place reaching a thickness of 12'. Usually it is a thin, rather lean, red shale ore: but in some places, a very superior quality of compact brown ore 10" to 15" thick underlies the red shale ore: and in just one place (on Low Moor property) I discovered a top layer 4" thick of beautiful, deep red, soft, fossil, dyestone ore. It is rare to find a bed of as much as 3' good furnace ore. The red shale is often found thicker, but the

Clinton ore in Va.

I am a little doubtful about the bed at Eagle Rock: tho' Prof. Campbell had no doubt.

thicker, the leaner.

The Clinton ores of Middle Virginia are usually rather low in phosphorus, and very low in silica. Hence they are used to some extent, but not so much as they should be, to mix with the cold short ores of other horizons.

The proportion of metallic iron in these ores varies from 60% down. The red shale ore rarely reaches 40%, but sometimes exceeds 50%.

The old Van Buren furnace of Shenandoah County worked these ores with an average of 45.56% metallic iron. The Clinton Ores of the Shenandoah Iron Works, Page County give

Iron	55.24
Phosphorus	0.10

Capon Mountain ore (Northern Virginia) gives 59.36 iron.

The average of three analyses of Clinton ores from Purgatory and Mays Mountains (near Buchanan) gives

Metallic iron	51.066
Phosphorus	.097
Sulphur	trace.

The average of seven other analyses of these fossil and red shale ores, West of Buchanan, are

Metallic iron -- 49.45
Phosphorus — .38

They were low in silica and high in alumina. All these analyses were of exceptionally good ores.

Three beds in S. W. Va.

In South West Virginia where the Clinton rocks are twice as thick as in Middle Virginia, there are differences in the ore beds. They are often three in number, and some distance apart. They have also a larger proportion of silica. The lithology of the group does not differ materially from that of other parts of the State. A calcareous band of 60' lies in the middle of the group in this section. Below this lie the three beds of ore, which are sometimes 50' or more apart. The middle bed is the best. Prof. Stevenson had a sample analysed from the Clinton of Wild Cat Hollow near the head waters of Powell River, and not far from Big Stone Gap, which gave

Iron – 52.6
Phosphorus – 0.116

In the same valley and formation, I saw one exposure of ore 20" thick, resembling the soft fossil ore of Alabama. And farther on 39", oölitic ore of good appearance. It was the lower of three beds. The middle bed was 26": top bed 20".

E. V. d'Invilliers, however, analysed a sample from an outcrop he thought was Clinton, which gave

Iron – – – – –	34.650
Phosphorus – –	.123
Silica – – – –	41.080

This is worthless.

Stevenson gives the ore bed at Pennington Gap, as follows:

Soft Ore – – – – – – –	4"
Clay slate – – – – – –	6" to 8"
Ore – – – – – – – –	24"

Analysed, this ore yielded,

Iron – – – – – – – –	50.050
Phosphorus – – – – –	.158
Silica – – – – – – – –	18.750

This is a "cold short" ore, but it

is rather an exceptionally good show as to quantity. It is the middle bed. On another property three miles farther West a Clinton Ore bed believed to be the same as Pennington's, gave the following poor result.

Iron - - - -	38.100
Phosphorus - -	.365
Silica - - - -	37.130

Proceeding toward the Tennessee line at Cumberland Gap, we find the Clinton rocks thinning until they nowhere exceed 500'.

I have a report on that region from P. N. Moore of the Kentucky Survey, from which I get the following statements concerning the Cumberland Gap ores. There are three beds of the red ore observed for five or six miles on each side of the Gap. The upper bed runs from 15" to 26". The middle bed is 27" to 30". The lower 6" or 7".

The upper bed is the most valuable. It is soft, fossiliferous and rich. The middle bed is hard;

silicious and not very fossiliferous.
The bottom bed is good ore.

These ores have been much used by the furnace at the Gap. The upper and middle are worked together. The upper ore is mined at 50 cents a ton by stripping. There are considerable areas where the ore lies on the back of a ridge with but little covering. The mining is begun at the bottom of the hill, and the waste thrown behind.

The following analyses are given by Mr. Moore.

	Upper bed	Upper bed	Middle bed
Metallic Iron	51.754	54.166	33.575
Silica	11.730	15.960	43.690
Carbonate Lime	4.510	.420	1.230
Phosphorus.	.140	.140	.251

The Clinton Formation in Tennessee and Georgia.

Judging from the meagreness of the official reports and the scantiness of printed matter generally, the States of Tennessee and Georgia have been very little prospected in any thorough and systematic way.

In the thickness of the group and its lithology the formation seems to resemble that of Alabama. It is made up of thin bedded sandstones of different colors and of variagated shales of 300' to 400', with occasional limestone beds. The rocks form ridges which extend from Cumberland Gap to Chattanooga, near which they enter Georgia. The ore is in thin beds two or three in number, which are often 3' thick, and are reported as seen 7'. In quality it does not differ much from the red ores mined in Alabama.

Clinton Ore in Tenn & Ga.

Mr. H. S. Chamberlain of Citico Furnace, Chattanooga, in a letter to me dated Sept. 21, 1888, furnishes the following information, which

Chamberlain's Statement

give in his own words. "What are called our river ores [Clinton] average about 48 of iron, 10 of silica, .4 phosphorus, 1 lime, 6 of alumina, balance moisture. The hard river ores run about 25 to 30 of iron, 5 of silica, same of phosphorus, not quite as much alumina, no sulphur. Brown ores run from 40 to 50 metallic iron, .2 to .5 phosphorus, about 10 silica".

"River ores cost us from $1.50 to $1.75 per ton, and brown ores $1.75 to $2. delivered here."

McCreath analyzed red fossil ores taken from the stock piles at the Chattanooga furnaces, with the following results.

	Soft.	Soft.	Hard.
Metallic Iron	44.700	49.150	26.600
Phosphorus	.429	.607	.388
Silica	19.760	14.480	8.210
Lime	– – –	– – –	27.070

Clinton Ore in Johnston Co., Tenn.

In the fall of 1887, I saw fine exposures of Clinton Ore in Johnson County, Tennessee. Here it was limonite or brown ore; showing simply as in all

similar cases that the ore had taken into its composition a larger proportion of water than it holds in its ordinary hematite state. The ore beds in Johnson County were from 3" to 6" in thickness, and reminded me, in their appearance and excellent quality of the Clinton ore bed at Eagle Rock, Botetourt County, Virginia, and on the Elizabeth furnace property at Buffalo Gap, Augusta County, Virginia. I have seen no analyses of the Johnson County ore, but it was in former times much worked in the little Catalan forges of the neighborhood, and with good results.

Clinton Ore in Ga. In Georgia the Red Ore group crosses the North West Corner of the State, in which is situated the Rising Fawn furnace.

Mr. H. S. Fleming gives the following as analyses of representative ores.

	No. 1	No. 2
Iron	38.48	46.82
Silica	7.32	22.69
Phosphorus	3.19	.350

There are three beds of ore said to vary in thickness from a few inches to 10'. Lime is a considerable element in many places.

The Clinton Ores of Alabama.

Ala. Clinton ores. These are all red ores, and are called red hematites. Strictly speaking they are not hematites in the full sense. They have the color, streak and powder of red ore, whilst certainly some of the samples contain as much water as the turgite and göthite varieties of brown ore. I can not say what ~~will be~~ is the content of water generally, for I have seen very few analyses that give the water. I may make similar remarks with regard to the specific gravity of this ore. The red hematites proper have a specific gravity of from four to five, whilst in ~~all~~ the few analyses that I have seen which give the specific gravity, it runs from three to four, which is the weight of brown ore.

In respect to a number of

elements which occur in these iron ores, I have never seen any statements with regard to them. I do not know that the Alabama red ores have ever been tested for titanium or arsenic, and but few of the analyses give even sulphur. All of which shows that we are greatly in need of exhaustive analyses of the Alabama red ores. I give below all the reliable analyses of these ores that I could obtain, excepting only those which I had made at the Sloss furnace laboratory, and which are reported in Part II. The ore as indicated by its name is red, yet it is of various shades and hues of red. The soft ores are commonly a dark, dull brown, and I have seen the ore almost black; commonly the color is a reddish brown. In some places it is lilac, and this I think is the characteristic color of the Wilson bed. When it contains a large proportion of lime it becomes bluish. Generally it is nearest a pure red when it is very fossiliferous and dry.

In respect to hardness, it is sometimes soft and crumbly, generally it is firm, never very hard when quite fossiliferous, but sometimes very hard when particularly sandy. Next in hardness is the blue limey ore. It is never as hard as the harder varieties of brown ore, but it is rarely so soft as to dispense with the necessity of blasting in the mine.

Fossils. Respecting the fossils, they are generally very indistinct. It is easy to see that there are numerous shells, crinoids and corals, but their characteristics are not sharply defined. Most of the corals are of the Cyathophylloid type or cup corals, and the only shell usually easy to determine is Pentamerus oblongus. I saw but one trilobite in the ore. Usually the crinoids are not so noticable as some other fossils, but occasionally they are the most numerous of all, as in case of a thin bed on West Red Mountain near Chepultepec, which is called the "button" ore from the

great number of crinoidal buttons or discs showing on almost every fragment. Paleontologists seem to think there is no doubt that the fossils are Clinton.

Structure of Ore

Oolitic

These red ores are often if not generally, oölitic in structure (a term which has reference to the roe of a fish). When this is the case the ore is made up largely if not chiefly of rounded particles usually the size of bird shot, but also of larger sizes, in rare cases reaching as much as an inch in diameter, in which latter case they are always flattened. This structure is an unfavorable indication in itself considered, because these pellets are often particles of silica inclosed in a film of iron ore, and the silica of the ore usually comes from this source, though not always. In some cases the ore is what may properly be termed sandy, that is ordinary grains of sand are mixed through and through the ore.

The pellets or pebbles, however, are frequently made up wholley of iron ore, sometimes of carbonate of lime, sometimes of chert, but most commonly of white quartz. It is not easy, however, by mashing the pellets always to determine the character of the contents. They may be carbonate of lime, or silica, and the most experienced observer be unable to decide by the eye which it is. Even mine bosses who spend their lives digging the ore, have admitted to me that they are often at fault in deciding this question — a question obviously of great practical importance. The material might be tested by acids, sufficiently for common purposes. The core of these pellets never seems to be so compact as the body of a white quartz pebble usually is. It is easily mashed and crumbled under a slight blow of the hammer. Sometimes however the pebble is solid quartz. Sometimes these pellets can be ground up by the blade of a pocket knife, or by

rubbing pieces of ore together; and this is always the case when they are made up wholly of iron oxide. Ore made up chiefly of hard pellets is called "rough" ore, and is rarely fit for the furnace.

Theory. This oölitic structure of the iron ore offers a difficult problem to the geologist. If as we suppose the ore has been formed by the leaching of limestone, whence came these pellets which are large and solid? The mere presence of silica does not constitute any difficulty, because analysis shows the iron bearing limestone to be very silicious; but large pebbles indicate that the parent rock was a conglomerate or that these pebbles are concretions, that is, formed by chemical attraction after the decomposition of the limestone. There is no need, however, that this question should here be discussed at length.

Of good quality. As shown by the table of analyses the ore used in the furnaces, is generally of excellent quality,

sometimes approaching 60% of metallic iron. The soft ores average highest. They have generally 50% or upwards of metallic iron. The hard ores that are worked in the furnace, about 40% or less; the proportion of iron being reduced by the presence of lime.

These ores are commonly low in sulphur; hence they are not "red short". Some of them may be called "cold short" on account of the percenitage of phosphorus, but usually, I think, they should not be put in that class. The phosphorus is very irregular. In a few samples it is low enough to make steel, and much of it would do for car wheels. But generally speaking these ores turn out foundry and mill irons of superior quality.

The lime content is usually wanting in the soft ore, or in small proportion: & wanting in some kinds of ~~much of the~~ hard ore. & where it exists the percentage is from 1 to 20. The lime is not particularly objectionable when its proportion

is nearly uniform, so that the founder will always know exactly how much limestone to add; but when it is of variable quantity it is objectionable by disturbing the calculations for fluxing the ore. I think, however, that practically whilst the founder would usually prefer to have his ore free from lime, he does not have much trouble with it, especially when he has by him a chemist who frequently determines the lime element.

Silica the great enemy.

Practically the most objectionable ingredient in the Alabama red ores is <u>silica</u>. The ore that is used in the furnaces ~~xxxxxxxxx~~ commonly has a moderate proportion of this element, say from 4 % to 15 %. But the Clinton red ores, on the whole, as they exist in their beds, must be classed as silicious. This element not unfrequently exceeds the iron, and a proportion of 25 % to 30 % is uncomfortably common.

It has been proved in

Low Moor furnace in Virginia, and no doubt in many others, that as long as the silica does not exceed 25% there need be no trouble in smelting the ore. It can be worked ~~xxxxxxxx~~ successfully with the proportion of 30%. Allowing all ores below 30% silica to be workable, there need be no present concern as to the ore supply in Alabama.

Mixing ores. Much of course may be done in fighting this and all other deleterious elements by a judicious mixture of ores. By working together even the red ores low in silica or phosphorus with those high in one or both of these elements, a good average is obtained. But the brown ores usually are very low in silica, and sometimes in phosphorus also, and hence do best for mixing. The time will come when neutral ores will be imported from Missouri and even from Lake Superior for mixing.

Analyses of the Clinton Red Iron Ores of Alabama.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
Silica	16.31	31.62	32.04	31.83	31.16	31.91	16.73	17.38	10.39	18.60
Lime	0.68	1.03								
Carbonate of Lime										2.86
Sulphur	trace							None	0.08	
Metallic Iron	54.98	43.71	41.98	42.36	41.91	42.22	46.79	50.82	55.51	50.35
Phosphorus.	0.22	0.18	0.19	0.19	0.19	0.19	0.16	0.09	0.06	0.28

See Geological Survey of Alabama, 1876 –
By Eugene A. Smith, page 59.

	No. 11.	No. 12.	No. 13.	No. 14	No. 15	No. 16.	No. 17.	No. 18	No. 19	No. 20
Silica	17.600	17.770	17.960	13.080	12.050	11.100	28.450	11.69	19.32	10.60
Lime	15.040	15.310	15.040	15.040	15.310	15.040	4.070			
Metallic Iron	52.425	52.650	52.275	39.525	39.325	39.425	41.762	50.60	51.60	54.88
Phosphorus	.262	.270	.323	.341	.341	.325	.307	1.06	.129	.287

	No. 21	No. 22	No. 23	No. 24	No. 25.	No. 26	No. 27	No. 28	No. 29.
Silica	17.32	17.08	18.38	17.10	21.38	13.52	16.31	31.16	31.62
Lime									
Metallic Iron	51.04	51.20	49.00	54.42	50.00	41.24	54.98	41.91	43.71
Phosphorus	.116	.464					.220	.200	.191

	No. 30.	No. 31	No. 32	No. 33.	No. 34	No. 35	No. 36
Silica	11.84	31.83	18.75	12.63	5.20	13.19	15.25
Lime				Trace	37.91	1.50	6.25
Sulphur		Trace					
Metallic Iron	51.94	42.36	49.36	55.97	33.09	53.95	50.33
Phosphorus	.269	.210	.232	.079	—	.223	.332

Nos 11–36 (Inclusive) from U. S. Geol. Survey, 1886. pages 89–91

	No. 37	No. 38.	No. 39	No. 40.
Silica	13.00	33.22	5.54	16.80
Lime		.18	5.06	.12
Sulphur				
Metallic Iron	47.83	44.71	61.240	56.45
Phosphorus.	.147	.50	.030	.34

Nos 37-40 (Inclusive) from U.S. Geol. Survey 1883-84. page 278

	No. 41	No. 42	No. 43.
Silica	14.56	9.04	12.18
Lime			0.28
Carbonate of Lime	0.00	22.42	
Sulphur			
Metallic Iron	52.48	40.81	56.64
Phosphorus.	0.45	0.24	0.14

Nos 41-43 (Inclusive) from Campbell & Ruffner, Page 31.

	No. 44	No. 45	No. 46	No. 47	No. 48	No. 49	No. 50
Silica	11.59	20.74	23.45	29.06	27.74	16.24	37.58
Lime	0.05					0.94	0.03
Carbonate of lime					17.89		
Sulphur			0.11			0.60	
Metallic Iron	61.61	53.81	49.08	44.61	36.02	49.40	43.31
Phosphorus.	0.04	trace	0.34	0.30	0.05	0.61	0.01

Nos 44-50 (Inclusive) from U.S. Geol. Survey "Mineral Resources" of the U.S." (Williams). p. 157.

Quantity of workable ores not unlimited.

As to quantity, the red ores of Alabama are beyond all computation. But this is true only when we include a vast amount of ore which at present would not be regarded as workable. I think it highly probable that nine tenths of the ore in the ore beds exceed 20% in silica, perhaps exceed 25%. Even one tenth of so great a whole amounts to an immense quantity. I wish I felt sure that one tenth comes within the limit of workable ores. Not one of the beds, whether they be three or seven in number, is continuously workable. As a general statement all of the beds are too silicious to be worked without mixture; and a large proportion of the area of each bed is so high in silica and so low in iron as to be outside of the limits of workable ores. And by an unworkable ore I mean an ore that has, say 40% silica and not over 30% iron. Even such an ore as this may become work-

able in the future. Now we have only exceptional areas of certain beds that can be economically worked at present. So far as I can learn, just three different beds or horizons of ore have been worked with success. These are the Big Bed, the Irondale and the Wilson and Aderholt: terms which will be explained hereafter. The Big Bed has been and is successfully mined along a line eight miles in length: the Irondale at just one mine, though proved to be good on a line three miles long: and the Wilson and Aderholt temporarily mined along a line of less than two miles. The Higgenbotham bed has been proved by analysis to be of good quality along a line of four or five miles. Some good ore has also been gotten temporarily from McShan Mountain for a short distance, and from some spots near Woodstock furnace; concerning which I am not particularly informed. This, I believe, covers the ground

Three ore beds worked in exceptional spots.

Another bed about to be added.

of actual mining. I have hopes in regard to some other points, as will appear when I reach the description of the Sloss properties. As to the thickness of the four beds mined, one of them is from 10' to 20', and the other three are about three feet and under: rarely over 3'.

The spread of these ore beds above water level mined I suppose average 1000 feet in ~~length~~ width. This will be explained when giving the structure of Red Mountain. Also the names, number and thickness of the ore beds.

The Sub-Carboniferous Ores.

These are the brown ores heretofore spoken of as formed by the decomposition of the lower limestone bed of the Sub-Carboniferous group. They are generally found lying on ridges which skirt along the base of the Sand Mountains, and are usually called Oak Ridges. These ores are of good quality, though not equal to the Dolomite ores. Unless selected with care they show too much silica though in no ordinary case is the proportion of silica so high as to render them unfit for furnace use. I do not know the proportion of phosphorus or sulphur to be found in them.

I have no reliable analyses of these ores except those of ores on Sloss lands, hereinafter reported.

As heretofore intimated these Oak Ridge ores are usually much scattered and rarely in beds large enough to justify any great cost in reaching them. In my description of the Sloss properties I describe what are probably the two best beds of Oak Ridge ore in this part of Alabama.

We often hear considerable talk respecting these ores in other parts of the State, and several towns have founded their booms on them.

The Pine Mountain Ores.

I give this name for want of a better to certain thin ore beds which lie in the upper division (No. 5) of the Sub-Carboniferous group. This group sometimes forms a separate ridge as on Beaver Creek, in Spradlin's Cove etc., and such ridges are generally called Pine Ridges, as the others are called Oak Ridges.

One of these beds is a red shale liver ore of good quality, the other two are brown ores, but I have never seen any one of them thick enough to work in the present state of the ore supply in Alabama; but no doubt the time will come when they will be mined. The best show of this ore which I have seen in Alabama was near Bullard Shoals (the gap of Valley Creek). It lay immediately under the Great Conglomerate or Millstone Grit. The exposure, when I was there some years ago, showed a thickness of about 2' of good limonite; but I have lately been told that the bed has been more thoroughly opened, and that it proved to have a thickness of 5'. Mr. Adams of the Sloss Mines told me that he saw it.

The Ores of the Coal Measures.

Thin beds of brown ore are common in the coal measures.

In Ohio their best ore is found among the coal bearing rocks: also in East Kentucky. In both states they have been largely worked, but the beds are so thin that I can hardly think they will continue to be worked for underground. And the experience in West Virginia has been that these carboniferous ores are not to be depended on for continuity. A thick outcrop will often thin down to nothing in a few hundred feet. In Alabama these thin beds of ore are associated with the Millstone Grit above as well as beneath, with the Newcastle coal bed both over and under, and on many other horizons. But it is, every where that I have seen it, so lean and thin-bedded as to possess no apparent value. It is commonly called "Kidney" ore, because it sometimes lies on the surface in flat lumps somewhat kidney shaped.

The Carbonate, or Black Band Ores are more promising, and have been somewhat used for mixture in the Birmingham furnaces. I have seen one bed of 16" between the Newcastle and Black Creek Coal beds, which was at one time used in the Sloss furnace. I saw also a bed of about the same thickness near Valley Creek between Mr. DeBardeleben's Little Basin and Rock Mountain. Mr. Aldrich reports another lower in the series. A thickness of 3' black band is claimed somewhere.

This completes the list of ore beds of that part of Alabama lying within the region that we are considering; and I may add that it is a complete list of the Alabama iron ores, excepting some thin beds of magnetite, specular ore, etc. which belong to the mineral belt heretofore spoken of as crossing the Georgia Pacific Railway between Tallapoosa and Villa Rica.

b. Coal.

I have made so many reports, published and unpublished, on the Alabama Coal Fields that it seems unnecessary for me on this occasion to discuss this subject with the detail I employ in the discussion of the Red ore. I am not able to add much to the information given in those Reports. There are however some important things to be added.

Warrior Jefferson Black Cr maintain this reputation.

All the seams that were mined five years ago are still mined. The Warrior and Jefferson seams and the Black Creek seam are still mined: But so far as I know they are not mined at any new places. The Jefferson and Warrior seams are rather slaty. The Black Creek seam rarely reaches even 30" in thickness; except in the Self Creek and Gurley Creek country, where the Black Creek in some places is full 3' in thickness. The only drawback about it is that the outcrop is near the level of the lowest creek beds. I

heard of a few points where it was said to be twenty or thirty feet above the creek. This coal will be used by the new Trussville furnace, and will be brought prominently into notice by the liberal policy of the Louisville and Nashville Railroad. Of course in time the Black Creek seam will be eagerly sought, and yet I can not say that its coke has ever passed the examination of a furnace stack. It is, I believe, much used in foundries with the best results. On the opposite side of the Birmingham Valley, however, in the Blount Mountain field, I have reason to believe that in certain localities the Black Creek seam is high on the hills, and of good thickness. Its area, however, is not large: and I have not seen the seam opened.

The Jefferson seam lies about forty feet above the Black Creek, and in many places contains about 3' of coal with some slate. This seam also will be valued in the future.

The Newcastle gains in reputation.

The great Newcastle bed has grown in reputation of late. It has been considerably mined for general purposes in the Cahaba field near the Georgia Pacific Railway and on Horse Creek on the West side of Democrat Ridge. There is large mining going on along the western edge of the Warrior Field close to the Georgia Pacific Railway, which turns out fine steam and grate coal, but whose identity has not been satisfactorily determined. It is the old Gaines and Patton bed, which on a short visit some years ago I thought might be the Newcastle. This however, is denied by some geologists, who have since studied the field more carefully than I did. They give it a separate place in the scale above the Newcastle.

Little Basin

But the most striking developments in regard to the Newcastle bed have been made within a few months in the Little Basin, on Blue Creek, a tributary of Valley Creek. This Little Basin is about twelve miles long and two to three

miles wide. It is a syncline, badly fractured in many parts, but apparently regular near its North end, where the Bessemer Iron and Steel Company are mining successfully, and producing a coke which has been and probably now is used in the Wheeling and Bessemer furnaces, with satisfactory results. This is something quite new and striking, inasmuch as it has generally been believed heretofore that the Newcastle coal could not be made into good furnace coke. Indeed strong efforts were made in the earlier period of iron making in this part of Alabama to use the coke from this coal, but according to the statement of the pioneer iron-master, Col. J. W. Sloss, all such efforts failed; not only because of the damaging amount of slate found in the Newcastle bed, but because the coke was not strong enough.

The trial local

The success which is now attending its use does not overthrow the former opinion on this subject.

so entirely as might be inferred.

The condition of the coal in the Little Basin is abnormal or exceptional. It has been subjected to extraordinary pressure which seems to have squeezed out most of the slate, and no doubt during the faulting and bending of the strata so much heat was evolved as to modify the character of the coal. Hence it cannot be inferred from the results in this locality that similar success will be met elsewhere in coking the Newcastle coal.

Exceptional.

The bed is in its normal state at the Newcastle mines, and not long since Mr. John T. Milner took a quantity of this coal to the Wheeling furnace, washed and coked it, and had it used in one of the Birmingham furnaces. I was in Birmingham at the time, and considered the result unsatisfactory. It is quite certain that as a general rule the Newcastle coal must be washed for furnace

use, and the evidence is yet lacking to show that even when washed it will make good furnace coke. Still the experiments made at Bessemer and Wheeling with the Little Basin coal will justify and encourage experiments in various parts of the field. Immediately West of the

Ala: Connellsville!

Little Basin in the vertical measures elsewhere described the Newcastle bed is 10' to 12' thick and will soon be tested as a furnace coal, but this also being in an unnatural state, can not be be accepted as a fair representative of the bed.

Variable bed. My observations on this bed have shown me that it is exceedingly variable. It runs from over 8' in thickness to a few inches; thus resembling the Quinnemont or Pocohontas seam in Virginia, and the Sewance in Tennessee. It usually has numerous slate seams which in some places render it almost worthless, and it is entirely free from slate in others. The lower

half of the bed is apt to be free from slate. The character of the coal also varies considerably, but generally it is very good. It comes out in good blocks, bears handling well and burns freely. The Henry Ellen mines in the Cahaba field are, as I think, in this seam; and its coal is popular as a family and boiler coal. I have seen the coal

Sometimes superior

in some places in the Warrior Field where to the eye it presents every mark of superior quality.

Representative samples of this seam do not analyse as well as the Pratt and Black Creek, nor show so much heating power.

Analyses.	Pratt	Newcastle	Black Cr.	Connellsville
Specific Gravity	1.299	1.33	1.36	....
Sulphur	1.041	.64	.10	.06
Moisture	1.025	.50	.12	1.20
Volatile matter	32.169	28.24	26.11	28.50
Fixed Carbon	63.370	59.69	71.64	64.12
Ash.	3.342	10.92	2.93	6.12

This table is taken from the Alabama State Report of 1886.

Experiments were made as to

the relative heating power of different coals by Prof. Landreth at Vanderbilt University in 1885. In these tests ten tons of coal from each seam was used; the selections made from stock piles on the market. Their relative heating powers are as follows, using the Cumberland Maryland coal as 100.

Table shewing relative heating power.

an important table, showing relative heating power.

Cumberland, Md.	100.0
Pratt	97.9
Pittsburg (Connellsville)	92.9
Helena	92.3
Sewannee (Tennessee)	89.8
Blocton	89.8
Black Creek	92.9
Henry Ellen (Newcastle seam)	88.3
Watt (Alabama)	86.6

These experiments put the Pratt coal above the Pittsburg or Connellsville coal: and puts the Henry Ellen 9.6 below the Pratt in heating power: & with the lowest.

I have always believed however that the Newcastle is a bed of great value. Owing to the failure of exper-

still, a very valuable coal bed.

iments I had doubts as to its coking quality even when freed from slate: but I always regarded this question as unsettled, and for general purposes I placed a high estimate on the bed from the time of my first examination in 1882: as is plain from the following language used in my published report (page 73):

"The Newcastle seam was worked successfully for a number of years. In many respects this is the most important coal seam in the Warrior Field. Its average thickness is greater than that of any other. In some places it exceeds 9', and, although variable, is of workable thickness wherever found. Hence it may usually be mined very cheaply. Its available area is far greater than that of any other seam. Whilst the quality of the coal varies, its average is good, and in many places superior. The only drawback is in the slate seams, owing to the presence of which, other seams are now having the preference; but unquestionably there is a great

future before the Newcastle seam."

Blocton. An interesting and successful experiment is also in active progress in the Cahaba Coal field at Blocton, Bibb County, conducted by the Cahaba Coal Mining Company. The mines are nine miles South East of the Woodstock station on the A. G. S. R'y. The company is now shipping 1700 tons daily (Sept. 17, 1888). Mr. T. H. Aldrich, the president of this company, in answer to a letter gave me the following information respecting the Blocton Mines.

Two coal seams are worked. The larger is the same as the Conglomerate seam at Helena: and the smaller the same as the Blackshale seam. The Cahaba Coal Field at this place is composed of two small synclinal basins and a monocline: that is to say, there are two regular basins parallel with each other, East of which the rocks dip only one way, namely South East, and are cut off by the fault which runs along the South East edge of the Cahaba Coal Field for nearly if not entirely its whole

length. The synclinal basins run N.E. & S.W. The more Westerly is a mile and a quarter across. In this the Black Shale, or Woodstock seam, is mined. The next basin to the East is two and a half miles wide, and five or six miles long. The dip of the coal where worked is 5° to 10°. The Conglomerate, or Underwood seam is worked in this basin. Between these two basins is an anticline and a double fault on each side of the pair. East of these two small basins is the remainder of the Cahaba field which is about six miles across, and is monoclinal in structure.

The Conglomerate seam at the Blocton Mines is reported as 6' in thickness, and the Blackshale (or Woodstock) as 3' to 4'.

Blocton seams identified

Mr. Aldrich suggests a doubt as to whether his Woodstock seam is the Blackshale: but he seems clear that the Conglomerate seam is the seam known as the Underwood in the Northern part of the Cahaba Field. Some years ago I identified the Underwood seam with the Black Creek seam of the

Warrior Field. It is possible that his Woodstock or Blackshale seam is the Warrior seam: but this is conjecture. Judging by Mr. Aldrich's description and cross section ~~(see below)~~ I do not think that either seam worked at Blocton is the Newcastle. I suspect that the Helena seam and the Newcastle are the same; in which case the Little Basin or Blue Creek seam and the Helena are the same. This however is surmise, though not without foundation. In fact it is not inconsistent with Mr Aldrich's statements made to me respecting the Blocton measures & the statements of his made to the State geologist, & afterward published in Campbell & Ruffner, pp 67 & 68, concerning the Warrior field.

On the next page I compare the two sections of Mr Aldrich.

Aldrich's Blocton Section

Helena Seam - - -	2' 6"
Rock with 4 small seams & Conglomerate	400'
Underwood or Conglomerate Seam -	6'
Rock with 3 small seams - - .	325'
Blackshale (or Woodstock - -	3' to 4'
Rock with 2 small seams - - -	300'
Coke Seam - - - - - - -	3'
Rock with one small seam - -	210
Coal seam - - - - -	3'
Rock with 2 small seams - - -	250'
Big Seam (poor) - - - -	12'

Aldrich's General Section (C. & Ruffner p 67)

Newcastle - - - - -	5' 8"
Rock with 6 small seams coal & conglomerate	304'
Black Cr. Seam - - -	2' 6"
Rock with 3 small seams - - - - - -	260'
Warrior Seam - - - - - -	2' 9"
Rock with 2 small seams - - - - -	325'
Coal - hard & bright - - - -	1' 6"

(Below this the 2 cannot be compared)

The variations of thickness of rocks & coal seams in the above two sections are not unusually great: & are not calculated to discredit the identity of seams as above suggested.

The Blocton coke is now being successfully used at the Eureka Co. furnaces in part; and in the furnace of the Pioneer Company it is used exclusively. The coke used to make a ton of iron (2268 lbs.) is 2700 to 2800 pounds. Ore used, one half red and one half brown.

The following analyses of the Blocton coals had just been received by Mr. Aldrich.

	Mine No. 1	Mine No. 2.	Mine No. 3.	Mine No. 4.
Moisture @ 212°	1.45	1.70	1.50	1.40
Vol. Combustle	32.21	32.21	30.95	34.05
Fixed Carbon	61.83	60.02	61.72	60.30
Ash	3.41	5.25	4.70	3.11
Sulphur	1.10	.82	1.13	1.14
Porter & Going. 17 W. 3rd St Cincinnati, O.	100.00	100.00	100.00	100.00

Warrior Field again

To return to the Warrior field, there is a coal bed about 40' above the Newcastle, 3' thick more or less, sometimes slaty, at other times with but little slate, which I have never heard called by any name except the Freel seam, and I have never heard of its being worked to any great extent. It is said to be one of the seams at the Morrow Mines. I saw this bed near Gurley Creek at its best, and no doubt it will receive a good share of attention before a great while. Close by I saw the Newcastle 5' 6" thick, with very little slate, and a compact beautiful coal.

Freel Seam

The next seam above of note is the Curry seam which so far as I know has never been systematically mined, but which I believe to be valuable.

Curry Seam

I will say more of all these seams in my Special Report on the Sloss property.

There only remains to be mentioned the famous Pratt bed

Pratt Seam

which is still preëminent in reputation, and in quantity used. The Tennessee Coal and Iron Company, and the Sloss Company still own the whole of the principal field containing this coal except a few small areas, owned by Thomas etc. The Pratt coal, so far as is yet known is not found any where in the Warrior field North of Valley Creek, excepting in the field near Birmingham. But South of Valley Creek and not far from it, it is found on top of certain high ridges, and it is reported to have considerable spread in Tuscaloosa County.

Blount Coal Field

There are some coal seams in the Blount Mountain field which have not been identified, and whose value is still a doubtful quantity. It is certain that they belong to the lower part of the coal series. If the Black Creek seam be there it is probably the highest seam represented in that field. Hence we may infer that there is not much of value to be found there. There is a Corne's seam & a Caskie seam of about 3' each

in thickness, and containing good coal. It is possible these two seams are one and the same, and it is not impossible that they may be the representatives of the Warrior seam which is worked North of Newcastle. I do not profess to have worked out the Blount field, but will tell all that I know about it when describing the Sloss properties.

Coal inexhaustible.

I will only add that the coal fields of Alabama are, so far as this generation and many future generations are concerned, is inexhaustible. Coal suited to all purposes exists in abundance above the drainage level.

C. Gold.

The only symptom of gold included within our limits is in the Huronian part on the South, and here I heard but little on the subject, and would scarcely mention it but for the fact that the gold belt which stretches North East through Georgia, North Carolina &c lies in the group of rocks which I described as Huronian. Redding Jones who lives in this region claims to have a vein of gold ore which was valued at $25,000. It is quite probable that gold bearing quartz veins run in various directions through this section of the country. And as unfortunate as gold enterprises have proved in this belt heretofore, we may justly expect better results from the rapid improvements now making in the reduction of the sort of refractory ores which characterize this belt.

d. Limestone.

The region is favored with an abundance of limestone at various horizons, and suited to all purposes. There are one or more bands of limestone traversing the Huronian rocks. I saw only a few fragments associated with the iron ores, but these showed the same laminated structure and talcose feel characteristic of the same group which I had seen in Virginia and elsewhere, and which is utilized for making lime in some places. Considering the convenience of larger and better beds, it is not likely that this Huronian limestone will be much used very shortly.

Good & abundant

The lower Silurian limestones are 2000' to 3000' in thickness and furnish every variety that can be desired for ordinary purposes. I do not think these limestones have ever been studied in much detail, and there are some useful varieties, as for example the hydraulic, which can not be judged

of conclusively by the eye. We have a right to expect that good hydraulic limestone can be found in Alabama among the lower strata of the Dolomite group.

As for the Dolomites, apart from their iron ore production they are often bedded and jointed so as to furnish good building stones and flag stones, and no doubt the true dolomitic limestone will be increasingly used in connection with the basic process of making steel. This class of limestone is found above as well as below the Chazy formation. An example is seen at the North Birmingham furnaces, where what appears to be a good quality of dolomite is found lying near the base of the Trenton formation.

The lower limestones are not usually so good for making lime as those of the Trenton division generally. There is a granular gray limestone which belongs at the base of the Trenton,

which is characterized by a great abundance of coral and other calcareous fossils, and with us in Virginia furnishes our handsomest building stone and best quality of lime, besides being marbleized in some places so as to furnish a good ornamental and statuary stone. I can not say to what extent this is represented in Alabama. But the upper half of the Trenton limestone seems to be well adapted to all ordinary purposes. The great quarries of the younger Sloss near Red Gap are in the upper part of the Trenton limestone, which here stands the most important of all tests viz. use as a flux in the blast furnaces. It is reported that a variagated marble is found in the Trenton limestone near Bucksville, Jefferson County.

The few limestone strata found in the Clinton group promise nothing for any ordinary purpose, and yet it has occurred to me that possibly it might answer

for some sorts of furnace linings, but this is only conjecture.

I have already expressed myself somewhat fully with regard to the limestones of the Sub-Carboniferous group. We can not hope to derive much benefit from the lower bed, except where its structure and location make it convenient for building purposes. It is too silicious for lime burning or furnace use. The upper bed, however, as is well known, affords limestone which is adapted to all purposes. The Tennessee marble comes from the Sub-Carboniferous and also the Silurian limestone.

I never saw any limestone in the coal measures except a thin and impure bed near Franklin's on Lost Creek.

e. Sandstones.

Vast quantity & valuable.

In respect to sandstones the supply is unlimited, and the varieties endless. The Potsdam ridge in Chilton county can be resorted to for beautiful, hard, white quartzites, much of which would no doubt furnish pure silica for mixing with fire clays etc. and possibly for making glass. The cherts belong to the same general class as the sandstones. They are a great nuisance agriculturally, but make good wagon roads. When naturally broken up and accumulated in heavy beds, they may be used as a cheap and excellent metal for turnpikes. An example of this we have at Red Gap. There are good sandstones in the Red Mountain group, whose hard texture, square fracture, and ease of quarrying adapt them for building foundations, abutments, culverts &c. It is possible that a handsome brown stone for house building might be found. Generally the colors are not good, however,

for handsome structures.

The Sub-Carboniferous group furnishes an unlimited field for sandstone quarries. Its lowest bed is sometimes a beautiful white sandstone, though generally its layers are impure and cherty.

The third division, Rocky Row, can supply any amount of beautiful white or cream colored sandstone, fine or coarse, crumbly, hard or flinty. It has been quarried at Gracie's Gap, and also East of Red Gap; and in many other places, for furnace purposes.

The Sand Mountain Conglomerate can also furnish sandstones of every variety. Formerly furnace hearths were built of this stone, and I suspect that excellent foundation stones for furnace chimneys, stoves and walls generally can be had in this great sandstone pile.

When we go into the coal field proper the sandstones are usually flaggy in structure and soft. But occasionally they are

massive and very hard, and also flaggy and hard. Their colors vary from white to dark steel gray. Curbstones and flat stones for side walks can be obtained without difficulty to any extent. The pavements of Birmingham are largely made of these carboniferous flags, and are often interesting by reason of the bold ripple marks which they exhibit.

Capt. E. A. Ruffner of the U. S. Engineer corps has proved by actual pressure under machinery that some of the sandstones of the West Virginia coal measures will bear more pressure than similar stones any where else in the United States. This is a matter which will excite attention when the locking and damming of Black Warrior River is undertaken.

f. Clay

I am not well informed with regard to the Clays of the region. We could hardly expect to find a good quality of kaolin, which usually results from the decomposition of feldspar which here is rarely seen. The clays of this region come from the decomposition of the shales, the limestones and the cherts. They are abundant and no doubt in places can be made useful in the manufacture of common pottery, and perhaps in exceptional spots for the manufacture of fire clay. Blue clay beds are found under almost every coal seam. But in a highly ferriferous and dolomitic region such as this it must be rare to find clay free from iron, lime and magnesia, all of which are injurious. This is a matter however, which is now under experiment in Birmingham and elsewhere perhaps. There are firebrick works in operation, & the clays near Bessemer are gaining in reputation.

Potters clay.

Fire-brick.

I have now completed what I have to say with regard to the mineral contents of the region, and will

will next take up the geological structure of the country, which will show how these rocks and ores lie in their beds, and what are their dips, uplifts and exposures. Thus will it be known where and how to find whatever is wanted, and what are the natural facilities for utilizing the mineral contents.