

ON THE MAGNETIC IRONSTONE OF ROSEDALE ABBEY,
CLEVELAND.

 BY JOHN MARLEY.

As the subject of the Cleveland Ironstone has an important bearing on iron making generally, it is hoped that some details respecting its more remarkable features may be of interest to a meeting such as the present held in the city of Glasgow, the centre of a large iron producing district.

The writer would, therefore, call attention to the extraordinary deposit of magnetic ironstone in Rosedale Abbey, now locally known as "Rosedale West." As the whole of the Cleveland ironstone district has become too large for dealing with in any single paper, it is thought that a full description of the results of the explorings of the last eleven years, showing the actual extent and position of such ironstone, will be acceptable to the profession as well as the public.

The author had the opportunity, during the month of June last, of visiting and examining this wonderful deposit of ironstone. In Part VIII. of Spon's Dictionary of Engineering, published in 1869, under the head of Boring and Blasting (page 501), the paper of our first President, the late N. Wood, on this Rosedale Ironstone, with the discussion thereon,* is given as an example of boring for minerals, and quoted nearly verbatim to show "the baseless fabric on which the so-called science of geology is made to rest."

The author felt induced to bring this subject before the present meeting thinking it a good opportunity of giving correct details of this magnetic ironstone, and at the same time of doing justice to the late N. Wood and the late J. Bewick, both of whom took a prominent part in the discussion quoted in Spon's Dictionary, the editor of which, it is understood, will be glad of the occasion afforded to place the real facts before the public, as to the extent and peculiarities of this deposit, in such a way as will show that, if the late President and Mr. Bewick

* Vol. VII. of Transactions of North of England Institute of Mining Engineers, February, 1859.

had before them correct data on which to form their judgment (using a quotation of the editor), the "so-called science of geology" would not have been in jeopardy, since it is now proved it was the borings alone that were visionary.

If any one wishes for further details as to the discovery, application, or geological formation of the Cleveland ironstone generally, as also on this Rosedale District, he is referred to the author's paper in June, 1857,* to Mr. Bewick's† and Mr. Wood's papers, read in Newcastle in 1857 and 1859, to Mr. T. Allison's paper, read in August, 1869, before the South Wales Institute of Engineers, and to Mr. W. Cockburn's paper, read at Middlesbro' before the Cleveland Institute of Engineers in 1869, as well as to the published work of Mr. Bewick on Cleveland ironstone in 1860.

In the paper of 1857, the Rosedale ore was alluded to on account of its large per centage of iron, the size of the deposit, and magnetic properties of the stone, and although iron had been made there 600 years ago, it was not until modern time, in 1834, and in 1853, that it again received attention, although previously, in 1851, a large quantity was worked for making and repairing roads.

In 1857, the quarry was unproved as to extent and thickness, the stone being in a conglomerate state, apparently not stratified, lying neither vertically nor horizontally, and allusion was made to the cheek or slip running parallel to the drift; attention was also called to the want of an exploring drift behind the quarry to prove the ironstone.

When making his examination in 1857, the writer had no doubt but that "Sheriff's Drift" seam, about 13 feet thick, was the top seam of the lias formation, now known as "the seam of the district," and the same seam as that at point A on the plan accompanying the paper of 1857, and also probably the same seam as that found at or adjoining the quarry. These suppositions, together with the fact that the top seam actually overlies the magnetic stone at the quarry forming the roof of the magnetic stone in drifting, have since been ascertained to be correct; the per centage of iron and quality, however, are very different.

Whether the writer was correct in his view as to the magnetic stone forming, or ever having formed part of, or ever having derived its high per centage of metal from the top seam, is still an unsettled question; on the other hand, it cannot now be called either a "vein" or a "bed."

* Vol. V. of Transactions of North of England Institute of Mining Engineers, June, 1857.

† Vol. VI., Do., December, 1857.

It was stated in 1857, that the extent was an unsolved problem, left to others to prove, but the boundaries of the formation are now given in this paper.

The stone, although attracted by the magnet before calcining, will only (with some very rare exceptions) attract iron itself; the best parts contain 49 to 50 per cent. of metallic iron; whereas the best parts of the main seam of Cleveland ironstone, at present in use, can only be said to yield 33 per cent., down to as low as 28 per cent.; the top seam of "Rosedale East" being said to be equal to about 35 per cent. and upwards, although the same seam, in the same valley, is found to yield in some places not more than 20 per cent.

The author gives, 1st, the following quotations from his own paper of 1857:—

"The only special district to which I think necessary now to allude is the Rosedale Abbey District, the ironstone from which has attracted a large amount of attention on account of the large per centage, immense deposit, and magnetic properties.*

"I have no doubt that this seam is the same as the seam at point A on the plan No. 6, as also the same as that found on the east side of Rosedale, in Captain Vardon's property, of varied thickness, as well as the same seam as that at Grosmont, Fryupdale, Swainby, and Boltby, known as the top seam of Cleveland, the 9 inches of coal in the pit sunk agreeing with Beckhole, near Grosmont, in particular, so that the only doubtful point is as to the portion from the outcrop at A to the so-called magnetic quarry, the most feasible solution being that it is a disjointed patch of the regular seam, known as the top seam, and not a vein, as has been said; and with all due deference to the parties who have had more opportunity for examining this district than I have, I propose leaving the extent of the magnetic and extra per centage tract as an unsolved problem, as it may vary from one or two acres to any indefinite extent, not being at all proved, to the south." †

2nd.—Mr. Bewick says, in his paper of December, 1857:—

"My object in thus troubling the members of this Institution with the foregoing remarks is twofold. First, to show that the iron ore of Rosedale, instead of being a large mineral field as was first asserted, and still believed to be so by many, is nothing more than a volcanic dyke; and, secondly, that the ironstone lately opened out in this locality is not as it is reported to be, the main seam now being worked in Cleveland and Grosmont districts, but is, in my opinion, if Mr. Marley will permit me to say so, the top seam." ‡

"The proofs afforded me are, first, its vertical or unstratified formation; secondly, from its containing no organic remains whatever; and thirdly, from its

* Vol. V., p. 207.

† Vol. V., p. 208.

‡ Vol. VI., p. 19.

being highly susceptible to magnetic influence, as well as exhibiting the appearance of its having been in a state of incandescence." *

"I would just observe that I consider boring a most fallacious mode of proving ironstone deposits in strata, such as that which these borings have gone through; you are so liable to mistake a nodule for a bed or a portion of a bed. I shall be much surprised if you do not find the section of your shaft, should you sink one, very different from the section of your borehole." †

3rd.—From the late Mr. Wood's paper, the writer has embodied, on the plans and sections here given, sufficient of his plan No. 1, and of the cross section as are necessary, to illustrate and show the extent of drifts in 1859, and the position of the borings. Mr. Wood says:—

"When this quarry was opened out, it was found to consist of apparently a confused mass of ironstone boulders of ellipsoidal structure, and of gigantic size, often 3 or 4 feet in diameter, the central part of these boulders being generally blue, and consisting of a solid dark oolitic magnetic iron ore, with, in many cases, sandy and solid ironstone crusts around it, and in receding from the centre the iron ore becomes paler, alternating with dark brown purplish layers; the layer then becomes pale brown, and the magnetic quality is lost. In most cases, however, the nodules are quite solid, and a slight stratification exists, though very obscure, and in several cases likewise the oolitic structure is merged into compact brown iron ore. In some parts also, where exposed to the water and to the weather, the iron ore is partly washed away, and a gritty ferruginous crust remains. These great variations do not occur where the ironstone is under cover, or covered by other strata, but appear to assume those different phases in consequence of its extreme susceptibility to change by exposure to air and water; and it is somewhat remarkable that the magnetic property is strongest where the mass is thickest, and scarcely shows any magnetism in places where it is thin, or where it has little cover, and, consequently, more exposed to decomposition or change.

"The great characteristic difference of composition between this ironstone and the top and main band of Cleveland is the entire absence of shells, the structure being entirely of an oolitic character, being entirely composed of small round concretions of iron ore cemented together with extremely thin silicious or arenaceous films, and in its magnetic properties exhibiting polarity, and likewise in its greater richness than the ordinary ironstone of Cleveland." ‡

"The boring through the ironstone beds was performed under the immediate inspection of Mr. Stott, a well-known experienced borer, who kept the specimens brought up the borehole, and I can add, that I examined a great many of the specimens myself with a magnet, and found them magnetic. There is not the least pretence of supposing that shale could be mistaken for ironstone. §

"Whatever opinion may, therefore, be arrived at with respect to the comparison of the beds proved in the borings, and in the pit with the beds at Grosmont, &c., there appears no doubt in my mind that the mass of ironstone of the quarry is a

* Vol. VI., p. 16. † Vol. VII., p. 97. ‡ Vol. VII., p. 89. § Vol. VII., p. 100.

detached portion of the thick or lower bed of ironstone, and that such bed exists *in situ* for a considerable, and of course at present, for an unknown, extent in the locality of Rosedale.*

“If it extends across the valley, as shown in Mr. Bewick’s plan, No. 5, then there is no reason to suppose that it may not extend to the same distance to the north; and if, according to Mr. Bewick, the borings have not yet reached to the top bed of ironstone, then the deposit of ironstone in the valley of Rosedale is richer in ore than either Professor Philips or myself have set forth.” †

4th.—Mr. T. Allison says:—

“This is the most singular deposit of iron ore in Cleveland, or even in England, inasmuch as its deposition does not appear to have been governed by any known law, we must, therefore, confess our ignorance, and call it the act of one of nature’s *unknown bye-laws*.”

Having given these quotations, the writer refers to the workings at “Rosedale West,” Plate No. XXXIII., which show the extent of each trough to be about 5 to 6 acres, or only about one-fifth of the superficial area originally expected from the borings alleged to be proved, and the two troughs to be only about 150 yards in greatest width, instead of two miles as stated, the greatest depth being about 32 yards.

Two longitudinal sections of each trough, with several cross sections, are also given, Plates XXXIV. to XXXVI., and also a general isometrical drawing, Plate No. XXXVII., of the two troughs is added, by way of showing the relative position of such cross sections, from which a better idea will be obtained of the relative positions and extent of each deposit; it will be remarked that although they do not touch as stated by Mr. Allison, they very nearly do so. The sides of the two troughs are irregular and shelvy.

It will be seen from the quotations given, that the late Mr. Wood, naturally inferring that the drifts and three borings had sufficiently proved the extent of magnetic ore, never doubted their accuracy; but from the information since obtained, it is seen that had his original advice been adopted when 300 yards in, to drive 100 yards of cross cuts north and south, the extent would soon have been at once definitely proved, and future errors prevented.

The drifts, however, on getting to the distance of 400 yards, came on a shale cheek in front, then 300 yards distant from No. 2 boring; this cheek had also been proved on each side of the troughs, and on following it up it was found to be the termination of the magnetic ore

* Vol. VII., p. 99.

† Vol. VII., p. 103.

to the west, and simultaneously with such termination a slip dyke riser to the west was found, as shown in the longitudinal section of Kitching's deposit, but as some details of this may be interesting, a sketch is given, Plate No. XXXVI., taken at the end of Garbutt's deposit, and attention is invited to the isolated patch of magnetic ore on the top of the dyke, having water washed pebbles between it and the top seam of the district, similar pebbles and shells having also been found in other parts of these two deposits lying between the top seam and the magnetic stone, as also occasionally on the side of the shale cheeks.

The slip dyke at the quarry, frequently named by both the late N. Wood and Mr. Bewick, the writer thinks is nothing more than a land-slip of the hill side, very prevalent in the district.

Having proved this termination of magnetic ore, by entering only on the top seam of the district, a drift of about 300 yards was with all speed continued up to No. 2 borehole, hoping that on reaching such borehole two magnetic beds would be got instead of the one lost, but it was shown on putting a staple up (having such borehole within its area) to the position of the alleged 13 feet of magnetic ironstone, that only ordinary common shale in situ was found, and on sinking this staple down to the alleged 32 feet of magnetic ore, nothing was found but the regular top seam of the district containing from 20 to 26 per cent. of iron, with the sandstone and shale usually found with it, and which top seam at the quarry is generally about 11 to 12 feet in thickness.

The regular dip of the strata is 1 in 23 to the south.

It will be as well here for the writer to say that it is not his intention to show how these two magnetic beds or specimens of magnetic ore got into the borehole, they were no doubt *artificial deposits*, and he leaves this part of the subject by stating that neither the late Mr. Wood, Mr. Philips, nor the late Mr. Stott had any idea of the error. Again, it may be said that a part of this paper should show how the deposit of magnetic ore got into these troughs, or how such troughs themselves were formed, these points, however, are left to the more learned, and to such as are well versed in the science of geology. The No. 2 borehole having been thus proved incorrect, it was not thought worth the cost of driving to Nos. 1 and 3.

Borings were also made at the Ingleby Mines to find the magnetic deposit, but without success.

The troughs alluded to are nearly due east and west, and some importance has been attached to this circumstance in endeavouring to explain their magnetic quality. It has also been thought to indicate the

action of icebergs, but however caused, it is clear they can no longer be called either one or two beds of regular strata, and as to being veins, not the slightest fissure of any kind has ever yet been found at the bottom of the two troughs, although diligently sought for.

Notwithstanding these deposits were much smaller than was originally expected, the present owners have, since they took possession in July, 1864, vended about half a million tons of magnetic ore from "Rosedale West," besides which, in the previous three-and-a-quarter years, viz. : from April, 1861, about a quarter of a million tons were sent away, and there is still a considerable quantity to work, although from its situation and shape, only a small quantity per annum can now be got.

The above named quantities are exclusive of stone that is not magnetic, or from inferior parts of the troughs, or from the top seam of the district. Fortunately at "Rosedale East," this seam has been found to be of extra richness, which has caused a large traffic and kept the public railway fully utilized.

The PRESIDENT remarked, that having had frequent opportunities of examining these remarkable deposits, he could confirm many of Mr. Marley's remarks. The theory of their volcanic origin was now quite exploded, and their structure was now admitted to be stratified, and to contain distinct traces of fossil flora, which would not have been the case had they been subject to plutonic action. He did not think there were any similar deposits in England, although, as Mr. Marley had remarked, present observation had been entirely confined to the west end of the valley of Rosedale. But he hoped, in the interest of the proprietors, other deposits of a similarly valuable nature might yet be found.

Mr. I. L. BELL, of Newcastle-on-Tyne, remarked that it had always appeared to him, on the discovery of these singular beds, that, from a strictly geological point of view, deposits which were come upon so suddenly, and which were of such unexpected thickness, might be found to take off in a correspondingly sudden manner; and he never could endorse the sanguine views of those gentlemen alluded to by Mr. Marley. He knew that at the time it was expected the magnetic stone would be found on the other side of the valley, *i.e.*, to the east, where the "top seam" was very clearly marked; but this proved not to be the case. Between the face of the hill, where it appeared in the great cliff, and the adjoining valley in a westerly direction, it had totally dis-

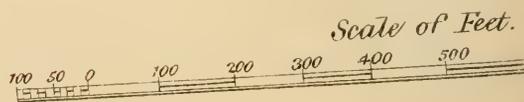
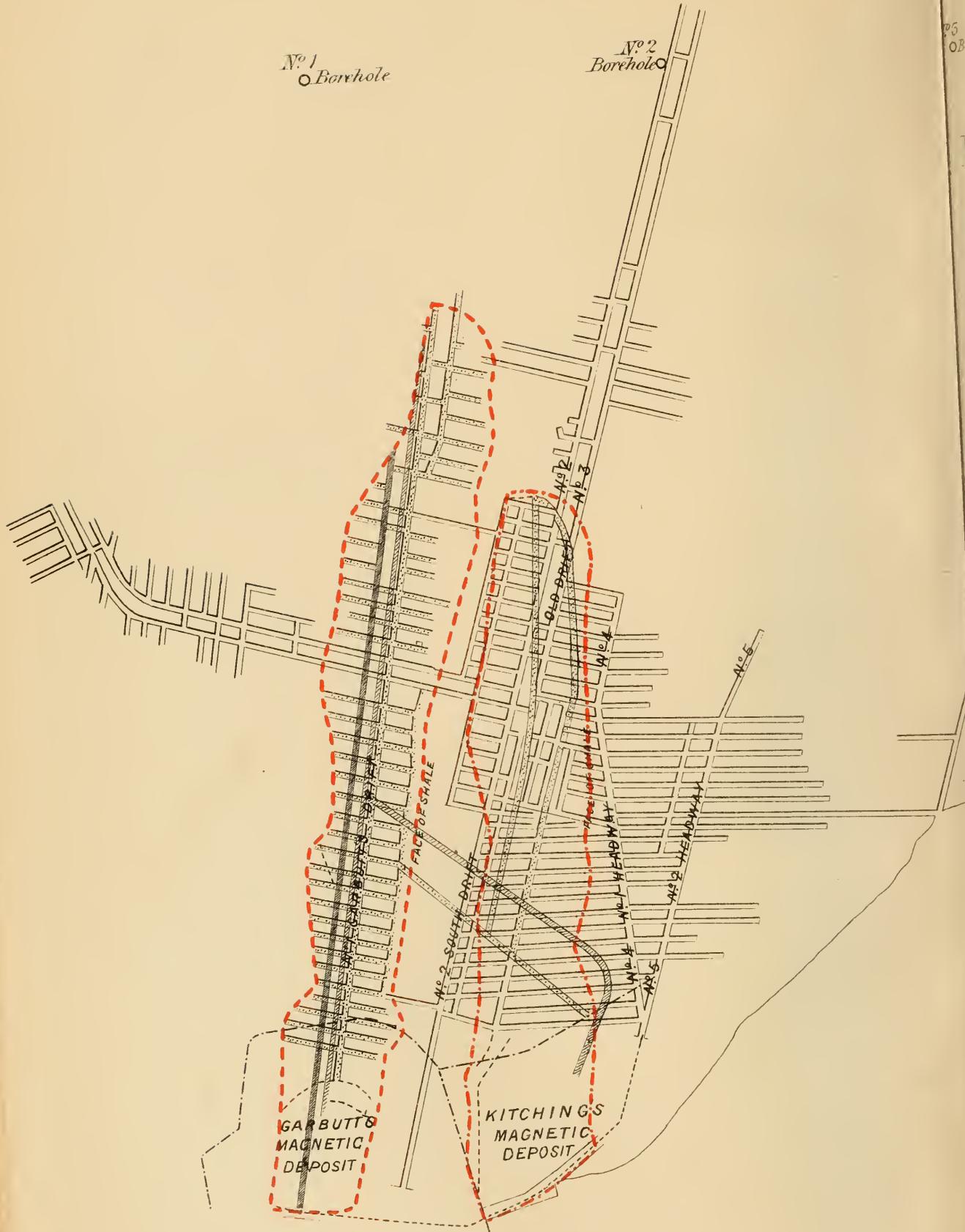
appeared—nor was there the slightest trace of the so-called magnetic stone in the “top seam.” With regard to the character of the deposit, its thickness might on first examination lead to the supposition of its being unstratified; but the circumstance to which the President alluded proves the contrary to be the case. All the analyses that he had seen indicated the presence of carbonaceous matter, and, he thought, some water not mechanically combined (which would not so much affect the question) but in a state of hydration; and these circumstances precluded the idea of volcanic action.

On the motion of the PRESIDENT, a vote of thanks was awarded to Mr. Marley for his valuable paper.

Mr. J. B. SIMPSON then read the following paper “On the Duty of Cornish and other Pumping Engines” :—

N^o 1
Borehole

N^o 2
Borehole

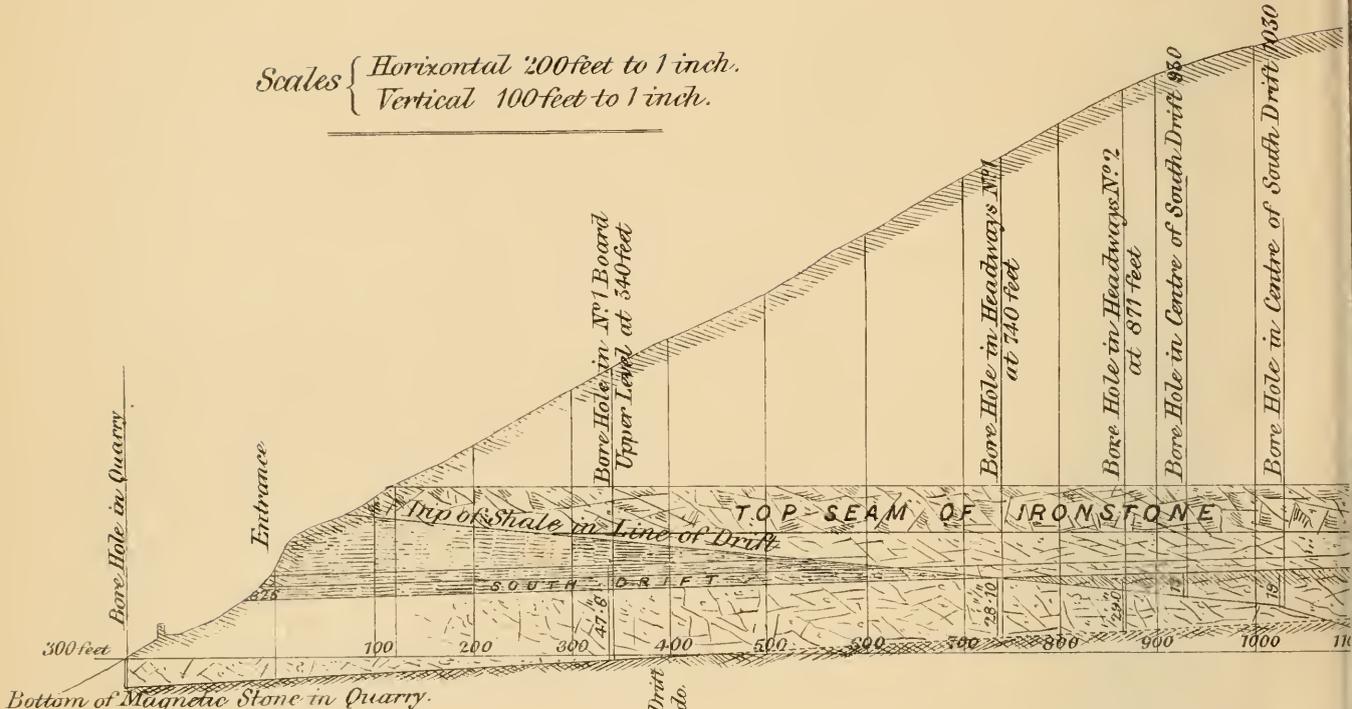


KITCHING'S DEPOSIT.

LONGITUDINAL SECTION.

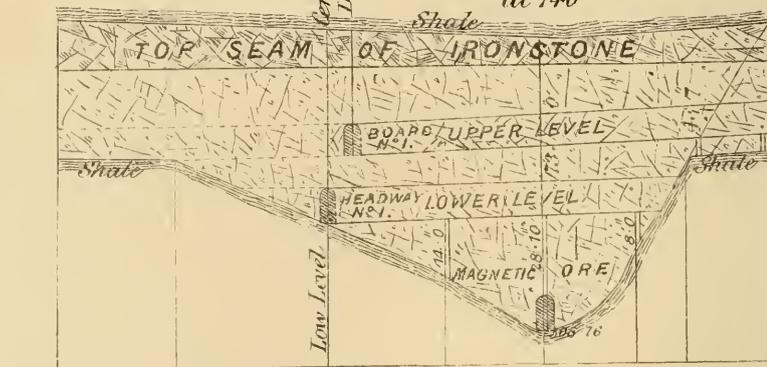
From Entrance to South Drift to N^o 2 Bore Hole.

Scales { Horizontal 200 feet to 1 inch.
Vertical 100 feet to 1 inch.

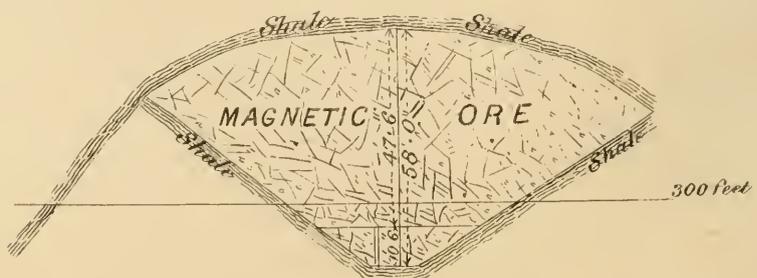


CROSS SECTIONS N^o 1 Headway at 740

SCALES FOR CROSS SECTIONS
Horizontal 100 feet
Vertical 50 feet



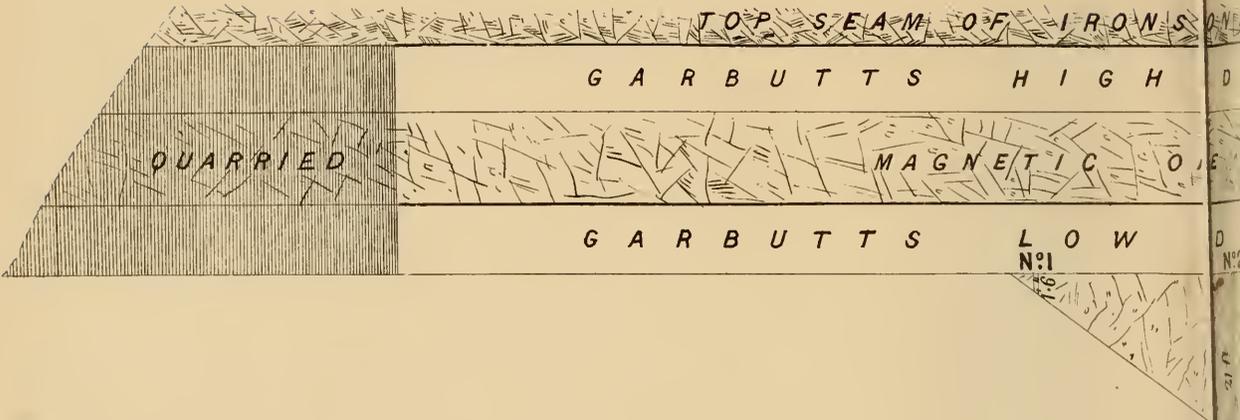
Through Quarry 150 feet outside of Entrance
to Low Level.



GARBUTT'S DEPOSIT.

Scales { *Longitudinal 150 feet = 1 inch.*
Vertical 25 feet = 1 inch.

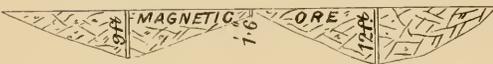
LONGITUDINAL



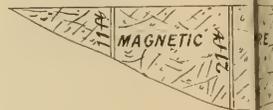
CROSS SECTIONS.

Scale 50 feet to 1 inch.

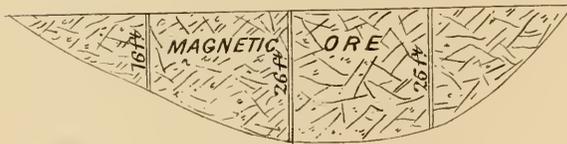
N° 1



N°



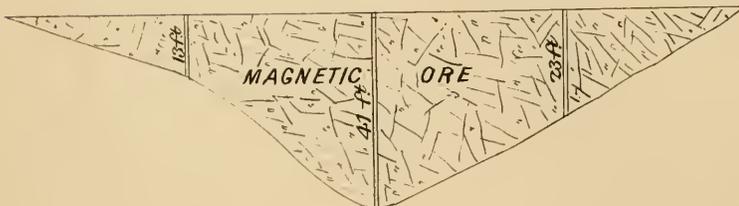
N° 3



N

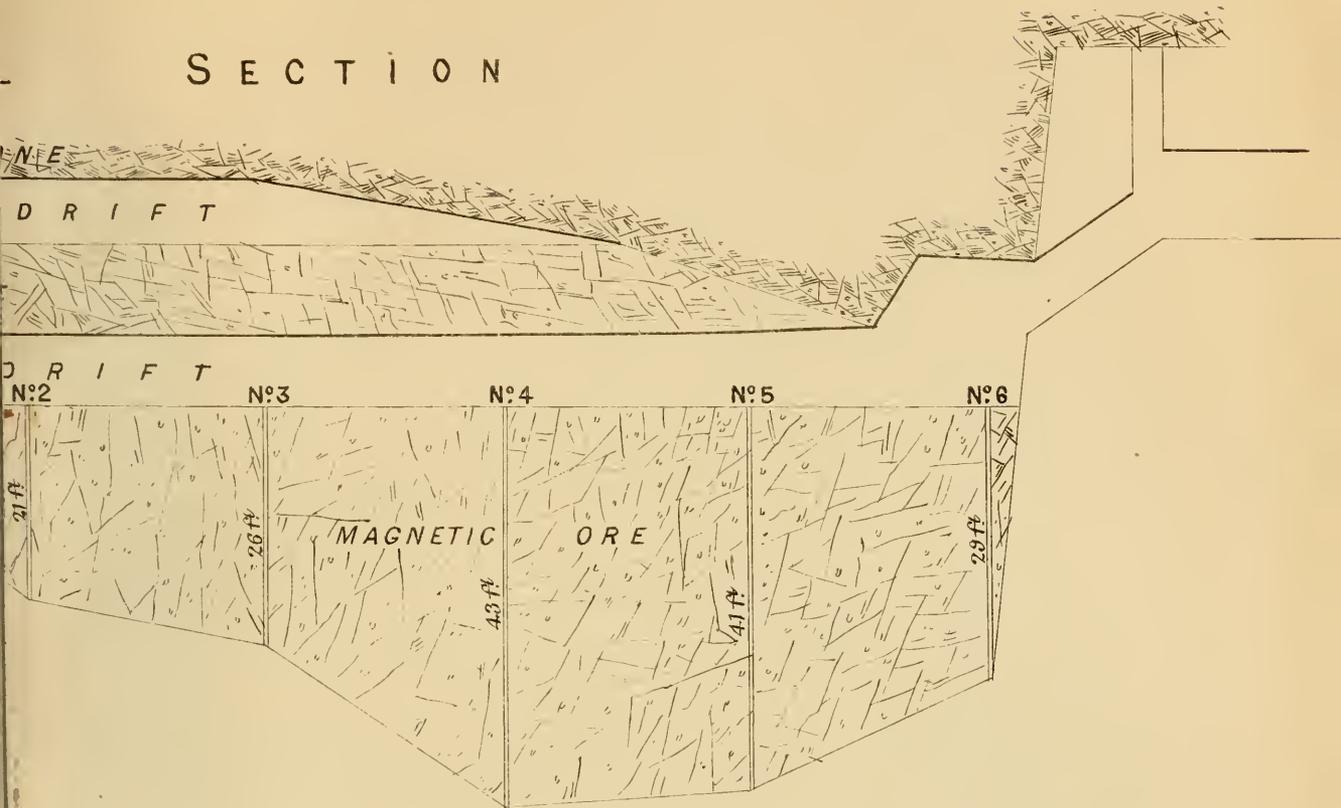


N° 5



(THE MAGNETIC IRONSTONE OF ROSEDALE ABBEY, CLEVELAND.)

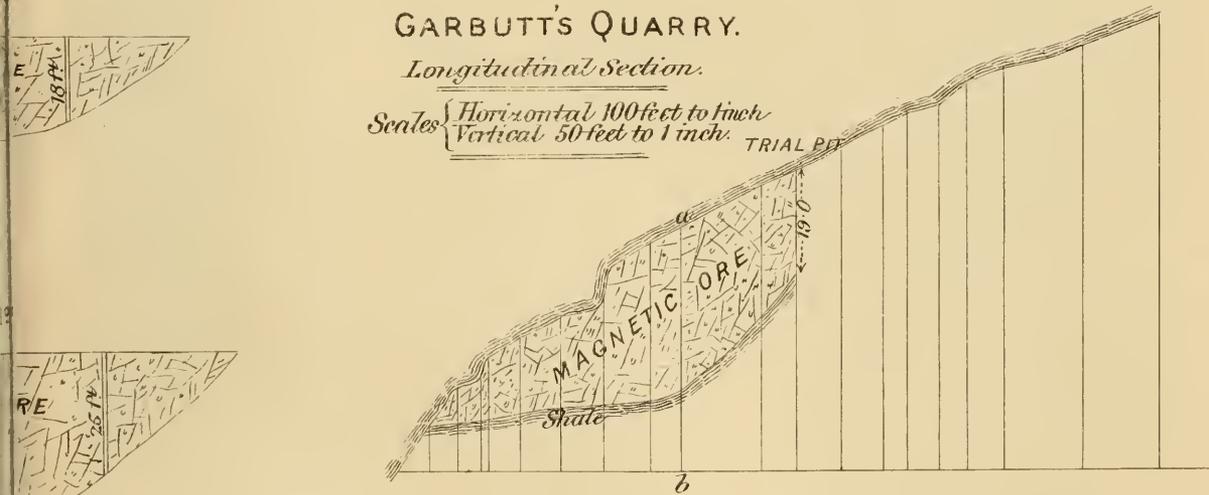
SECTION



GARBUTT'S QUARRY.

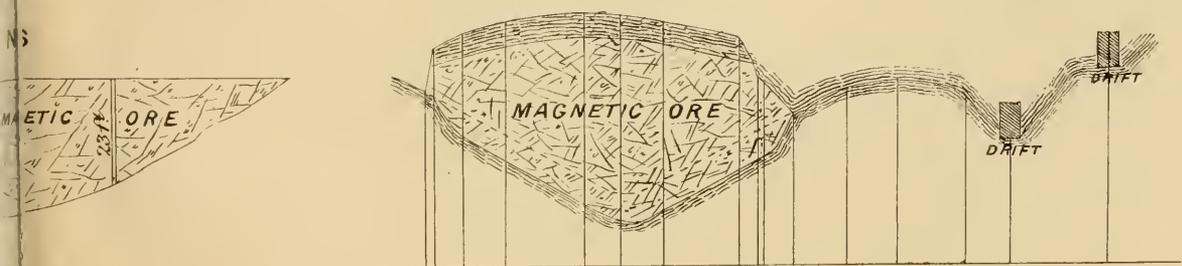
Longitudinal Section.

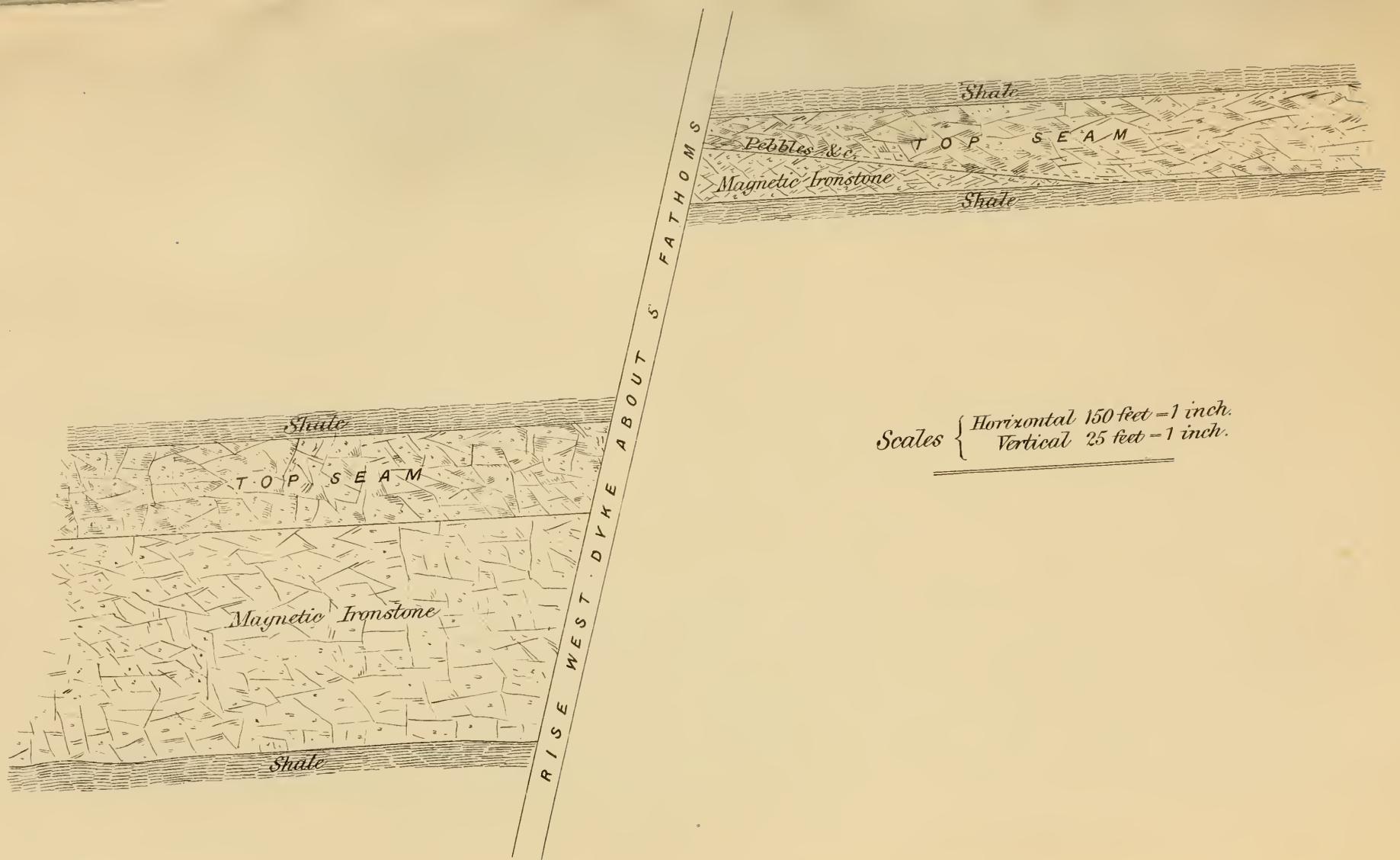
Scales { Horizontal 100 feet to inch
Vertical 50 feet to 1 inch.



CROSS SECTION AT a. b.

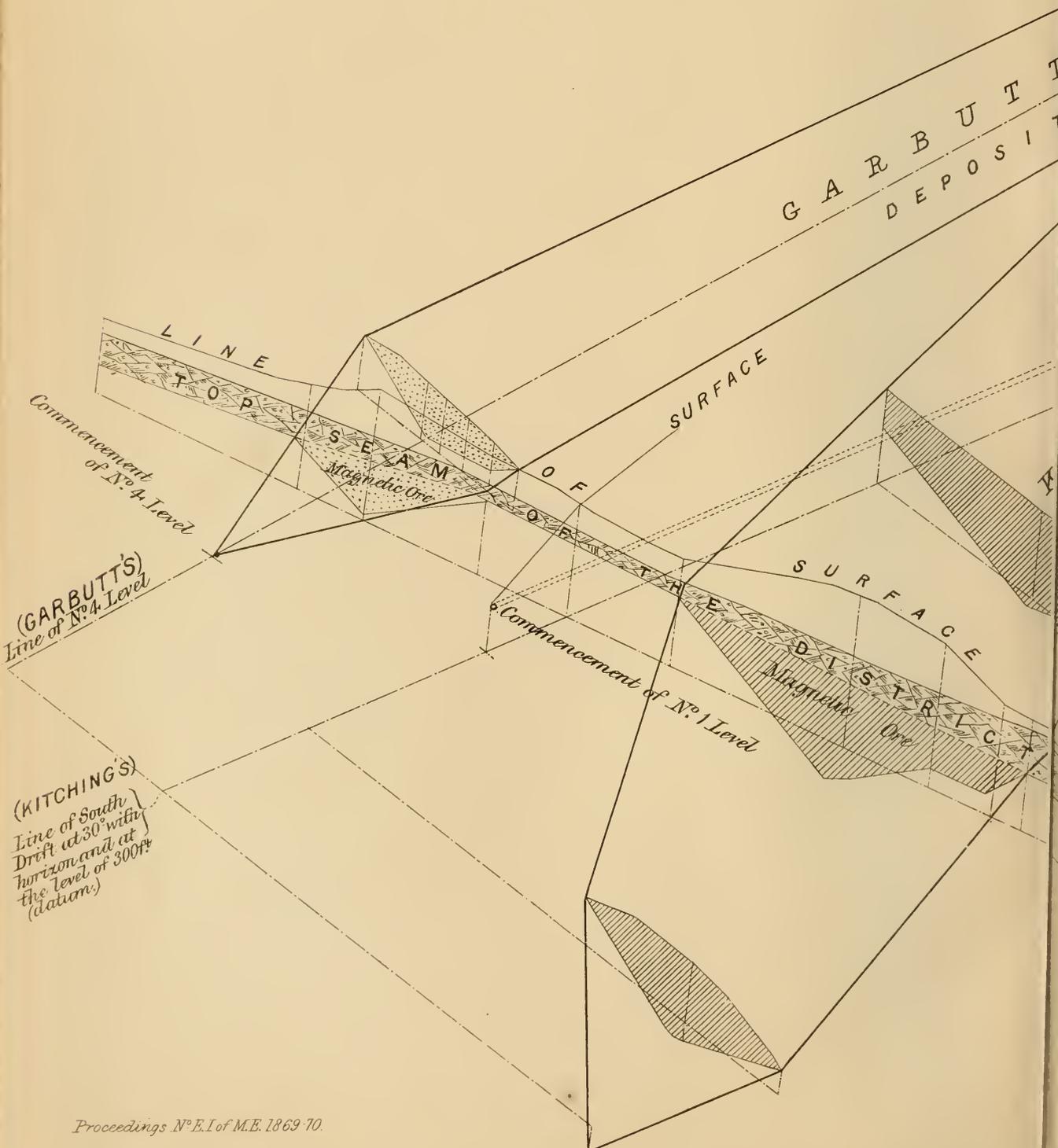
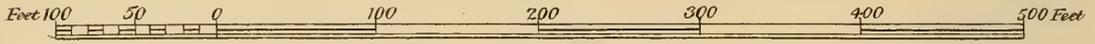
Entrance of Drifts.



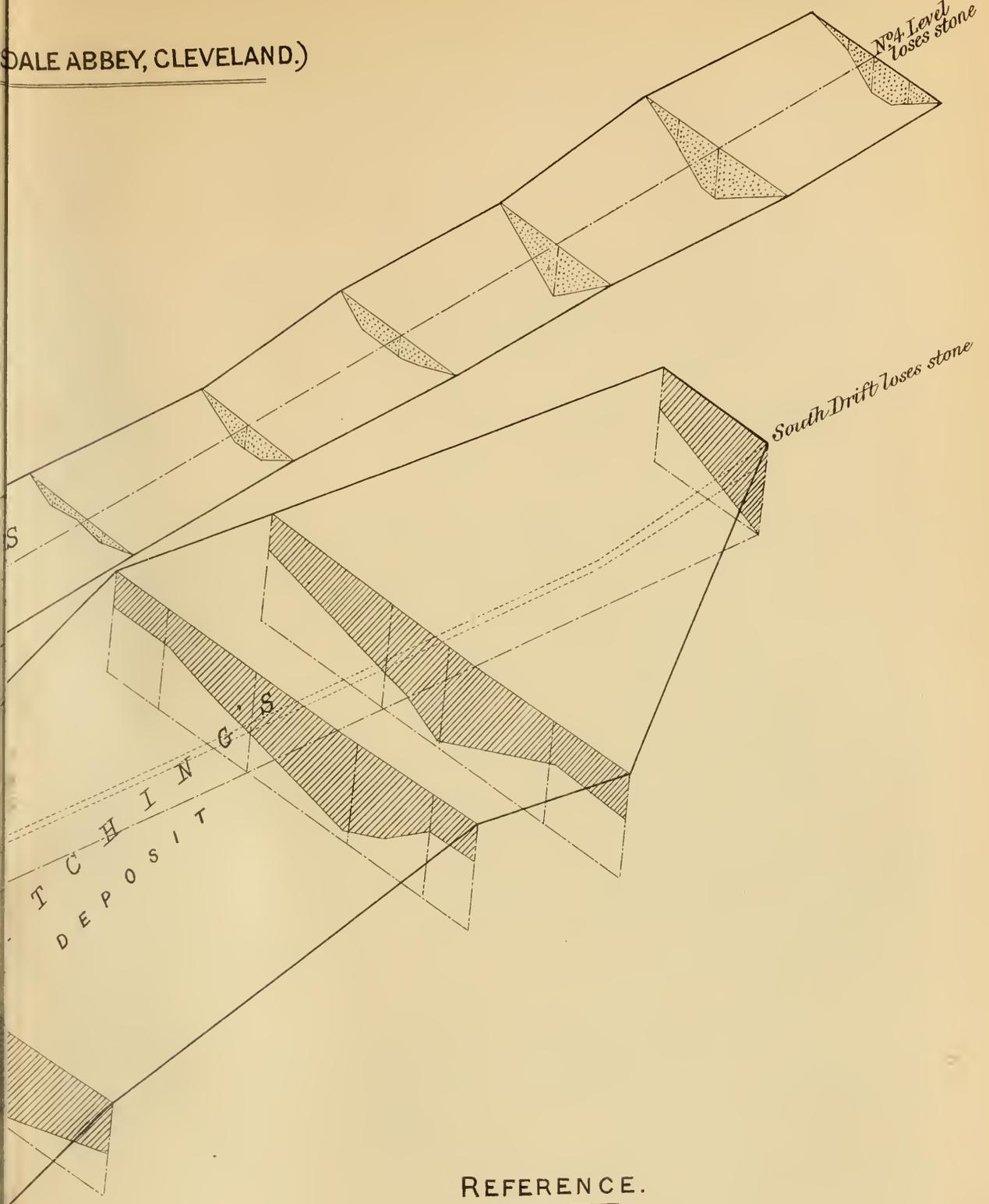


ISOMETRIC PLAN OF ROSEDALE MAGNETIC IRONSTONE.

Isometric Scale for Vertical lines, and for Horizontal lines which are at 30° from the Horizon. All the Horizontal lines are at the same datum (300 feet) and are, as well as the Vertical lines shewn thus.



DALE ABBEY, CLEVELAND.)



REFERENCE.

- Section of Kitchings deposited or Magnetic Stone shewn thus*..... 
- Section of Garbutt's do. do*..... 
- Top Seam of Ironstone of the District*..... 