

1. Name  
2. Date of receipt 16.  
3. Initials of Referee 15-5-37  
M.R.O. 1-50,000-10-10-30.

# MADRAS RECORD OFFICE.

Government of Madras.

*Public*

DEPARTMENT.

G.O. No.

1328

Press  
Mis.

Dated

30 - 8 - 1918

Not to be folded or roughly handled

*Proceedings of the Madras Government, Public Department,  
30th August 1871.*

No. 159. Read the following letter from the Under Secretary to the Government of India, Department of Agriculture, Revenue, and Commerce, to the Superintendent of the Geological Survey of India, dated Simla, the 11th August 1871, No. 35, (Minerals, &c.):—

I am directed to acknowledge the receipt of your letter, No. 138, dated 12th ultimo, forwarding copy of a Report by Mr. W. T. Blanford of the result of his proceedings in search for coal in the Godavery Valley near Dumagudem, and, in reply, to inform you that the Governor-General in Council desires that his thanks may be conveyed to Mr. Blanford for this interesting report, which will be published for general information in the Supplement to the *Gazette of India*.

2. I am to request that the suggestion made by Mr. Blanford in the last paragraph but two of his Report may be acted upon, and the surveys and researches in this tract continued at as early a date as possible.

No. 36.

Copy of the above and of the Report forwarded to the Government of Madras for information.

(By order.)

(Signed) J. GEOGHEGAN,  
*Under Secy. to the Govt. of India.*

REPORT on the Progress and Results of Borings for Coal in the Godavery Valley, near Dumagudem, and Bhadrachalam, by W. T. BLANFORD, Esq., F.G.S., Deputy Superintendent, Geological Survey of India, dated Calcutta, 6th July 1871.

The occurrence of fragments of shaly coal in the bed of the Godavery, close to the spot where the Tal river joins it from the north, about twelve miles above Dumagudem, has been known for several years. It was noticed by Mr. Wall in his report of his journey to Kota, near Sironcha, in 1857, and the coal was by him supposed to be derived from the Tal river. An examination of the Tal for a considerable distance above its junction with the Godavery, however, having proved fruitless, Colonel Haig, the Superintending Engineer of the Godavery Navigation Works, asked me to examine the spot when I was marching down the valley in May 1867. I found that in the Tal, near its junction with the Godavery, the only rocks exposed belonged to the Talchir group, whilst the Damuda shales and sandstones, which alone have been hitherto found in the Indian Peninsula to contain coal, appeared at the spot where the smaller stream joined the Godavery, and I suggested that the coal probably came from a seam buried beneath the sand of the river, and advised exploration by digging away the sand and closely examining the rocks. This was done by Mr. Vanstavern, Executive Engineer, and resulted in the discovery of coal in four places, all a little lower down the river than the mouth of the Tal, so that the bed from which the fragments first found were derived has not yet been detected; but, as a large quantity of silt and sand has been accumulated near the mouth of the Tal of late years, it is probably now covered to a considerable depth. The quality was inferior. Of the seams found, two, neither of them exceeding two feet in thickness, were detected close to the left bank of the river, opposite the village of Lingala. The quality of the coal is rather inferior, and both seams thin out and disappear within a few yards; moreover, as the dip of the rocks at Lingala is towards the river-bed, or south-west, and the outcrop exactly parallel with the bank, it is clear that the beds, even if of good quality, could not be easily worked at this spot, as the whole of them within any reasonable depth must be beneath the bed of the river.

The third seam found crops out in the middle of the river-bed; it is about five feet thick, and the quality appears better than in the other seams. The reef of sandstone resting on this coal

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can be fairly traced at intervals for some distance, and, after running along the river for about a mile, it turns in towards the right, or south-west bank. Here its course becomes obscure. Borings were put down by Mr. Vanstavern near the spot where the coal would probably crop out on the bank, but without success. Another thin seam, only two feet thick, has also been detected by Mr. Vanstavern on the right bank of the river. This, like the two first met with, thins out within a few yards in one direction.

I reached Dumagudem on the 25th December 1870, and learned from Colonel Haig that, besides the coal at Lingala, near the mouth of the Tal, some had been reported further down the river at a village named Madavaram, below Bhadrachalam. This place is below the first barrier on the Godavery, and is consequently at all times in free communication by water with the coast, whilst Lingala is above the first barrier, and, although communication is now possible during the greater part of the year, it is not easy for laden boats except for a few months. At the spot where coal was said to have been found I could detect nothing except some shaly dark coloured sandstone; but the rocks around were unmistakably Damudas, and there was every reason to hope for success in the search.

An examination of the ground showed that the Damuda rocks extend for a short distance on both banks of the river, but that sections are very few and imperfect. On the left bank, which belongs to the Upper Godavery\* districts, there are scarcely any rocks visible except at the hills near Daorpali, and these are probably of a higher group, nearly the whole surface elsewhere being covered with alluvium. The beds appear to extend about six miles along the river from Gogubaka to Nandigur, but not more than from a mile to a mile and a half from the bank. On the right (south) bank of the river they extend about five miles from Palaram to the bend below Madavaram, stretching for a mile and a half to two miles inland. Above Palaram there is a break occupied by metamorphic rocks for a mile and a half; above this, again, at Pundigul, the Damudas re-appear and occur for about one-and-a-half miles to a little above Amravaram; then they are covered apparently by the Kamthis, but the two groups here resemble each other so much in mineral character that their limits are difficult to define, especially as nearly the whole surface of the country is thickly covered with alluvial deposit. The Damudas near Amravaram cannot be traced more than about a mile and a half from the river's banks; beyond this limit they are entirely overlapped by the Kamthis.

Along the right (or south) bank of the Godavery a tolerable section of the Damudas is exposed, consisting of conglomerate, sandstone, shale, and clay, but no coal. There are, however, many breaks in the section, and it is evident that an examination of these by boring would prove conclusively the presence or absence of any bed of coal extending over the whole field. Local beds, of course, might be found elsewhere, but their value must be comparatively small. It is also manifest that a thorough exploration can only be made south of the river; as to the north the beds are so much concealed that, except in a few spots, all borings must be put down at haphazard.

The general dip seen in the river's bank near Madavaram is to the westward, the rocks at the village being inclined at a high angle, and much broken and disturbed; a short distance to the east down the river is an anticlinal, at the spot where a small stream enters the river. From this point eastwards to the bend of the river, a distance of less than a quarter of a mile, the rocks either have a low dip to the east or are horizontal, and the prevalence of conglomerate shows them to be in all probability near the base or limit of the formation.

It is evident that the anticlinal exposes the lowest rocks to be seen on the river bank, and that a boring at this spot must penetrate beds lower in the series than any exposed elsewhere. On the arrival of the boring tools I arranged with Mr. Vanstavern for a borehole to be begun at this spot. This was commenced on January 17th and carried on until April 12th, up to which time

\* I do not know who bestowed this name on the districts, but it is an absurd misnomer. The Upper Godavery can only be that portion of the river's course above its junction with the Pranhita, if not higher still, where it traverses the Bombay Presidency. Sironcha, at the upper extremity of the "Upper Godavery districts," is 210 miles, as the crow flies, from the mouth of the river, and 400 miles from its source!

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192 feet had been penetrated; the borehole was then stopped in consequence of the tools being required to prove the coal discovered on the opposite side of the river. The section passed through was—

|                                                                                       | Ft. | In. |
|---------------------------------------------------------------------------------------|-----|-----|
| 1.—Brown sandstone                                                                    | 24  | 6   |
| 2.—Shale and clay of various colours, mostly dark-grey                                | 21  | 1   |
| 3. { Coal and shale mixed                                                             | 0   | 6   |
| { Dark-grey shale                                                                     | 0   | 7   |
| { Do. do. with fragments of coal                                                      | 0   | 8   |
| { Do. do.                                                                             | 18  | 9   |
| 4.—White sandstone, conglomeratic in places, with thin beds of shale towards the base | 53  | 9   |
| 5.—Shale and clay with a little sandstone                                             | 37  | 2   |
| 6. { Coal                                                                             | 0   | 8   |
| { Black shale and coal                                                                | 1   | 4   |
| 7.—Dark-grey shale with a few fragments of coal in two places                         | 26  | 1   |
| 8.—White sandstone                                                                    | 8   | 4   |
| Total...                                                                              | 193 | 5   |

I next arranged for a series of fourteen borings to explore the portions of the section not exposed in the river banks to the west of Madavaram, between that village and Damarcherla. These varied in depth from six to two hundred feet, according to the extent of the breaks in the section, and the plan proposed was that all the smaller boreholes not exceeding thirty-five feet in depth, nine in number, should be made by jumpers with extra lengths of light rods to screw on. The remaining five boreholes alone would require the use of the heavier boring rods. In the ground opposite Madavaram no boreholes were put, because the breaks on the section are trifling and the disturbance so great that there is reason to believe that a repetition of beds takes place.

To the west of Damarcherla one or two additional boreholes might have been required; but a little beyond the village the beds turn up, dipping east, and then roll over again, and just beyond the small anticlinal very unpromising conglomerates, perhaps belonging to a higher group, come in, in which there is no break of section which could conceal a coal seam. Two or three small jumperholes were put down to the east of Madavaram.

Of the holes proposed, six were carried out, viz., four jumperholes and two boreholes, when peremptory orders were received from the Government of India to discontinue all boring operations in the Nizam's Dominions. It is doubtful whether the boreholes in the bed of the river were in the Nizam's Dominions; but, pending a reference to the Government of the Central Provinces, one set of boring tools was moved across the river into British territory, in order to test some ground near the boundary of the field, and close to the base of the measures, on a horizon which did not appear to have been proved by the borings on the opposite bank.

It should be stated that the borings, so far as they had been carried out on the right bank, had shown the existence of sandstones and shales similar in every respect to those seen in the bank of the river, except that in two or three instances small fragments of coal, proving the existence of very thin seams, probably not exceeding two or three inches in thickness, had been brought up by the borer. These little seams, although absolutely worthless in themselves, are of importance, as indicating that the mineral does occur in the beds, and that hopes may be entertained of larger seams being found.

The place selected for a boring on the north or British bank of the Godavery was on the right or west bank of a stream called the Ganar, rather less than half a mile from the Godavery, and about the same distance east of the village of Tatpali, at a spot where some brown sandstone, dipping to the south, is seen on the bank of the watercourse. A little more sandstone of the same kind is seen up the stream to the north, and then metamorphics crop out, the latter appearing about 500 yards north of the spot selected for boring. For some distance east and west all is alluvium. It was hoped that a borehole at the spot selected would afford a section of the lowest

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Damuda beds, lower than any passed through in the boring east of Madavaram. The borehole was commenced on the 12th April, and the section traversed was—

|          |                                 | Ft. | In. |
|----------|---------------------------------|-----|-----|
| (No. 1.) | Soil and gravel                 | 8   | 6   |
| *1.      | Brown and yellow sandstone      | 25  | 6   |
|          | Shale, pale above, darker below | 7   | 0   |
|          | Coal                            | 3   | 0   |
| 2.       | Do. mixed with shale            | 1   | 0   |
|          | Dark carbonaceous shale         | 5   | 0   |
|          | Coal                            | 3   | 0   |
|          | Dark shale with two inches coal | 6   | 0   |
| 3.       | White sandstone                 | 27  | 0   |
| Total... |                                 | 86  | 0   |

The higher three feet of coal appears to be of better quality than the lower; an analysis of the small fragments washed from the samples brought up from the borehole gave the following (average of three samples from three different levels)—

|          |       |
|----------|-------|
| Volatile | 37.7  |
| Carbon   | 42.7  |
| Ash      | 19.6  |
| Total... | 100.0 |

The volatile portion comprised 10.8 per cent. of water. This is by no means a good result, but still some use could be made of such coal, and it should be remembered that analyses of such samples as are obtained from borings are only approximations, although they are usually not far from the true composition.

When I heard of the discovery of coal I was about forty miles from the spot. I marched to it at once; but, before I reached it, Mr. Heppel, who was carrying on the borings, had commenced a second borehole on some sandstone in the bed of the Ganar stream below No. 1 borehole at a distance from the first of 125 yards south-east by east. This (No. 2) gave the following remarkable section:—

|          |                                      | Ft. | In. |
|----------|--------------------------------------|-----|-----|
| (No. 2.) | 1.—Yellow and brown sandstone        | 28  | 0   |
|          | Shale, partly dark-grey, partly buff | 1   | 6   |
|          | Coal                                 | 2   | 0   |
|          | Shale                                | 2   | 2   |
|          | Coal                                 | 0   | 6   |
|          | Shale                                | 0   | 6   |
|          | Coal                                 | 1   | 4   |
|          | Shale                                | 1   | 4   |
|          | Coal                                 | 1   | 0   |
|          | Shale                                | 1   | 2   |
|          | 2. Coal                              | 1   | 8   |
|          | Shale                                | 1   | 2   |
|          | Coal                                 | 1   | 11  |
|          | Shale                                | 0   | 10  |
|          | Coal                                 | 1   | 0   |
|          | Shale                                | 2   | 8   |
|          | Coal (shaly)                         | 1   | 9   |
|          | Shale                                | 1   | 4   |
|          | Coal                                 | 0   | 8   |
|          | Black shale                          | 5   | 0   |
|          | 3.—White sandstone                   | 3   | 2   |
| Total... |                                      | 60  | 8   |

\* The numbers 1, 2, 3 before the several beds in the sections indicate those which are supposed to be representative of the same part of the series in each.

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Altogether the combined bed of shale and coal measures twenty-nine feet and six inches, of which eleven feet and eight inches is coal; but the bands of coal and shale are intermixed in a way which would much increase the cost of working the seam. The astonishing change, however, in so short a distance as 125 yards from a bed twenty-five feet thick containing seven feet of coal in two well-defined seams exceeds anything usual even in India, amongst the very variable seams sometimes met with in the Barakar group, and this amount of change within so short a distance rendered it doubtful whether the seam could be traced to any distance.

It was now desirable, first, to ascertain the extent of the seam, and second, its quality. For the extent two boreholes were put down, one to the east, the other to the west, at a distance of about one-third of a mile from No. 1 on the supposed strike of the coal seam. All the ground east and west for a considerable distance being completely covered by alluvium, the true strike could only be inferred from the line of outcrop of the metamorphic rocks to the northward. To the east the borehole (No. 4) was a complete failure. It was put down in an open plain north of the village of Ganara. It passed through thirty-four feet of earth and eighteen feet of quicksand, in which no further progress could be made, as the sand filled the tube faster than it could be removed by the "pump" or mineral lifter. A second borehole 200 yards farther south (No. 5) was equally unsuccessful. After passing through twenty-two feet of soil and twenty-four feet of quicksand it also had to be abandoned. There was not time for more attempts in this direction.

The boring to the west (No. 3) was on higher ground, just south of the village of Tatpali.

It gave—

|          |                                                         | Ft. | In. |
|----------|---------------------------------------------------------|-----|-----|
| (No. 3.) | Soil and gravel                                         | 3   | 7   |
| 1 ?      | Sandstone, yellow, brown, and red                       | 29  | 9   |
|          | Pale-coloured shale                                     | 10  | 0   |
| 2 ?      | Red and yellow sandstone with some shale                | 7   | 0   |
|          | Shale, pale and dark                                    | 13  | 0   |
| 3 ?      | White sandstone with a little shale and brown sandstone | 24  | 8   |
| Total... |                                                         | 88  | 0   |

In my absence this borehole was stopped by Mr. Heppel, and another (No. 6) started 250 yards to the south-east. This was on somewhat lower ground, and, as the beds dip south at a low angle, the section is probably that of the same beds—

|          |                                   | Ft. | In. |
|----------|-----------------------------------|-----|-----|
| (No. 6.) | Soil                              | 11  | 0   |
| 1 ?      | Brown sandstone                   | 13  | 10  |
|          | Buff shale                        | 6   | 0   |
| 2 ?      | Red sandstone                     | 2   | 0   |
|          | Dark shale                        | 6   | 0   |
| 3 ?      | White sandstone with darker bands | 46  | 0   |
| Total... |                                   | 84  | 10  |

These sections I am strongly inclined to believe are in the same beds as Nos. 1 and 2. We have the same general succession, brown and yellow sandstone above, then a thick bed of shale and then white sandstone. I have recommended that one of the boreholes should be carried on to a greater depth on the possibility of these beds belonging to a higher horizon, but I cannot think this at all probable. The evidence afforded by these boreholes appears to indicate that the coal thins out and disappears to the westward within a short distance.

Meantime, a locality for a small pit had been selected up the Ganar stream 350 yards north-east of No. 1 borehole, at a spot where some yellow sandstone, just like that immediately over the coal, crops out in the bank of the Nala, in the expectation that this would be close to the outcrop of the coal, and that a sinking of a few feet would produce abundance of coal to enable the quality

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to be fairly tested. A jumperhole, subsequently deepened by boring (No. 7), was put down in order to ascertain the presence of the coal. This gave—

|          |                     | Ft. | In. |
|----------|---------------------|-----|-----|
| (No. 7.) | 1.—Yellow sandstone | 29  | 6   |
|          | 2. { Buff shale     | 24  | 0   |
|          | Dark shale          | 6   | 0   |
|          | Coal                | 1   | 3   |
|          | Dark shale          | 26  | 3   |
| Total... |                     | 87  | 0   |

showing that the beds are nearly flat, and that a great increase of thickness in the shale has been accompanied by a diminution in the coal. A pit was, therefore, commenced close to No. 2; but, when it was only thirteen feet deep, the quantity of water met with retarded progress so much that it was considered advisable to commence another on the high ground thirty yards west of No. 1, as, although it would be a little deeper, it would not be equally liable to flooding, and might be used for the extraction of coal. A borehole has shown that the section is the same as at No. 1. This pit is now in progress.

Meantime, one more boring (No. 8) was made only 200 yards west-by-north from No. 1. The section was—

|          |                                    | Ft. | In. |
|----------|------------------------------------|-----|-----|
| (No. 8.) | Soil and gravel                    | 10  | 5   |
|          | 1.—Coarse brown sandstone          | 4   | 0   |
|          | 2. { Light coloured and buff shale | 9   | 0   |
|          | Red sandstone                      | 3   | 0   |
|          | Light blue shale                   | 2   | 9   |
|          | Red sandy clay                     | 14  | 3   |
|          | Variegated clay                    | 13  | 0   |
|          | Dark shale                         | 21  | 7   |
| Total... |                                    | 78  | 0   |

This boring was in progress when I had to leave at the end of May, and I have not yet received accounts of its completion. The enormous thickness of shale recalls the section in No. 7, and both sections may possibly be below the white sandstone which underlies the coal. But it is more probable that the shale represents the shale and coal found in the two first boreholes.

Lastly, as the absence of coal had been proved to the north-east and west, and no borings had been found practicable to the east, while the ground to the south appeared equally unfavourable for boring, except at a place on the bed in the Godavery where operations might at any moment, at the season now reached (June) have been stopped by a rise in the river, a borehole was recommended 200 yards south of No. 8 and south-west of No. 1. This (No. 9) has given the following section, sent to me by Mr. Vanstavern since my arrival in Calcutta:—

|          |                                     | Ft. | In. |
|----------|-------------------------------------|-----|-----|
| (No. 9.) | Soil, &c.                           | 39  | 0   |
|          | 1.—Brown sandstone and conglomerate | 23  | 0   |
|          | Dark shale                          | 3   | 0   |
|          | Ironstone                           | 2   | 6   |
|          | Shale                               | 2   | 0   |
|          | Coal                                | 1   | 6   |
|          | Shale                               | 2   | 0   |
|          | Coal                                | 2   | 1   |
|          | Shale, carbonaceous                 | 2   | 0   |
|          | Coal                                | 1   | 6   |
|          | 2. { Shale, carbonaceous            | 1   | 6   |
|          | Coal                                | 1   | 6   |
|          | Shale, carbonaceous                 | 1   | 0   |
|          | Coal                                | 1   | 0   |
|          | Shale, carbonaceous                 | 2   | 0   |
|          | Coal                                | 1   | 0   |
|          | Shale, carbonaceous                 | 1   | 0   |
|          | Coal                                | 2   | 0   |
|          | Shale                               | 23  | 0   |
| Total... |                                     | 112 | 7   |

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The section is remarkably like that at No. 2. It decidedly strengthens the evidence in favour of all the boreholes having passed through the continuation of the same beds, for we have in this case a great thickness of shale, as in Nos. 7 and 8, with the coal as in No. 2. The total thickness of coal as yet proved in this last borehole is 10 feet and 7 inches.

To sum up the evidence: the presence of coal has been proved over a small area which contains probably about 25,000 tons, of which quantity it is as well not to assume that more than one-half can be profitably extracted, owing to the great admixture of shale. It is probable that the seam may be traced for some distance to the south, because the amount of coal, so far as is known, increases in that direction; but it is hardly likely that a seam which thins out and disappears within so short a distance as 200 yards can be depended upon for any long distance. The quality has not yet been accurately ascertained. If on cutting into the coal it is found to burn fairly, a considerable quantity may be extracted, far more than sufficient to well repay the expenditure incurred in boring; but, except in the improbable case of the coal continuing for a distance to the south and east, no permanent supply can be depended upon from this locality. The great admixture of shale and the variation in the seam will render it necessary to mine a large quantity of useless rock, and this will increase the cost of the coal; but, in a country where no other supply exists, this alone should not prevent the coal being worked.

The locality is most favourable. The river is within half a mile when full, and about a mile during the dry season, and, so soon as the coast canals are completed, it will be in constant water communication with Madras.

In conclusion, I would recommend that the remainder of this small tract of coal-bearing beds be thoroughly explored, as, even if no extensive seam of coal be found, a considerable quantity of useful fuel might be discovered, which would be available on an emergency. North of the river a borehole should be put down below the high bank at Rajgumpa, at a spot where conglomerate is seen in the river-bed, in order to test if the coal continues so far to the south-east. A boring might also be made where sandstone occurs in the stream north-east of Gaoriopeta, and another south of the large tank near Egerpeta, west of Tatpali, and one of the boreholes already sunk, for preference No. 1, should be continued until the metamorphics or Talchirs are reached. There is little chance of good from any further exploration on the north bank. On the south or right side of the river the series of borings planned west of Madavaram should be carried out. The small breaks in the section near Amravaram might be explored in the same manner, and especially a spot above the mouth of the large stream which enters the Godavery just above the village, as small fragments of shale and coal are hereabouts scattered along the edge of the river, and may indicate a coal seam below the sandstone exposed at a place where there are some bushes beneath the bank.

If all endeavours to find a permanent coal supply in this locality fail, an eventuality for which we must be prepared, the next chance is near Lingala. Here I consider further exploration in British territory as almost hopeless; the Talchirs must crop out everywhere below the mouth of the Tal close to the river bank, so that the Damudas are confined, or nearly so, to the bed of the river and the country on the opposite side. Above the mouth of the Tal for some distance it is simply impossible to say what exists, for the whole country is covered with thick alluvium as far as Cherla, where the only rocks that are known to occur appear to me undoubtedly Kamthis, and all the Damudas and Talchirs are overlapped. The only plan by which any good can be done is an exploration of all the breaks in the section exposed above the top of the Talchirs at Sangaram, on the right bank of the river, in the same manner as I have recommended near Madavaram. The dip varies from 10° to about 20°, and the depth to which the boring in each case must be sunk will be found by multiplying the length of the break by the tangent of the angle of dip.

I am under great obligation to Mr. Vanstavern for the very thorough manner in which he has aided me, and for his readiness to carry out every suggestion I made. Mr. Heppel's services in charge of the boreholes were invaluable; it is mainly due to his thorough knowledge of boring and to his hard work, in an intensely hot season and despite many difficulties, that so much has been accomplished in a short time.

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30th August 1871.*

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No. 160. ORDER THEREON, 30th August 1871, No. 1328.

To be recorded.

(True Extract.)

R. S. ELLIS,  
*Chief Secretary*

**Obbt. of 1871 ~~20~~ 2000.**

**PUBLIC.**

*Dated August, 30th.*

*Recd.*

*Int.*

*G. O., 30th August 1871, No. 1328.*

**AUGUST.**

**Nos. 159-160.**

---

Recording papers received from the Government  
of India reporting the result of the search for coal  
by Mr. Blanford in the Colavey Valley, near  
Dongadum.

From

J. Geoghegan Esq.  
 Under Secretary to the Govt of India,  
 Department of Agriculture,  
 Revenue and Commerce

To

The Superintendent Geological  
 Survey of India  
 Simla the 11 August 1871

Sir,

(Minerals)

I am directed to acknowledge the receipt of your letter No. 138 dated 12<sup>th</sup> ultimo, forwarding copy of a report by Mr. W. J. Blandford of the result of his proceedings in search for coal in the Godavery Valley near Dumagudium, and in reply to inform you that the Governor General in Council desires that his thanks may be conveyed to Mr. Blandford for this interesting report which will be published for general information in the Supplement

Supplement to the Gazette of India.

I am to request that the suggestions made by Mr. Blandford in the last para but two of his report, may be acted upon, and the surveys and researches in this tract continued at as early a date as possible.

I have &c

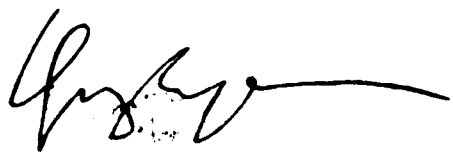
S<sup>r</sup> J. Geoghegan

Under Secretary to the Govt of India

V. 36

Copy of the above, and of the report, forwarded to the Government of Madras, for information.

By order



Under Secretary to the Govt of India

Public

100299?

I think much to send the Govt. a notice in reference to the before referred to report of Mr. Blandford of the result of his proceedings in search of coal in the Godavery valley near Dimgudem. I have ordered my agents to undertake the necessary work.

c. 28/8. 159-160.

Public 1871 Sept.

From

The Under Secy Govt of India, Dept of Agri. & Culture &c.

Simla, No. 36

27/11/71 } Aug/71.

1 Enc. No. 1797.

Forwarding copy of a letter to the Sup<sup>t</sup> Geo. logical Survey of India, & of a report by Mr. H. J. Blandford of the result of his proceedings in search of coal in the Godavery valley near Dimgudem.

Wpccamund 30 Aug 1871. No 1328.

Recorded

To the Secy, Dept of Agri. & Culture

No 3008  
G.O. of 1871 30 Adm.

PUBLIC.

Dated August, 30th.

Recd. Sep 18

Ind.

G. O., 30th August 1871, No. 1328.

AUGUST.  
Nos. 159-160.

Record of the Government  
of India, the search for coal  
by the Government of the  
Dumra Valley, near  
Dumra.

No 3008  
Comm. S. K. S.  
S. K. S.  
18 Dec 1871

65  
Govt. of 1871 Madras.

Public

Dated Aug. 30 }  
Recd.

Encl.

G. O. 30 Aug. 1871, No. 1328

No. 159-160.

Regarding papers received  
from the  
Govt of India reporting the  
result of the search  
for Coal by Mr Blandford  
in the Godavery Valley near  
Punnapachies.

*Proceedings of the Madras Government, Public Department,  
30th August 1817.*

Altogether the combined bed of shale and coal measures twenty-nine feet and six inches, of which eleven feet and eight inches is coal; but the bands of coal and shale are intermixed in a way which would much increase the cost of working the seam. The astonishing change, however, in so short a distance as 125 yards from a bed twenty-five feet thick containing seven feet of coal in two well-defined seams exceeds anything usual even in India, amongst the very variable seams sometimes met with in the Barakar group, and this amount of change within so short a distance rendered it doubtful whether the seam could be traced to any distance.

It was now desirable, first, to ascertain the extent of the seam, and second, its quality. For the extent two boreholes were put down, one to the east, the other to the west, at a distance of about one-third of a mile from No. 1 on the supposed strike of the coal seam. All the ground east and west for a considerable distance being completely covered by alluvium, the true strike could only be inferred from the line of outcrop of the metamorphic rocks to the northward. To the east the borehole (No. 4) was a complete failure. It was put down in an open plain north of the village of Ganara. It passed through thirty-four feet of earth and eighteen feet of quicksand, in which no further progress could be made, as the sand filled the tube faster than it could be removed by the "pump" or mineral lifter. A second borehole 200 yards farther south (No. 5) was equally unsuccessful. After passing through twenty-two feet of soil and twenty-four feet of quicksand it also had to be abandoned. There was not time for more attempts in this direction.

The boring to the west (No. 3) was on higher ground, just south of the village of Tatpali. It gave—

|          |                                                             | Ft. | In. |
|----------|-------------------------------------------------------------|-----|-----|
| (No. 3.) | Soil and gravel                                             | 3   | 7   |
|          | 1 ?—Sandstone, yellow, brown, and red                       | 29  | 9   |
|          | (Pale-coloured shale                                        | 10  | 0   |
|          | 2 ? { Red and yellow sandstone with some shale              | 7   | 0   |
|          | (Shale, pale and dark                                       | 13  | 0   |
|          | 3 ?—White sandstone with a little shale and brown sandstone | 24  | 8   |
|          | Total...                                                    | 88  | 0   |

In my absence this borehole was stopped by Mr. Heppel, and another (No. 6) started 250 yards to the south-east. This was on somewhat lower ground, and, as the beds dip south at a low angle, the section is probably that of the same beds—

|          |                                       | Ft. | In. |
|----------|---------------------------------------|-----|-----|
| (No. 6.) | Soil                                  | 11  | 0   |
|          | 1 ?—Brown sandstone                   | 13  | 10  |
|          | { Buff shale                          | 6   | 0   |
|          | 2 ? { Red sandstone                   | 2   | 0   |
|          | { Dark shale                          | 6   | 0   |
|          | 3 ?—White sandstone with darker bands | 46  | 0   |
|          | Total...                              | 84  | 10  |

These sections I am strongly inclined to believe are in the same beds as Nos. 1 and 2. We have the same general succession, brown and yellow sandstone above, then a thick bed of shale and then white sandstone. I have recommended that one of the boreholes should be carried on to a greater depth on the possibility of these beds belonging to a higher horizon, but I cannot think this at all probable. The evidence afforded by these boreholes appears to indicate that the coal thins out and disappears to the westward within a short distance.

Meantime, a locality for a small pit had been selected up the Ganar stream 350 yards north-east of No. 1 borehole, at a spot where some yellow sandstone, just like that immediately over the coal, crops out in the bank of the Nala, in the expectation that this would be close to the outcrop of the coal, and that a sinking of a few feet would produce abundance of coal to enable the quality

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to be fairly tested. A jumperhole, subsequently deepened by boring (No. 7), was put down in order to ascertain the presence of the coal. This gave—

|          |                     | Ft. | In. |
|----------|---------------------|-----|-----|
| (No. 7.) | 1.—Yellow sandstone | 29  | 6   |
|          | 2. { Buff shale     | 24  | 0   |
|          | Dark shale          | 6   | 0   |
|          | (Dark shale         | 1   | 3   |
|          |                     | 26  | 3   |
|          | Total...            | 87  | 0   |

showing that the beds are nearly flat, and that a great increase of thickness in the shale has been accompanied by a diminution in the coal. A pit was, therefore, commenced close to No. 2; but, when it was only thirteen feet deep, the quantity of water met with retarded progress so much that it was considered advisable to commence another on the high ground thirty yards west of No. 1, as, although it would be a little deeper, it would not be equally liable to flooding, and might be used for the extraction of coal. A borehole has shown that the section is the same as at No. 1. This pit is now in progress.

Meantime, one more boring (No. 8) was made only 200 yards west-by-north from No. 1. The section was—

|          |                               | Ft. | In. |
|----------|-------------------------------|-----|-----|
| (No. 8.) | Soil and gravel               | 10  | 5   |
|          | 1.—Coarse brown sandstone     | 4   | 0   |
|          | Light coloured and buff shale | 9   | 0   |
|          | Red sandstone                 | 3   | 0   |
|          | 2. { Light blue shale         | 2   | 9   |
|          | Red sandy clay                | 14  | 3   |
|          | Variegated clay               | 13  | 0   |
|          | Dark shale                    | 21  | 7   |
|          | Total...                      | 78  | 0   |

This boring was in progress when I had to leave at the end of May, and I have not yet received accounts of its completion. The enormous thickness of shale recalls the section in No. 7, and both sections may possibly be below the white sandstone which underlies the coal. But it is more probable that the shale represents the shale and coal found in the two first boreholes.

Lastly, as the absence of coal had been proved to the north-east and west, and no borings had been found practicable to the east, while the ground to the south appeared equally unfavourable for boring, except at a place on the bed in the Godavery where operations might at any moment, at the season now reached (June) have been stopped by a rise in the river, a borehole was recommended 200 yards south of No. 8 and south-west of No. 1. This (No. 9) has given the following section, sent to me by Mr. Vanstavern since my arrival in Calcutta:—

|          |                                     | Ft. | In. |
|----------|-------------------------------------|-----|-----|
| (No. 9.) | Soil, &c.                           | 39  | 0   |
|          | 1.—Brown sandstone and conglomerate | 23  | 0   |
|          | Dark shale                          | 3   | 0   |
|          | Ironstone                           | 2   | 6   |
|          | Shale                               | 2   | 0   |
|          | Coal                                | 1   | 6   |
|          | Shale                               | 2   | 0   |
|          | Coal                                | 2   | 1   |
|          | Shale, carbonaceous                 | 2   | 0   |
|          | Coal                                | 1   | 6   |
|          | 2. { Shale, carbonaceous            | 1   | 6   |
|          | Coal                                | 1   | 6   |
|          | Shale, carbonaceous                 | 1   | 0   |
|          | Coal                                | 1   | 0   |
|          | Shale, carbonaceous                 | 2   | 0   |
|          | Coal                                | 1   | 0   |
|          | Shale, carbonaceous                 | 1   | 0   |
|          | Coal                                | 2   | 0   |
|          | Shale                               | 23  | 0   |
|          | Total...                            | 112 | 7   |

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The section is remarkably like that at No. 2. It decidedly strengthens the evidence in favour of all the boreholes having passed through the continuation of the same beds, for we have in this case a great thickness of shale, as in Nos. 7 and 8, with the coal as in No. 2. The total thickness of coal as yet proved in this last borehole is 10 feet and 7 inches.

To sum up the evidence: the presence of coal has been proved over a small area which con-

half can be profitably extracted, owing to the great admixture of shale. It is probable that the seam may be traced for some distance to the south, because the amount of coal, so far as is known, increases in that direction; but it is hardly likely that a seam which thins out and disappears within so short a distance as 200 yards can be depended upon for any long distance. The quality has not yet been accurately ascertained. If on cutting into the coal it is found to burn fairly, a considerable quantity may be extracted, far more than sufficient to well repay the expenditure incurred in boring; but, except in the improbable case of the coal continuing for a distance to the south and east, no permanent supply can be depended upon from this locality. The great admixture of shale and the variation in the seam will render it necessary to mine a large quantity of useless rock, and this will increase the cost of the coal; but, in a country where no other supply exists, this alone should not prevent the coal being worked.

The locality is most favourable. The river is within half a mile when full, and about a mile during the dry season, and, so soon as the coast canals are completed, it will be in constant water communication with Madras.

In conclusion, I would recommend that the remainder of this small tract of coal-bearing beds be thoroughly explored, as, even if no extensive seam of coal be found, a considerable quantity of useful fuel might be discovered, which would be available on an emergency. North of the river a boring might be made where sandstone occurs in the stream north-east of Gaoriopeta, and another south of the large tank near Egerpeta, west of Tatpali, and one of the boreholes already sunk, for preference No. 1, should be continued until the metamorphics or Talchirs are reached. There is little chance of good from any further exploration on the north bank. On the south or right side of the river the series of borings planned west of Madavaram should be carried out. The small breaks in the section near Amravaram might be explored in the same manner, and especially a spot above the mouth of the large stream which enters the Godavery just above the village, as small fragments of shale and coal are hereabouts scattered along the edge of the river, and may indicate a coal seam below the sandstone exposed at a place where there are some bushes beneath the bank.

If all endeavours to find a permanent coal supply in this locality fail, an eventuality for which we must be prepared, the next chance is near Lingala. Here I consider further exploration in British territory as almost hopeless; the Talchirs must crop out everywhere below the mouth of the Tal close to the river bank, so that the Damudas are confined, or nearly so, to the bed of the river and the country on the opposite side. Above the mouth of the Tal for some distance it is simply impossible to say what exists, for the whole country is covered with thick alluvium as far as Cherla, where the only rocks that are known to occur appear to me undoubtedly Kamthis, and all the Damudas and Talchirs are overlapped. The only plan by which any good can be done is an exploration of all the breaks in the section exposed above the top of the Talchirs at Sangaram, on the right bank of the river, in the same manner as I have recommended near Madavaram. The dip varies from 10° to about 20°, and the depth to which the boring in each case must be sunk will be found by multiplying the length of the break by the tangent of the angle of dip.

I am under great obligation to Mr. Vanstavern for the very thorough manner in which he has aided me, and for his readiness to carry out every suggestion I made. Mr. Heppel's services in charge of the boreholes were invaluable; it is mainly due to his thorough knowledge of boring and to his hard work, in an intensely hot season and despite many difficulties, that so much has been accomplished in a short time.

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No. 160.

ORDER THEREON, 30th August 1871, No. 1328.

To be recorded.

(True Extract.)

R. S. ELLIS,

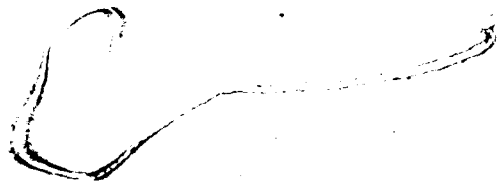
*Chief Secretary*

*(True Copies)*

*Admitted by A.E.*

*Under Secy & Secy Mr. B.  
for Chief Secy*

*To the Revenue Department.*



*Proceedings of the Madras Government, Public Department,*

*30th August 1871.*

No. 159. Read the following letter from the Under Secretary to the Government of India, Department of Agriculture, Revenue, and Commerce, to the Superintendent of the Geological Survey of India, dated Simla, the 11th August 1871, No. 35, (Minerals, &c.) :—

I am directed to acknowledge the receipt of your letter, No. 138, dated 12th ~~ditto, forwarding copy of a Report by Mr. W. T. Blanford of the results of~~ proceedings in search for coal in the Godavery Valley near Dumagudem, and in reply, to inform you that the Governor-General in Council desires that his thanks may be conveyed to Mr. Blanford for this interesting report, which will be published for general information in the Supplement to the *Gazette of India*.

2. I am to request that the suggestion made by Mr. Blanford in the last paragraph but two of his Report may be acted upon, and the surveys and researches in this tract continued at as early a date as possible.

No. 36.

Copy of the above and of the Report forwarded to the Government of Madras for information.

(By order.)

(Signed) J. GEOGHEGAN,  
*Under Secy. to the Govt. of India.*

~~REPORT~~ on the Progress and Results of Borings for Coal in the Godavery Valley, near Dumagudem, and Bhadrachalam, by W. T. BLANFORD, Esq., F.G.S., Deputy Superintendent, Geological Survey of India, dated Calcutta, 6th July 1871.

The occurrence of fragments of shaly coal in the bed of the Godavery, close to the spot where the Tal river joins it from the north, about twelve miles above Dumagudem, has been known for several years. It was noticed by Mr. Wall in his report of his journey to Kota, near Sironcha, in 1857, and the coal was by him supposed to be derived from the Tal river. An examination of the Tal for a considerable distance above its junction with the Godavery, however, having proved fruitless, Colonel Haig, the Superintending Engineer of the Godavery Navigation Works, asked me to examine the spot when I was marching down the valley in May 1867. I found that in the Tal, near its junction with the Godavery, the only rocks exposed belonged to the Talchir group, whilst the Damuda shales and sandstones, which alone have been hitherto found in the Indian Peninsula to contain coal, appeared at the spot where the smaller stream joined the Godavery, and I suggested that the coal probably came from a seam buried beneath the sand of the river, and advised exploration by digging away the sand and closely examining the rocks. This was done by Mr. Vanstavern, Executive Engineer, and resulted in the discovery of coal in four places, all a little lower down the river than the mouth of the Tal, so that the bed from which the fragments first found were derived has not yet been detected; but, as a large quantity of silt and sand has been accumulated near the mouth of the Tal of late years, it is probably now covered to a considerable depth. The quality was inferior. Of the seams found, two, neither of them exceeding two feet in thickness, were detected close to the left bank of the river, opposite the village of Lingala. The quality of the coal is rather inferior, and both seams thin out and disappear within a few yards; moreover, as the dip of the rocks at Lingala is towards the river-bed, or south-west, and the outcrop exactly parallel with the bank, it is clear that the beds, even if of good quality, could not be easily worked at this spot, as the whole of them within any reasonable depth must be beneath the bed of the river.

The third seam found crops out in the middle of the river-bed; it is about five feet thick, and the quality appears better than in the other seams. The reef of sandstone resting on this coal

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can be fairly traced at intervals for some distance, and, after running along the river for about a mile, it turns in towards the right, or south-west bank. Here its course becomes obscure. Borings were put down by Mr. Vanstavern near the spot where the coal would probably crop out on the bank, but without success. Another thin seam, only two feet thick, has also been detected by Mr. Vanstavern on the right bank of the river. This, like the two first met with, thins out within a few yards in one direction.

reached Dumagudem on the 25th December 1870, and learned from Colonel Haig that, besides the coal at Lingala, near the mouth of the Tal, some had been reported further down the river at a village named Madavaram, below Bhadrachalam. This place is below the first barrier on the Godavery, and is consequently at all times in free communication by water with the coast, whilst Lingala is above the first barrier, and, although communication is now possible during the greater part of the year, it is not easy for laden boats except for a few months. At the spot where coal was said to have been found I could detect nothing except some shaly dark coloured sandstone; but the rocks around were unmistakably Damudas, and there was every reason to hope for success in the search.

An examination of the ground showed that the Damuda rocks extend for a short distance on both banks of the river, but that sections are very few and imperfect. On the left bank, which belongs to the Upper Godavery\* districts, there are scarcely any rocks visible except at the hills near Daorpali, and these are probably of a higher group, nearly the whole surface elsewhere being covered with alluvium. The beds appear to extend about six miles along the river from Gogubaka to Nandigur, but not more than from a mile to a mile and a half from the bank. On the right (south) bank of the river they extend about five miles from Palaram to the bend below Madavaram, stretching for a mile and a half to two miles inland. Above Palaram there is a break occupied by metamorphic rocks for a mile and a half; above this again, at Pundigul, the Damudas re-appear.

and occur for about one-and-a-half miles to a little above Amravaram; then they are covered apparently by the Kamthis, but the two groups here resemble each other so much in mineral character that their limits are difficult to define, especially as nearly the whole surface of the country is thickly covered with alluvial deposit. The Damudas near Amravaram cannot be traced more than about a mile and a half from the river's banks; beyond this limit they are entirely overlapped by the Kamthis.

Along the right (or south) bank of the Godavery a tolerable section of the Damudas is exposed, consisting of conglomerate, sandstone, shale, and clay, but no coal. There are, however, many breaks in the section, and it is evident that an examination of these by boring would prove conclusively the presence or absence of any bed of coal extending over the whole field. Local beds, of course, might be found elsewhere, but their value must be comparatively small. It is also manifest that a thorough exploration can only be made south of the river; as to the north the beds are so much concealed that, except in a few spots, all borings must be put down at haphazard.

The general dip seen in the river's bank near Madavaram is to the westward, the rocks at the village being inclined at a high angle, and much broken and disturbed; a short distance to the east down the river is an anticlinal, at the spot where a small stream enters the river. From this point eastwards to the bend of the river, a distance of less than a quarter of a mile, the rocks either have a low dip to the east or are horizontal, and the prevalence of conglomerate shows them to be in all probability near the base or limit of the formation.

It is evident that the anticlinal exposes the lowest rocks to be seen on the river bank, and that a boring at this spot must penetrate beds lower in the series than any exposed elsewhere. On the arrival of the boring tools I arranged with Mr. Vanstavern for a borehole to be begun at this spot. This was commenced on January 17th and carried on until April 12th, up to which time

\* I do not know who bestowed this name on the districts, but it is an absurd misnomer. The Upper Godavery can only be that portion of the river's course above its junction with the Pranrita, if not higher still, where it traverses the Bombay Presidency. Sironcha, at the upper extremity of the "Upper Godavery districts," is 210 miles, as the crow flies, from the mouth of the river, and 400 miles from its source!

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192 feet had been penetrated; the borehole was then stopped in consequence of the tools being required to prove the coal discovered on the opposite side of the river. The section passed through was—

|                                                                                       | Ft. | In. |
|---------------------------------------------------------------------------------------|-----|-----|
| 1.—Brown sandstone                                                                    | 24  | 6   |
| 2.—Shale and clay of various colours, mostly dark-grey                                | 21  | 1   |
| 3. { Coal and shale mixed                                                             | 0   | 6   |
| { Dark-grey shale                                                                     | 0   | 7   |
| { Do. do. with fragments of coal                                                      | 0   | 8   |
| { Do. do.                                                                             | 18  | 9   |
| 4.—White sandstone, conglomeratic in places, with thin beds of shale towards the base | 53  | 9   |
| 5.—Shale and clay with a little sandstone                                             | 37  | 2   |
| 6. { Coal                                                                             | 0   | 8   |
| { Black shale and coal                                                                | 1   | 4   |
| 7.—Dark-grey shale with a few fragments of coal in two places                         | 26  | 1   |
| 8.—White sandstone                                                                    | 8   | 4   |
| Total...                                                                              | 193 | 5   |

I next arranged for a series of fourteen borings to explore the portions of the section not exposed in the river banks to the west of Madavaram, between that village and Damarcherla. These varied in depth from six to two hundred feet, according to the extent of the breaks in the section, and the plan proposed was that all the smaller boreholes not exceeding thirty-five feet in depth, nine in number, should be made by jumpers with extra lengths of light rods to screw on. The remaining five boreholes would require the use of the heavier boring rods. In the original plan five boreholes were put, because the breaks on the section are trifling and the disturbance so great that there is reason to believe that a repetition of beds takes place.

To the west of Damarcherla one or two additional boreholes might have been required; but a little beyond the village the beds turn up, dipping east, and then roll over again, and just beyond the small anticlinal very unpromising conglomerates, perhaps belonging to a higher group, come in, in which there is no break of section which could conceal a coal seam. Two or three small jumper-holes were put down to the east of Madavaram.

Of the holes proposed, six were carried out, viz., four jumperholes and two boreholes, when peremptory orders were received from the Government of India to discontinue all boring operations in the Nizam's Dominions. It is doubtful whether the boreholes in the bed of the river were in the Nizam's Dominions; but, pending a reference to the Government of the Central Provinces, one set of boring tools was moved across the river into British territory, in order to test some ground near the boundary of the field, and close to the base of the measures, on a horizon which did not appear to have been proved by the borings on the opposite bank.

It should be stated that the borings, so far as they had been carried out on the right bank, had shown the existence of sandstones and shales similar in every respect to those seen in the bank of the river, except that in two or three instances small fragments of coal, proving the existence of very thin seams, probably not exceeding two or three inches in thickness, had been brought up by the borer. These little seams, although absolutely worthless in themselves, are of importance, as indicating that the mineral does occur in the beds, and that hopes may be entertained of larger seams being found.

The place selected for a boring on the north or British bank of the Godavery was on the right or west bank of a stream called the Ganar, rather less than half a mile from the Godavery, about the same distance east of the village of Tatpali, at a spot where some brown sandstone, dipping to the south, is seen on the bank of the watercourse. A little more sandstone of the same kind is seen up the stream to the north, and then metamorphics crop out, the latter appearing about 500 yards north of the spot selected for boring. For some distance east and west all is alluvium. It was hoped that a borehole at the spot selected would afford a section of the lowest

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Damuda beds, lower than any passed through in the boring east of Madavaram. The borehole was commenced on the 12th April, and the section traversed was—

|          |                                         | Ft. | In. |
|----------|-----------------------------------------|-----|-----|
| (No. 1.) | Soil and gravel ... ..                  | 8   | 6   |
| *1.—     | Brown and yellow sandstone ... ..       | 25  | 6   |
|          | (Shale, pale above, darker below ... .. | 7   | 0   |
|          | Coal ... ..                             | 2   | 0   |
| 2.       | Do. mixed with shale ... ..             | 1   | 0   |
|          | Dark carbonaceous shale ... ..          | 5   | 0   |
|          | Coal ... ..                             | 3   | 0   |
|          | Dark shale with two inches coal ... ..  | 6   | 0   |
| 3.—      | White sandstone ... ..                  | 27  | 0   |
| Total... |                                         | 86  | 0   |

The higher three feet of coal appears to be of better quality than the lower; an analysis of the small fragments washed from the samples brought up from the borehole gave the following (average of three samples from three different levels)—

|                 |       |
|-----------------|-------|
| Volatile ... .. | 37.7  |
| Carbon ... ..   | 42.7  |
| Ash ... ..      | 19.6  |
| Total...        | 100.0 |

The volatile portion comprised 10.8 per cent. of water. This is by no means a good result, but still some use could be made of such coal, and it should be remembered that analyses of such samples as are obtained from borings are only approximations, although they are usually not far from the true composition.

When I heard of the discovery of coal I was about forty miles from the spot. I marched to it at once; but, before I reached it, Mr. Heppel, who was carrying on the borings, had commenced a second borehole on some sandstone in the bed of the Ganar stream below No. 1 borehole at a distance from the first of 125 yards south-east by east. This (No. 2) gave the following remarkable section :—

|          |                                              | Ft. | In. |
|----------|----------------------------------------------|-----|-----|
| (No. 2.) | 1.—Yellow and brown sandstone ... ..         | 28  | 0   |
|          | (Shale, partly dark-grey, partly buff ... .. | 1   | 6   |
|          | Coal ... ..                                  | 2   | 0   |
|          | Shale ... ..                                 | 2   | 2   |
|          | Coal ... ..                                  | 0   | 6   |
|          | Shale ... ..                                 | 0   | 6   |
|          | Coal ... ..                                  | 1   | 4   |
|          | Shale ... ..                                 | 1   | 4   |
|          | Coal ... ..                                  | 1   | 0   |
|          | Shale ... ..                                 | 1   | 2   |
| 2.       | Coal ... ..                                  | 1   | 8   |
|          | Shale ... ..                                 | 1   | 2   |
|          | Coal ... ..                                  | 1   | 11  |
|          | Shale ... ..                                 | 0   | 10  |
|          | Coal ... ..                                  | 1   | 0   |
|          | Shale ... ..                                 | 2   | 8   |
|          | Coal (shaly) ... ..                          | 1   | 9   |
|          | Shale ... ..                                 | 1   | 4   |
|          | Coal ... ..                                  | 0   | 8   |
|          | Black shale ... ..                           | 5   | 0   |
| 3.—      | White sandstone ... ..                       | 3   | 2   |
| Total... |                                              | 60  | 8   |

\* The numbers 1, 2, 3 before the several beds in the sections indicate those which are supposed to be representative of the same part of the series in each.