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THE ORES OF VIRGINIA.

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Mr. President and Gentlemen:—

I should say at the start that this paper is only meant as a preliminary or introduction to another which I trust to be able to read before our next meeting. I desire to say that I have only been down South a little over three months, and during that time my attention has been mostly occupied in carrying out the work assigned me as the Mining Engineer of the Rockbridge Company. I had really but a few short evenings to prepare this paper. My first intention of reading was suggested by the invitation of our respected Secretary. I felt, however, no diffidence in selecting my subject. We are expected, as mining engineers, to have a practical acquaintance with a great proportion of the ores and minerals furnished by our earth. Indeed, the better we are acquainted with the different ores and minerals and the various modes of working them, the better we are equipped to fulfill the arduous and delicate duties of our profession.

I thought, gentleman, that the specimens brought with me for inspection would be interesting to those worthy coal managers who have made coal mining a special and exclusive study, and who owe, to-day, their success to this fact. I thought it would be an agreeable change for them to see some of the product that pay tribute to the Black Diamond. At the same time I believe there are amongst my specimens a few forms of crystallization that will be interesting to those who have given my subject a more elaborate study.

There is one thing I feel the want of, viz.: plans and sections. I have not had time to prepare them, but hope to produce them at our next meeting. At present I am working out such a plan for our company and locating thereon all the different formations; also a section across the strike of the beds in a straight line for ten miles. With this section I could show the different strata from the Archæan to the more recent formations. As the strata in this locality is tilted and contorted in every conceivable shape, you will admit that such a section and plan must be interesting to the geologist. My principal

object in working out this is to show in my office all the rocks in the property, all the clays and all the ores, specimens of which I faithfully keep.

Gentlemen, I need hardly state that the South is advancing with rapid strides to the front as an industrial section of this great country. For instance,

TAKE GLASGOW.

On March 5, I believe, or about this time, the only habitable building in Glasgow was a brick house, used as a hotel, and known as the Brokenborough House. To-day there is almost completed a \$100,000 hotel, covering an acre of ground; one of the largest stove factories in Virginia almost finished; an elaborate rolling mill; two saw mills; one pulley factory; powder factory; buggy factory; toy factory; mantle and grate works; steel car works; brick yards, and one cement works, all in different stages of development. At Buena Vista, Logan City, Mineral City, and other places, much the same state of things exist. It is booming all along the Norfolk & Western, and the prospects are most encouraging. The same can be said of the Chesapeake & Ohio and Shenandoah Valley railroads. There is no question but that East and West Virginia, Kentucky, and Tennessee are highly favored in every respect and are destined to have a prosperous future.

Gentlemen, as my paper is on some of the ores of Virginia, I shall only briefly mention its

GEOGRAPHICAL AND GEOLOGICAL FEATURES.

Geographically, Virginia lies in latitude $36^{\circ} 33'$ to $39^{\circ} 27'$ north, which corresponds to Southern Europe, Central Asia, Southern Japan and California. Its longitude is $75^{\circ} 13'$ to $83^{\circ} 37'$ west from Greenwich. It is bounded on the north-east by Maryland, on the south it butts against North Carolina, 826 miles, and Tennessee for 114 miles. On the west and north-west by Kentucky for 116 and West Virginia for 450 miles. On the east and south-east, the Atlantic Ocean for 125 miles. The State has an area of land surface, 40,122 sq. miles and a water surface of 2,325 sq. miles.

The geology of Virginia is highly interesting, but I cannot at this time but mention that it comprises the Archæan, Paleozoic, Mesozoic and Cenezoic grand divisions. The more recent formations are found in the geographical division called the Tide water, and from thence to the lower strata ascend in terrace form to the Blue Ridge, where the granitic rock before me appears in large quantities. Much is known of the geology

of Virginia, but during my short acquaintance with the country I have found out that our best authorities have still much to learn here. But to do them justice, it is surprising how very nearly accurate are the deductions of Profs. Rogers, Proctor and Campbell on places almost inaccessible for them to have examined. The works of mining engineers cannot fail to help these gentlemen naturally in their laudable efforts to decipher this distorted chapter of geology.

THE ORES OF VIRGINIA,

like its other features almost stagger one who tries to speak on them. One hardly knows where to commence, and their variety to the amateur or uninitiated is perplexing. The other day I wrote to a gentleman not far from Glasgow asking him what minerals he had found on his ground. His reply is characteristic of what is to be expected. "Below," he states, "I hand you a list of the ores I have found on the Blue Ridge, Virginia: Allanite, carrying cerium and lanthamite; potter's clay, brown stone, tireous or hyacenith lead, silver, iron pyrites, copper pyrites, mispickle, sulphur, brick clay, soap stone, sand stone, marble clay, slate, silica, corundrum, chrystalized quartz, mica, asbestos, talcose slate, molydynite, dye-stone, lime-stone, hydraulic lime, fire-clay, magnetic iron, appatite, black oxide of copper and red or erubistis, hematite iron, lemonite iron, tin ores (abundant), stream tin, gold, dyfrenite, graphite, kaolin, zinc ore, manganese, granite, platinum and diamonds."

I have many of the subjects here mentioned before me. I have no diamonds however, and am sorry for it.

Of the ores on the list presented, iron is the most important product thus far. What the mines of silver, gold, lead, tin and sulphur will develop it is premature to say. The prospects of some of them are undoubtedly promising, and the locality of the specimens here from Mineral City are worthy of being examined and the facts we shall mention about the tin to be investigated.

The iron ores most abundant are found in the Ferriferous Shales, the greatest and most reliable repository of limonite and manganese. But we shall mention these later on and commence with the oldest and lowest tone of ores.

THE MAGNETIC IRON ORES.

Before you, you will find a specimen from Glasgow, Mineral City, Amherst, England, and Magnet Cove, Arkansas. I give specimens of the two last places in order that you may

compare them. The *Magnetic Vein* on the Blue Ridge is reported as being $2\frac{1}{2}$ feet thick, and proved by analysis to be a rich Bessemer ore.

The magnetic iron ores are found, as a rule, in the lower formations, Prof. Dana, in his *Manual on Geology*, remarks: "Abundance of iron-bearing minerals is a striking characteristic of the Archæan rocks. It is the cause of the frequent reddish color of the feldspar of the granitic rocks. It is especially manifested in the existence of immense beds of iron ore which consists either in magnetite ($Fe^3 O^4$) or of hematite ($Fe^2 O^3$)." Prof. Proctor, in calling attention to the Archæan rocks of Glasgow, says: "In these rocks are found the great deposits of magnetites in the lake region, in Canada, in the Adirondack Mountains, in northern New Jersey, and in western North Carolina."

Some of the characteristics of magnetic ores are, as its name implies—its strong magnetic properties. If one of you have a little pocket compass you will note how the needle is affected. Large bodies of this ore in a state of magnetic polarity, constitute what is called lode stone or native magnetic. Dana puts the composition of this ore as 72.4 iron, 27.6 oxygen. It is infusible before the blow pipe, yields a bottle-green glass when fused with borax in the inner flame. The presence of this ore in the Blue Ridge is a significant evidence in regard to the resources of Virginia.

These magnetic ores occur in lentecular masses of more or less magnitude and a small trace on being opened out often develops into a large deposit. Prof. Proctor believes the zone from which the ores before you were taken to be the same with that of the celebrated Cranberry mine in Western North Carolina. Supposing such to be the case, the quantity of this ore in Virginia must be enormous.

The next ore in the ascending order is the

SPECULAR ORES,

specimens of which you have before you from Glasgow, Logan, Mineral City, Isle of Elba, New York state, and a micaceous fossiliferous variety from Pennsylvania. That from Glasgow is found at Matts creek, and is located in a series of schists and conglomerates, and is probably in the same horizon as that of the specular ores in the Lake districts and the copper ores of the Bucktown, Tenn., district. I have observed two beds of red ore in this formation. The same has been noticed by Prof. Proctor, for he states: "One was a thick bed visited by me, on Matts creek. The ore here is twenty feet thick, and embedded

between walls of indurated shales, dipping to the southeast near 50 deg. Another bed about 300 feet higher on the hills is about four feet thick." I have traced these veins for over 15 miles, and think it highly probable that it exists in very large quantities about Glasgow and through Virginia. As the varieties before you show, specular ores assume many forms. Its fundamental form, however, is rhombohedral, with a cleavage usually indistinct, often massive, granular, sometimes lamellar or micaeous; also persistent and earthy. Color, dark steel gray or iron black; hardness 5.5 to 6.5 gr. 4.6. This ore is highly prized by puddlers for lining their furnace, and in many localities valued for its adaptation to making steel. I beg to call your attention to one of the specimens of this ore. It came from the outcrop of a limonite vein. At first, I took it for Galena, but soon discovered my mistake. It may be interesting to some of you to note the rock in which this ore makes. This is it— [exhibiting.]

The next vein in ascending order is a limonite vein. It overlies the schise rock of the specular ore, and underlies the quartzose of the Potsdam sandstone. I find two beds of limonite in this zone. I say two beds. I am not positively certain of this; after a more careful examination I may find that there was an overlapping at the place I was at. The sandstone rock with the limonite specimen is the well-known Potsdam sandstone. On the outcrop of this vein, close to the town of Glasgow, it is covered with lumps of the character of that before you, weighing over one ton in weight. This vein being up in the hill, not much has been done to it than exposing it along its strike.

Overlying the quartzose of Potsdam sandstone comes the prolific zone of the

FERRIFEROUS SHALE ORE, AND MANGANESE DEPOSITS,

according to Proctor, probably the greatest and most reliable repository of limonite and manganese ores in America. The charcoal furnaces in Page, Rockingham, Augusta, Rockbridge, Botetourt, Roanoke, Floyd, Carroll and Grayson counties in Virginia, and in Johnson, Carter and Union counties in Tennessee drew the bulk of their ores from this formation and ores have been mined from some of the mines in these shales from colonial times to the present day, and as yet only the outcrop of these great ore deposits has been reached.

These ores really form one of the props of the foundation of Glasgow and other towns of the South. For fifteen miles I have observed them, sometimes three hundred or four hundred feet above the horizon of the beautiful flat lands, through which

the James and North flow and meet. The Shenandoah and James River Divisions of the C. & O. Railroad meet to part on their northern route. It is on these flat lands the rising town of Glasgow is to be seen, and the beautiful residence of its urbane, active and business-like president, Gen. Fitzhugh Lee. These ores I have observed are to be found 300 or 400 feet up the hill. They also can be found in the valley and low lands; indeed, I am now satisfied that the town of Glasgow overlies a deposit of ore. The ores in the flat land do not crop up to the surface, but in some places they are under cover, and their strike evidently make 3 deg. and 4 deg. double curve. As yet no one has clearly and definitely laid the order of these ores down. Prof. Proctor, whom I presume to be the best authority on the geology of this State extant, has correctly, I believe, given the general order of the ores in the aggregate, but stops here with characteristic prudence. I should say that Prof. Proctor has made a most elaborate report on Glasgow, and from having followed his steps over the same area, I quote him to-day with confidence and the respect due to him as a geologist of high standing and recognized merit.

CONSIDERABLE GUESSWORK.

In some parts of the property the ores of different seams intersect, forming a large deposit. But, as we have stated, no one has laid the order of the seams down. Hon. W. Anderson informed me the other day that no two persons ever went over the ground of our prosperous neighbor, Buena Vista, and formed the same opinion in reference to the number of seams there. The best geologists can but shrewdly guess. The prospector finds ore in abundance, and jumps from one discovery to the other, and gets lost while trying to associate his last find with the first. But if he is favored with a strong imagination he is bound to explain the whole thing to you. Don't contradict him. It will do no good. Take his facts. The worst kind of prospector is the visionary one who always magnifies his discoveries. You must be careful of him.

EASE OF WORKING.

Owing to these ores ascending so high up the hill, they can be worked very cheaply. Close to Glasgow, at the Echol mine, I am opening out a mine with the ore thus situated, by entries driven from the base of the hill and made to communicate with others, so as to form sections for systematic workings. I wish time would permit me to explain more fully my *modus operandi*. I can only say that the configuration of the

ground enables me to select many places for working as at Echol, but there are other places where shafting will be required. For the location of these shafts great care is necessary; so much so that I shall not attempt to commence them until I have faithfully ascertained the relation of all the ores, limestone and other rocks, to the place decided upon.

PROBABLE AMOUNT OF ORE.

Gentlemen, I shall conclude my remarks on these famous ores by giving you some idea of their magnitude as estimated over an area of about five miles long on one seam, given by such authorities as Prof. Proctor, Mr. R. Moore, an English expert, who represented the English capital acquired by the Rockbridge Company through the influence of Hon. W. Anderson, and others. The latter gentleman states: "I think at a low estimate 8,000,000 tons of ironstone may be got from this seam; from Glenwood and Echol, 1,000,000 tons." Prof. Proctor states: "I feel assured that there is enough of ore of excellent quality to be won at a small cost to supply a large iron industry for many years. Making large deductions for erosions, we can safely count on five miles, carrying 300 feet of ore-bearing shales, above drainage; or in five miles, 7,920,000 tons."

In reference to the quality of the ores before you, according to Campbell, they are as follows:

Locality.	Kind of Ore.	Metalliferous Iron.	Silica.	Sulph.	Phosphorus.
Greenlee,	Limonite,	51.50	9.96	0.01	0.22
Pipe Ore Bank,	Limonite,	55.60	3.98	trace	0.55
Skelton Mt.	Specular,	44.55	21.50	0.03
Matts Creek,	Specular,	56.00	20.88	0.02
	Manganese,	4.15	4.15

*4.15 above the English standard.

Amongst the ores of this section you will find some good specimens of Dufrenite and Gothite and different varieties of Limonite. I beg to call your attention to the ore in the small

sandstone. This is a pseudo Limonite formed by the displacements of pyrite. Another specimen comes from Pennsylvania formed in the same manner.

The next ore I will mention is Manganese. The specimen before you comes from Cromora and Glasgow. I have made no decided search for this but find traces of it, of the nature of that before you in many places. In Cromora, there is a rich mine of it, I am informed. While about Glasgow I have seen many places favorable for its location. Manganese is rather a precarious substance to hunt for, but an old hunter finds many things about it to help him. It is worth about \$13.00 a ton at Cincinnati today. Its use in the making of steel I need not mention.

OTHER MINERALS.

My paper is exceeding the length I intended for it, so I can but briefly mention my other subjects, viz :

Hydraulic Lime. The specimen before you comes from Glasgow, but is common in Virginia, and is well known as the James River Cement. The formation belongs to Prof. Roger's No. II. overlying the Potsdam sandstone and below the Utica slate or its corresponding number. It is an Argillo Magnesian Limestone, possessing Hydraulic energy in a high degree.

I have traced it for about 50 miles ; sometimes it is seen on edge at the bottom of the valley or pitched 500 or 600 feet on the top of some mountains.

The *Sandstone* exhibited makes good glass sand. It overlies the *Quartzose* of the Potsdam Sandstone.

The *White Kaoline* is being examined for porcelain working.

The *Red and Yellow Ochre* follow the Cement Rock in great abundance.

The *Tin* of this region is found in the form of crystal threads or strings and in masses of varying sizes, disseminated in fissure veins traversing in all directions the granite and Archæan Rock. The tin ore before you came from Irish Creek, Rockbridge County. Prof. Jed Hotchkiss states that Prof. Campbell sampled 72 inches of the thickness of the vein including the wall and rock involved with the ore and found it to contain 66 pounds of metallic tin to the ton. The Casserite will yield by itself from 65 to 70 per cent of metallic tin ; 3,000 pounds was sent to England and claimed to answer well. Prof. Hotchkiss concludes his remarks on this place as follows : "The geological and mineralogical conditions of the Irish Creek tin-bearing region are similar to, if not even identical with those of the Cornish and other noted regions."

Iron-Pyrites, Silver, Lead, Zinc and Gold.—Of these ores you see some fine specimens, presented me by Messrs. Sheppard, real estate agents, Glasgow, and Mr. Flannagan, manager at Mineral City, from whence these specimens have come. Mineral City relies mainly for its future prosperity on its large sulphur deposits. You have a beautiful specimen before you, taken 500 feet deep. It is claimed that the veins have been traced for miles. Two mines make an annual output of 70,000. The analysis of the sulphur varies between 30 to 55 per cent of sulphur. In Johnson's New Mineral Cyclopedia you will find the following statement: "Among those materials and products of science and art that constitute the main pillars of modern civilization, sulphuric acid occupies incontestably a first rank; probably none other except the metal iron could be justly regarded with it in this regard."

In reference to the *Gold*, specimens of it from Walton mine were awarded the first premium over all competitors at the Centennial Exhibition and World's Fair at Philadelphia, in 1876.

CONCLUSION.

Gentlemen, I can not ask you to extend me your indulgence any further. I will conclude by mentioning that with the ores I have mentioned, you will find specimens of the following: Galena, silver, zinc, mica clays, granite, allanite, schist, menacanite, wolfranite from Cornwall; tin from Irish Creek, Va., and England; gold and iron pyrites from Mineral City; specular and iron ores from Glasgow, Logan City and Arkansas; manganese from Glasgow, Logan City and Cromora. Of some of the varieties of these I wish you to examine the varieties of dufrenite and specular ores; the goethite or limonite, the mecaassous fossiliferous referred to, the angillo magnesian limestone and kaolin clays, etc.

MR. PRICE: Mr. President, this is highly interesting. Prof. Orton's remarks last night were beautiful, but this interests me more and I move that we tender Mr. Ede a vote of thanks for his paper and for the samples that he brings.

The motion being seconded, was unanimously adopted.

MR. EDE: I wish to say, gentlemen, that there is no special object in this thing. I mentioned Glasgow, where I am staying, because that is the only place where I could take my specimens from, and I would be pleased to leave them in Columbus, if Prof. Lord will accept them.

PROF. LORD: Mr. President, I accept them at once with pleasure and thanks. I shall be very glad to have them for the school of mines in the University, as well as any other specimens that he may wish to leave with us and shall mark them with the donor's name. It is about the only way that we can build up a collection satisfactorily. Specimens obtained in this way, of which you know the history, and which are directly associated with a paper, are of much more value than those purchased from a dealer. We will have Mr. Ede's paper printed and in the university with the specimens which illustrate it. I wish to tender a special vote of thanks on the part of the university for the present which Mr. Ede confers upon the school. I would like to ask Mr. Ede if he has found any evidence of nickel in any of the pyrites.

MR. EDE: No, sir, I have not discovered or seen any.

PROF. LORD: I asked the question because two or three years ago I had several specimens of pyrites from Virginia and West Virginia, which showed distinct traces, and in some cases considerable fractions of a per cent of nickel.

SECRETARY HASELTINE: After listening to Mr. Price and Prof. Lord's remarks, and Mr. Ede's, I feel that I, as secretary, on behalf of the institute in general ought to extend to him our sincere thanks for the effort he has made to make an exhibition of the ores and for the able paper he has prepared. The only salvation that the institute has to maintain its prestige, is by the preparation of papers and if we could have more members who would take half the interest that Mr. Ede has in preparing this paper, it would add greatly to the interest of our meetings and to the education of ourselves. I wish to say to Mr. Ede, as Secretary of the institute, that I am especially grateful to him for his efforts on this occasion.

THE CHAIR: Are there any further remarks on the paper? If not, we will call on Prof. Lord for his paper.

MR. PRICE: I understood Mr. Ede to make mention of a certain number of feet, but he didn't state that. He stated

how many miles square, and the kind of ore there was, and so many feet. I want to ask the question if that was so many feet in height of ore in these mines.

MR. EDE: Yes, sir, it was estimated at 300 feet deep and five miles long.

MR. PRICE: That is, different seams or veins of ore ?

MR. EDE: No, sir, it is one seam of ore.

MR. PRICE: 300 feet perpendicular ?

MR. EDE: Yes, sir, they dip sometimes at an angle of 50 and sometimes 45. It depends very much upon the configuration of the surface. They are sometimes tilted and sometimes they are vertical and go down vertically for perhaps 300 feet and but 100 feet wide.