THE COAL RESOURCES OF INDIA AND THEIR DEVELOPMENT

By

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A PAPER READ BEFORE THE INDIAN SECTION OF THE SOCIETY OF ARTS

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INDIAN SECTION.

Thursday, February 6, 1902; The Right Hon. LORD GEORGE HAMILTON, M.P., Secretary of State for India, in the chair.

The paper read was—

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BY PROFESSOR WYNDHAM R. DUNSTAN, M.A., F.R.S., Sec.C.S., F.I.C.,

Director of the Scientific and Technical Department of the Imperial Institute.

It is unnecessary to dwell upon the importance to any country of an enormous supply of coal, since coal for the present, at any rate, is the principal source of mechanical power both on land and at sea. The general prosperity of a nation must be intimately bound up with a cheap supply of coal, for not only is it required for ships and railways, factories and mills, but it is essential to some of the greatest of our metallurgical industries, and is, moreover, an important means of employing labour. The question of the coal resources of our own country has been always regarded as a vital one by our economists and manufacturers. The larger question of the coal resources of our colonies and dependencies throughout the Empire has, however, not yet received the attention it deserves, closely connected as it must be with the prosperity of the nation as a whole. Now that reciprocity in trade and Imperial Defence are regarded as political ideals, it is to be expected that our knowledge of the coal supplies of the Empire may be put upon a sound basis.

Of all our dependencies none deserves more consideration than India. Every British statesman has recognised the importance of promoting the industrial development of this great country with its splendid stores of mineral wealth, yet for the most part undeveloped, and its unrivalled forests of vegetable produce. Nothing can contribute more powerfully to this end than the opening up of new coal resources, and the provision of such satisfactory methods of transport and communication that the products of the mines shall become available for use all over India, and for export to the principal ports of the Eastern World.

That India possesses a practically inexhaustible supply of coal is a fact but little known in this country. The history of the development of coal mining as an industry is brief and comparatively recent. Although several collieries were working in 1837 supplying a small local demand, it was not until 20 years later, under the beneficent reign of Lord Dalhousie, that the enterprise showed signs of the development which has now made it an important factor, not only in Indian, but in Imperial affairs. In 1880 the output from the Indian mines had just exceeded 1,000,000 tons, about 98 per cent. of which was produced in Bengal, whilst the remainder was taken entirely from the Central Provinces. In 1900 the output from the Indian collieries exceeded 6,000,000 tons, and whilst Bengal contributed nearly 5,000,000 to the total, Burma, Assam, Central India, the Punjab, Baluchistan and the Nizam's Territories, in addition to the Central Provinces, figure as important producers, the Nizam's Dominions alone contributing nearly half-a-million tons, this province now standing next to Bengal in its output of coal (Appendix, Table I.). As will be seen from the Table (Appendix, Table II.) the Indian output now exceeds that of any British dependency, although New South Wales and Canada are near with outputs of over 5,000,000 tons, being about the same as that of Bengal. The Indian output is about 1-35th of that of the United Kingdom and Ireland.

For some years an increasing quantity of foreign coal was imported into India. Between 1885 and 1895 it varied between 600,000 and 800,000 tons per annum, most of it shipped from the United Kingdom, some from Australia and Japan. Japan has been sending an increased amount of coal to India, much of which, however, is said to be of inferior quality. In the last few years, the imports of coal into India have fallen considerably, and in 1889 they had sunk to 422,376 tons, and for 1900 the figure was only 127,318 tons, including coke and patent fuel (see Appendix, Table III.). This fall is to be accounted for partly by increased internal production and facilities for transport, partly by the rise in the price of British coal, consequent chiefly on the export tax. It is to be remarked that most of the imported

coal goes to Bombay for use in mills and factories, Bombay being far removed by sea or land from the coalfields. There can be hardly a doubt, that as means and conditions of coal transport are improved, the import of foreign coal will entirely cease, and this may be expected to occur within a very few years.

The exports of coal from India tell an entirely different story. In 1892, India, chiefly Bengal, exported 15,620 tons, in 1896 the amount had risen to 136,719 tons, whilst in 1900 the figure is 541,445 tons (see Appendix, Table III.). It is interesting to note that of this large quantity, Colombo took 369,000 tons, Singapore 66,000 tons, and Aden 53,000 tons. Colombo is an important coaling station, which formerly did not take much Indian coal; now, however, it is extensively employed, and is also burned on the Ceylon railways.

The internal consumption of coal in India has greatly extended. It is now burned on nearly all the Indian railways, some of the railway companies having their own mines. There can be no question, that with cheaper and better means of transport it will be possible to start several new industries depending on the use of coal. Of these, by far the most important will be iron and steel production from the abundance of excellent iron ore to be found in India. This is a momentous question for India, but I cannot do more than refer to it generally in this paper.

With these general remarks on the present production of coal in India, I pass to consider more in detail some important points such as the distribution and nature of Indian coal. These subjects were briefly discussed in the "Report on the Coal Supply of India," which I made at the instance of the Government of India in 1898. This Report included the preliminary analytical and technical examination of a large number of samples of coal taken from all the principal seams in India, which were carried out in the Research laboratories of the Scientific and Technical Department of the Imperial Institute, with the object of determining which coals were deserving of more complete investigation. (See Appendix, Table V.)

Distribution of Coal in India.

The coal measures in India belong to a geological period considerably more recent than that in which the coal measures of the United Kingdom and Europe are deposited. In the Indian peninsula the coal is of the permio-triassic age, and belongs almost entirely to the lower Gondwana period. This includes the Bengal coalfields. Outside the Indian peninsula the coal is still more recent, mostly belonging to the tertiary age. This coal is probably less widely distributed than that of the older series, but it occurs in very thick deposits in Upper Assam. Considerable deposits of cretaceous coal also occur both in Assam and Bengal. In connection with the development of the coal resources of India, it is important to bear in mind that coal does not occur at all outside the region of these geological formations, and that, therefore, no considerable quantity of genuine coal is likely to be discovered in Southern India, including Madras and Mysore, where the geological formations are for the most part of older date than those which in India bear coal. True coal is not likely to be found in any quantity in Bombay, except perhaps at great depths, and geologists generally are of opinion that it is not to be expected below the alluvial deposits of Sind, the North-West Provinces, and Rajputana.

The difference in age accounts to a large extent for the difference in character shown by peninsular and extra-peninsular coal. Taking the Bengal coal as a representative of the former, it is somewhat bituminous, with a rather high percentage of mineral constituents (ash). This coal often furnishes a good coke. The tertiary coal of Assam, representing the extra-peninsular deposits, is usually soft and bituminous, containing a high percentage of volatile constituents (hydro carbons) and much less mineral matter than Bengal coal. Some of this coal also forms good coke.

The Upper Gondwana (Jurassic) coal of the peninsula is at present of little importance; the seams are usually thin, and the coal of inferior quality.

Deposits of lignite occur scattered throughout the Himalayas and elsewhere, but these are at present only of secondary importance.

No accurate statement can be made as to the total amount of coal which occurs in India, chiefly owing to the want of information as to the exact extent of some of the fields, and of the thickness of the seams. Geologists are inclined to put the total coal area as occupying about 45,000 square miles. Having regard to the extreme thickness of many of the seams, which sometimes exceed 100 feet, it is clear that India possesses, even after all allowances have been made for difficulties of working and

other deficiencies, an enormous supply of fuel which will soon render her independent of other sources of supply, and which in time to come may even be drawn upon by other nations whose coal deposits are now in process of depletion.

Provincial Coalfields and Collieries. Characters of Coal.

We may now consider the more important coalfields, and the collieries which have been established in them.

Bengal.—In 1900, 238 collieries were at work, the output being nearly 5,000,000 tons.

The principal coalfields in this province are those of Karharbari (Giridih), Raniganj, Jheria, and Karanpura. Karharbari (Giridih), 200 miles from Calcutta, covering about eight square miles, is estimated to contain 136,000,000 tons of coal. The collieries in this field are served by the East Indian Railway Company, which itself works some of the pits. The most important seam is the lower seam, which occupies an area of about seven square miles, and varies between 12 and 30 feet in thickness. Some of the pits are very deep; in one case reaching to 630 feet. From the Table of Analyses appended (Appendix, Table V.), it will be seen that Karharbari coal is of good quality, the fixed carbon in some cases amounting to nearly 67 per cent., with from 5 to 10 per cent. of ash, and a calorific equivalent of about 7,000 calories. It is a good steam coal, and some of it cokes well.

The Raniganj-Barakar field is about 130 miles from Calcutta, and is one of the most important in India. It extends westward along the valley of the Damuda River, and is virtually enclosed by the rivers Damuda and Adjai. The East Indian Railway, running from Calcutta to Patna, passes through the middle of the field. It covers 500 square miles, not including the dip below the alluvial bed to the east. The amount of coal it contains is estimated at 14,000,000,000 tons. The seams vary in thickness. The field is worked by numerous collieries. The coal contains, as a rule, between 50 and 60 per cent. of fixed carbon, about 10 per cent. of ash, whilst the calorific value lies between 5,000 and 6,000 calories. The Sanctoria is a good coal of this series, and cokes well. The coal of the Desherghur seam is held in high repute in India. Sebpore coal is also largely used.

The Jheria field is about 16 miles to the west of that of Raniganj. It is connected with the main line of the East Indian Railway by a branch terminating at Jheria and Katrasgarh. The field has an area of about 200 square miles, and is supposed to contain 864,000,000 tons. Its coal is of the Raniganj and Barakar series, and several of its seams yield a good steam coal resembling that of Karharbari. Though the samples analysed (see Appendix, Table V.) are inferior in yielding much ash, it appears that the coal, as generally mined, is of better quality.

The Bokara field is about two miles west of Jheria. It covers 220 square miles, and is estimated to contain 1,500,000,000 tons; some of the seams are very thick.

There are several other fields in Bengal not yet developed or connected with the railway which are capable of furnishing large quantities of coal.

These are North Karanpura 472 square miles, containing 8,750,000,000 tons, and South Karanpura representing about 75,000,000 tons. The Karanpura fields, situated at the head of the Damuda Valley, are difficult of access, being hemmed in by hills and not yet connected with the railway. The coal is stated to be of good quality, and this field may become of considerable importance in the future, as iron ore of excellent quality is said to occur near the coal measures.

Smaller fields or coal areas are those of Ramgarh, Daltonganj (Palamow), Talchir, and Rajmahal, not at present worked to any extent, but some appear to furnish fair steam coal. (See Appendix Table V.) Railway communication with these fields is needed.

Important additions to the railway communications within the Bengal fields have been recently sanctioned by Government. The Grand Chord of the East Indian Railway is to be completed by a line from Gya to Katrasgarh, a distance of 112 miles, thus giving additional connection with the Jheria field. The Bengal-Nagpur Railway is to extend by a new main line from Midnapur through Bishenpur to Bugudih, bridging the Damuda River, and connecting with the local lines within the field.

A branch line from Katrasgarh to the coalfields of Daltonganj (Palamow), passing through the intermediate coal areas and connecting with the new line of the East Indian Railway from Some River junction to Daltonganj, would be of great assistance to

The further development of this important coal district.

In the Darjiling district, on the frontier of Nepal, there is a narrow field of anthracitic coal much crushed and very friable, and probably unworkable on the large scale. If made into briquettes, it furnishes a useful steam coal, and it is also said to make good coke. This seems to be the nearest approach to Welsh coal which so far has been found in India. A sample from Rakti Naddi, analysed by the Geological Survey, contained nearly 80 per cent. of fixed carbon. Further exploration of this district, between the Lisu and Ramthi rivers, has disclosed a field of about 97 acres, containing about 5,500,000 tons of coal, some of the seams being from 16 to 20 feet thick. This coal furnishes coke, and contains, on an average, 61 per cent. of fixed carbon, and about 12 per cent. of ash.

In connection with the establishment of an iron and steel industry in India, the question of the coking qualities of the Bengal coal is a matter of considerable interest. Coke has been made for some years at Barakar for use in the Bengal ironworks, which have been recently successful in smelting iron from the local ore. This coke, however, is chiefly produced in open ovens, and modern methods do not seem to have been permanently adopted either in respect of washing the coal, or manufacturing the coke. The coke appears to be of inferior quality, being deficient in strength, whilst the percentage of ash ranges as high as 15 to 24 per cent. This question has been fully and ably inquired into by Major R. H. Mahon, R.A. ("Iron and Steel Manufacture in India," Simla, 1899.) The soft coals of the Raniganj-Barakar series, such as that of Sanctoria (Desherghur seam), were found not to produce a satisfactory coke, but those of Giridih and Jheria (Kenwadih and Kustore), when efficiently washed and coked in a closed oven, furnished an excellent hard coke, containing little sulphur, and yielding from 10 to 12 per cent. of ash, which, though higher than that of English coke, would not be an obstacle to its use if the phosphorus in it is not excessive (see Appendix, Table IX.). In fact, the coke so produced seems, from Major Mahon's account, to leave little to be desired from a metallurgical point of view, and should be well adapted for the manufacture of iron and steel. The cost of production is calculated as not exceeding Rs. 4 a ton on the spot.

Central Provinces.—In 1900 eight collieries were at work, the output being 174,842 tons.

In the West, the two principal fields are those of Mohpani and Warora. Owing to the position they occupy midway between Bombay and Bengal, the coal of their fields is likely to hold an important place. They are both connected by branches with the Great Indian Peninsular Railway.

The Mohpani field is rather less than 100 miles from Jabulpore, and 322 miles from Allahabad; everything points to Jabulpore becoming in the future an important industrial centre. The area of the field is not great and the output small. Difficulties are said to have been encountered in working this field. The samples of coal examined (see Appendix, Table V.) were of fair quality. They did not form coke, except those from seams 2, 3 and 4.

The Warora field has an area of about 420 acres, and is estimated to contain about 20,000,000 tons, not including a much larger area (Ghajas, Wun, &c.), at present unworked. The seams vary in thickness from 12 to 13 feet.

The Great Indian Peninsular Railway is connected with the field by a branch line from Wardha, 60 miles in length. Nagpur is about 120 miles, and Bombay 500 miles distant by rail. It has been proposed to carry a line from the Nizam's State Railway through the field which would bring it within 400 miles of Masulipatam. The mines are owned by Government, and nearly the whole output is taken by the Great Indian Peninsular Railway. The samples received varied much in quality, and were in general distinctly inferior to Bengal coal.

Some of the Mohpani coal of this province appears to coke, a point which should be further examined as being of great importance in connection with the alleged occurrence of good iron ore and limestone in the district. For this reason the whole of this region deserves attention. Other small coalfields occur here, as those of the Satpura district, and Shahpur and Pench. The coal is little known, but further development is now possible through the branch line of the Bengal-Nagpur Railway to Chindwara.

To the East, adjoining the Bengal fields, are several coal areas deserving attention. In the Mahanadi Valley there are the fields of Korba, Mand, Talchir, and Raigarh-Hingir, covering an area of about 1,000 square miles, the coal of which is also little known, but is stated to be of good quality. The Rampur field on the Eeb River

to the north-west of Sambalpur has been recently re-examined, and appears to furnish a good steam-coal, which should be further investigated. It is desirable that these fields should now be brought into railway connection.

Central India.—In 1900 only one mine was in active working, the output being 164,489 tons.

The most important field of this district, and the only one at present worked, is that of Umaria, which is 34 miles from Katni on the Great Indian Peninsular Railway, and connected by a branch line. The field has an area of about three square miles, and is estimated to contain 28,000,000 tons of coal. The samples examined (see Appendix, Table V.) show that the seams vary in quality; some of the coal previously examined is better than the present sample. None of the coal appears to form coke. Other fields of this district are Sohagpur (Singrowli), through which a branch line of railway now runs connecting Katni on the East Indian Railway and Bilaspur on the Bengal-Nagpur line. The coal of the fields of Korar, Johilla, and Bisrampur (Sirguja, strictly in Bengal), appears to be similar to that of Umaria, but requires further investigation.

Nizam's Dominions (Hyderabad). — In 1900 five collieries were at work, producing 469,291 tons.

This territory contains coal chiefly of the Barakar series. The largest field and the only one systematically worked is the Singareni in the Godavari Valley, which occupies about eight square miles, and contains about 36,000,000 tons of coal. There are a number of seams, one over 40 feet in thickness. The collieries show an increasing output, and do a considerable trade both with Madras and Bombay. The field is connected by a branch line with the Nizam's State Railway, whence Masulipatam is 146 miles, and Bombay 653 miles distant. Railway and canal communication can also be had with Madras, 350 miles away. Singareni coal has a good reputation as a steam coal. The samples examined were of fair quality, giving a moderate amount of ash, and a fairly high calorific value (see Appendix, Table V.). The coal appears to coke very slightly, if at all. The coal of other fields of this district (Kamaram, Chinar, &c.) is little known, but probably will be found to resemble that of Singareni.

The discovery of a good coking coal in this district would solve the problem of smelting the excellent iron ore which occurs in quantity in Madras.

Madras.—The Presidency is not officially recognised as a coal producer. Very little true coal is likely to be discovered here. As the occurrence of good coal in this area would be of the highest importance, especially in connection with the smelting of the excellent iron ores of the Salem district, borings for the mineral have constantly been made, but with very unsatisfactory results. Having regard to the importance of the Madras Presidency, and especially to its mineral wealth, this district should be brought into railway communication with the coalfields of the Central Provinces and Bengal.

The Rajahzampolli mines in the Godavari Valley, near Rajahmundry, belonging to the Godavari Coal Company, are said to show an increasing output. No samples have been received for examination. The mines are stated to be not yet fully established.

Beddadonal is probably the most southern place in which coal is found in India. The coal is stated to be of very inferior quality, but the products of this and of the whole of the Madavaram field deserve fuller examination.

Rajputana.—There is one mine worked in Rajputana, namely at Palana, in the Bikanir region. The output in 1900 was 9,250 tons. Little is known of the quality of this coal, which appears to be of the nature of lignite.

Baluchistan.—In 1900, nine collieries were at work, producing 23,281 tons. Thin seams of tertiary coal occur in several places in this province, as in the neighbourhood of Quetta. Coal is worked at Khost, and at Mach, in the Bolan Pass.

The Khost colliery is working seams from 6 inches to 2½ feet thick on the side of the hill. The coal, which is easily mined, is conveyed by a branch line of the North-Western Railway. Khost coal is a bituminous coking coal of fair quality, but contains a large proportion of sulphur. Its calorific value is high. The Khost coal is apt to disintegrate in mining, and the dust is made into patent fuel.

Closely resembling it, is the coal from the neighbouring Killa-Hakim seam, which is nearly free from sulphur.

The output from Mach is small. The coal resembles that of Khost.

Punjab. In 1900 two collieries were at work, producing 74,083 tons. Tertiary or perhaps cretaceous coal occurs in several

localities in the Salt Range, but usually in small quantity in thin seams.

The Dandot collieries in the Jhilan district, 2,000 feet above the sea-level, owned by the North-Western Railway Company, work a seam between 2 and 3 feet thick, which is mined at a number of places in the roughest manner, instead of from one shaft from the centre. The coal is used by the North-Western Railway. The samples sent for examination were of inferior quality, containing less than 40 per cent. of fixed carbon, but showed a fairly high calorific value (see Appendix, Table V.).

The Bhaganwala field, at the extreme east of the Salt range is estimated to furnish about 1,000,000 tons of coal. The sample examined was of poor quality, but showed a tendency to coke. The coal from Pidh and Shahrig in this province is of inferior quality, but may be useful for some purposes, as its heating power, dependent on the presence of solid hydrocarbons, is greater than was to be supposed. It might be expected to furnish oil or gas, on distillation, but the samples sent did not give satisfactory results. All these coals possess the disadvantage of containing a relatively high percentage of sulphur.

Kashmir.—Coal is known to occur in several localities, especially in the Sangar Marg hill. The seam appears to be only from 2 to 3 feet thick, and might, therefore, be comparatively expensive to work.

Assam.—In 1900 six mines were at work producing 216,736 tons.

The coal of Assam is, as a rule, either cretaceous or tertiary, the latter occurring in seams of great thickness, chiefly in Upper Assam. The tertiary coal is the more important; cretaceous coal, as a rule, being somewhat woody and resinous, burning quickly.

Cretaceous fields are those (Daranggiri, &c.) of the Garo, Khasi, and Jaintia Hills. In working these mines tunnels are made horizontally into the sides of the hills. Tertiary coal is similarly worked at Makum and at Cherrapunji.

The Makum mines, in the district of Lakimpur, which are the most important as coal producers, contain very thick seams, some between 75 and 100 feet thick, and are estimated to contain about 18,000,000 tons of coal. These mines are near the terminus of the Assam-Bengal Railway and are likely to show a considerably increased output in the future. The coal furnishes little ash and gives out more heat than most Bengal coal. It is regarded as one of the best steam coals in India. It is evident, however, that it varies much in quality (see Appendix, Table V.). Certain samples formed coke. Further information is desirable as to a seam near Tikak, from which an excellent sample was taken.

The Cherrapunji field is situated on a ridge of the Khasia Hills. It is distributed over an area of less than a square mile, and is estimated to contain about 1,000,000 tons. The sample examined, though it formed a good coke, and showed considerable calorific power, was inferior to that previously analysed, which was of first rate quality (see Appendix, Table VI.). More information is desirable as to the average quality of this coal and of that contained in other fields of this district, especially of Lakadong in the Jaintia Hills, where similar coal is being worked on a small scale. In the Saffrai (Nazira) and other districts of the Naga Hills, hard durable coal has been found, of which we have little knowledge at present. Since good iron ore and limestone are said to occur in Assam, the question of the average quality of the coal is of much interest, and should be further examined.

Burma.—In 1900 only one colliery was in active working, producing 10,228 tons.

The coal of Burma is chiefly cretaceous. Though not of the highest quality, there can be no doubt that some of it makes serviceable fuel.

The chief fields are those of Thingadaw in the Shwebo district, including the Letkokbin mine on the west bank of the Irawaddy, about 60 miles from Mandalay. The seams are from 4 to 5 feet thick. The coal is compact and hard, resembling the cretaceous coal of Upper Assam. No satisfactory sample was submitted for analysis.

The Chindwin fields near Kaliwa on the Chindwin River, contain good cretaceous coal in seams from 1 to 12 feet thick. The ash of all the Burma coal is small.

Reference may be made to the coal occurring in the Northern Shan States and on the Great Tennasserim River, as deserving of further investigation.

I have now given a brief and necessarily general account of the Indian coal deposits. For further information as to the precise character of the seams, &c., recourse must be had to the memoirs and records of the Geological Survey of India, to which we are almost exclusively indebted for our precise knowledge

of the localities where coal exists. The latest information is, however, scattered and inaccessible, and requires to be brought together in a single volume. This is the more necessary as Ball's "Economic Geology of India" is now much out of date.

Quality of Indian Coal.

The numerous analytical results given in the Tables V., VI., and VII. appended to this paper show that excellent steam and coking coal occur in India, especially in Bengal and Assam. These Tables include all the principal analyses which have been recorded. Indian coal, as a rule, affords more ash than the best European coal, and its calorific power is usually somewhat lower. Taking all the defects of Indian coal of average quality into account, it may be said to be from 17 to 20 per cent. inferior to average British coal of the same type. The chief types of Indian coal which were analysed are compared with average British coals in the accompanying tables (see Appendix, Table VIII.)

The fact that the seams furnish coal which varies greatly in quality, even in one and the same seam, is evident from the comparison of the results of examination of different samples (see Appendix, Tables V., VI., VII.). My own results in certain cases show considerable variation from those of previous observers, chiefly of the Indian Geological Survey. From information I have received from users of Indian coal, it is apparent that this aspect of the matter is one which should receive much more attention from the colliery companies and their agents. Complaints are not uncommon as to the disappointing results which have been obtained from the trial of Indian coal reputed to be of good quality.

I was glad to see that Mr. H. H. Macleod, in a speech delivered at the last meeting of the Indian Mining Association, drew attention to the subject and remarked:—

"Our only serious rival—English coal apart—is Japan, although at some time or other we may have to contend with the limitless deposits of China. But that is in the future, and the mere fact of such a contingency should make us all the more energetic at present. What we have now to do is to strive to displace Japanese coal in those Eastern markets, where it is ahead of us. Singapore, for instance, is a port where we ought to do a very great deal better than we have done hitherto. I notice that the imports of Japanese coal into Singapore for the years 1898-1899 were 263,051 and 280,665 tons, respectively, as against 80,090 and 73,695 tons respectively, of Bengal coal, while the average price was 15 dols. 20 cents., and 10 dols. 35 cents per ton for Japanese, 10 dols. 18 cents and 9 dols. 70 cents per ton for Bengal. We know that cheap freight is the rule rather than the exception from Japanese ports to the Straits, as it is to Bombay; and we would, therefore, naturally expect to see a close approximation between the prices of Japanese and Bengal coals at a Straits port like Singapore. Such, however, is not the case, and it is interesting to inquire why Japanese coal should realise one to five dollars per ton more than our article. There is no parallel for such a difference either in Colombo or Bombay; and the only possible explanation is that the Bengal coal sent to Singapore has been inferior in quality to that sent from Japan. And here it seems to me that we come to what may be, unless we are watchful, the greatest stumbling block to the development of our foreign trade. This question of quality cannot be too strongly insisted upon. And when we hear of a cargo of Bengal coal reaching its port of destination only to be condemned, and of trials made at another port giving unfavourable results, we have before us object-lessons which afford food for very serious reflection. In my opinion nothing can be so damaging to our future prospects as the shipment of indiscriminate qualities. It is a direct menace to the future of the trade, and will do more than anything else to handicap us in those markets where we have to compete with foreign coal. As for our other great rival—English coal—we know that prices are falling, and we expect them to fall still further. Consequently, with low outward freights, Bengal coal may be, so to speak, squeezed out to a certain extent. But I think to a certain extent only, because the case of Bombay shows that our best qualities have held their own even with English prices at their lowest level. And if that has been our experience at Bombay, there is no reason why it should not be so elsewhere. I have said our best qualities, because the question of quality is, if anything, even more important in our competition with English coal than it is when we are struggling against Japanese. Hitherto we have blamed, and I must say, to a large extent rightly blamed, the railways and the Port Commissioners for the slow progress of our foreign trade. But if when our coal actually gets into foreign markets, it is rejected because of its inferior quality, or for the same reason is sold at unprofitable prices, the onus of our failure will rest upon ourselves. Our railway and dock difficulties will be surmounted in time. It may be a long time, but whether it be long or short, let us at any rate take care to do nothing in the interval to damage our ultimate chances in foreign markets, by offering coal which is useless to them and discreditable to us."

Many of the questions which are raised in the development of the coal industry in India require the advice of an expert for their deter-

mination, and I venture to suggest that the Government of India, through the Geological Survey, might render important service to the development and extension of this industry. Economic geology should occupy an important position in a country like India, where industrial enterprise is one of the most pressing needs. Much still remains to be done in exploring many of the Indian coalfields, and in ascertaining precisely the quality of the coal they furnish, and the purposes for which it is adapted. In all these respects the department of the Geological Survey, if so requested by Government, might render considerable assistance if it were understood to be the principal duty of several of its highly qualified officers to make all the necessary investigations of the Indian coalfields, from an economic as well as from a scientific standpoint, and to supply information of industrial value on the many questions involved in their successful working. There can be little doubt, that some of the coal seams have suffered considerably from having been improperly worked in the first instance without technical advice.

From the results of the most recent examinations of samples of Indian coal, I am led to conclude that coal of better quality is being mined from certain seams than was formerly the case.

It should not be forgotten that cheapness is the factor which chiefly determines the present increasing output of Indian coal, and for this reason Indian coal of poorer quality is taken by steamships in preference to the better English coal on account of its much smaller cost.

It is desirable that exact information should be obtained as to the extent to which the different varieties of Indian coal are likely to undergo deterioration during transport and storage, so that the necessary precautions maybe taken. It is certain that some Indian coal will give trouble on account of the readiness with which it fractures. Other varieties are liable to the disintegration which is the result of atmospheric weathering. I allude elsewhere to the means by which the "slack" and broken coal could be utilized.

Since Indian coal is now largely consumed by steamship companies plying in Indian waters, I have enquired of the principal steamship companies trading with India, to what extent they consume Indian coal, and what their experience is of its use. I summarise the replies I have received from the chief steamship companies :—

1. "I am desired to inform you, that all the Company's Indian coal purchases are made at Calcutta, and that, although the qualities of the various descriptions obtainable there differ considerably, our general experience may be set down to indicate that the consumption is 25 per cent. above that of Welsh coal.

"I may add, that in our mail steamers, we have never been able to obtain a satisfactory result in point of speed, from the sole employment of Indian coal; to affect this, a mixture with Welsh coal in the proportion of, say one-third of the former, to two-thirds of the latter is necessary."

2. "All the coal we have purchased east of the Suez Canal, during this year (1901) has been Indian coal, with the exception of the small quantity we required for a vessel under our charter, which vessel not being provided with forced draught was unable to make satisfactory use of Indian coal.

"We may say generally that our experience is that the Indian coal has improved in quality, and we consider it likely to hold its own in the supply of the Eastern market."

3. "We are large users of Indian coal. It is difficult to give you any definite information as to the practical value of Indian coal, that is steam coal, such as we use for our steamers, owing to the widely fluctuating results in consumption as they appear to us from experience. We have tried the various qualities of coal supplied at Calcutta, in some cases buying these coals through the London agents of the suppliers, or in other cases buying them through our agents in Calcutta; but in all cases our enquiries have been made for, and our object has been, to purchase the best description of coal for steamer purposes.

"We have been most disappointed in results, as a general experience; and we think we are not far wrong if we state that we have found the general character of Indian coal far worse in practical value than any other coals which we are accustomed to deal with. At the same time the exigencies of our trade compel us to have recourse to Indian coals even in the face of such drawbacks.

"We are being impressed by degrees that a better description of coal is being produced in certain parts of India than any which we have been accustomed to have supplied to us at Calcutta.

"We consider that the coal business of India could be immensely developed by means of supplies to steamers if only shipowners could be made acquainted, on unquestionable authority, with the names of the best descriptions of coal suited for the purpose. We consider, upon such imperfect knowledge as we possess of the circumstances affecting the coals shipped in Calcutta, that the coal proprietors do not give proper or efficient supervision in raising the coal and sending it for shipment to ensure that it has

been cleaned of the enormous percentage of dirt which apparently is raised with it.

"We have found some of the coal capable of fairly raising steam, but it has been sadly depreciated by the large amount of dirt which is mixed with the coal. We are sure this could be obviated to a large extent in the same way as is now done in this country if only proper machinery were made use of for cleaning the coal.

"There is a great opening for the Government to assist in the development in the coal resources of India by establishing some system which shall ensure the coal being sent to port in a much cleaner condition, and which shall prevent the large percentage of dirt and rubbish which now goes under the name of coal. Also, as Government control the railways, they might bring about some improvement by a better supply of railway trucks.

"Our steamers use coal from various countries. We buy largely of British coal (Welsh, North Country and Scotch), also we are large users of Natal coal and of Australian coal, as well as of coals raised in the United States and shipped at the Atlantic ports, New York, &c. Our reason for purchasing these various descriptions is that it is convenient for the trades in which our steamers are engaged, but as your enquiry appears to be more particularly as to the Indian coals we may state that we often give a decided preference to one or other of these coals (which can be obtained in India) over the Indian coals even at a very large increase in price. If some means could be taken to improve the quality of the Indian coals obtainable at Calcutta and other Indian ports, we have no doubt we should be able to reduce our use of other coals, and thus take a larger share of our requirements in Indian coals, and in this way we have no doubt the development of the coal resources of India would be accelerated."

4. "The Assam coal is good, but, with two or three exceptions, we have found Bengal coal not at all suitable for our steamers. At the same time we use it freely on board our vessels, as the cost of it is small compared with the price of imported fuel."

5. "This company have been using Indian coal as steam coal for the past five years or so; and in spite of repeated trials with different qualities, they have come to the conclusion that Indian coal does not answer the purpose for fast-going steamers, as it does not give the required pressure for a certain speed which British coal generally gives, the consumption being at an average of 40 per cent. higher.

"For this reason, which is capital, it is likely that the company, and no doubt all others entrusted with mail contracts, will not extend the employment of Indian coal as long as British coal is procurable with advantage.

"Indian coal will still and always be of great advantage to cargo-boats and tramps for which speed is a matter of no importance."

6. ". . . We have been supplying only Indian coal here (Bombay) to our steamers since the great rise of prices in Cardiff two years ago.

"Our engineers have found that the 'Desherghur' from Bengal gives the best results. I may add that the Indian coal is generally considered to be about 10 to 15 per cent. less effective than Cardiff, the evaporation being quicker.

"Our present price for 'Desherghur' is 20s. per ton, while Cardiff could not be had under 28s."

7. "Indian coal is used exclusively in the Company's steamers trading east of Suez, as it is cheaper than British coal; the company's steamers trading between Europe and the East use English coal only west of Suez, where, as yet, Indian coal cannot compete with English coal."

8. ". . . . We have only carried Bengal coal once for use in our steamers, and the result was so bad that we never tried it again. We are sorry we are unable to give you the name of the mine whence it came or any particulars, other than that it was taken in at Rangoon and consumed between that port and Colombo."

9. "The facilities for transport and distribution are greatly hampered, as the supply of railway rolling stock does not meet the requirements of the trade. We are also of the opinion that if the railway rates were reduced, the distribution to more distant places would be the result. We consider the Government should assist the development of the coal resources of India by arranging for greater railway facilities. This is a matter which has frequently been brought to the notice of the Government of India in recent years.

"In our steamers and factories we consume about 5,000 tons of Indian coal per month, and we find it a fair steaming coal; but to get the same results out of a boiler as you would with Welsh coal, it is necessary to have about 15 per cent. more grate surface. We only employ British coal on this side of the Suez Canal."

10. "The number of steamers in our company (including launches) is 86, and the coal consumed during the year 1900 amounted to about 1,050,000 tons, the whole of which was raised in India.

"We may state that with a good quality of Indian coal we have no difficulty in maintaining steam in any of our vessels, and, so far as we can trace, we have never used any other than Indian coal since the formation of our company nearly 60 years ago. For very many years our supplies were drawn exclusively from the coalfields on the Burdwan and Raniganj districts in Bengal, and we still draw the bulk of our Calcutta requirements from that region. In 1885, coal from the Lakimpur district, in Assam, became available, and since that date our requirements for the Brahmaputra line have been drawn from that district, Dibrugarh being the port of shipment. This Assam coal is superior in steam raising power to the Bengal product, and is used as much as possible, but the cost of carriage prohibits its use in Bengal. We are, therefore, in the advantageous position of being able

to dairy coal supplies at both extremes of our principal (*i.e.*, Assam) line."

As Ceylon is becoming a large user of Indian coal, the following statements as to experience of its use there are of interest:—

"The Indian coal imported into Ceylon is drawn from Bengal, and the quantities imported since 1894, have been as follows:—

	Tons.
1894	61,586
1895	47,566
1896	67,417
1897	105,213
1898	213,852
1899	163 908
1900	335,346
1901 (For 9 months, Jan. 1 to Sept. 30)	260,869

"From this it appears that the offtake is increasing rapidly, the greater part being for the supply of steamers calling at Colombo; but about 40,000 tons a year are now being consumed on the Ceylon Government Railway.

"The objections to Indian coal as compared to Welsh coal are, that the former leaves more ash, and consequently about 25 per cent. more is required to accomplish the same amount of evaporative work.

"The chemical analyses of some well-known Indian (Bengal) coal is as follows:—

	Per Cent.
Carbon fixed	65·75
Volatile matter	26·05
Ash	6·55
Moisture	1·65
	100·00

"Steamers are finding it so much cheaper than Welsh coal that it is being more largely used every year, and there is every likelihood of it coming into general use for all but mail steamers, which require Welsh coal on account of the speed required to be maintained. Indian coal is used by industrial establishments in Colombo, such as ice factories, the electric car generating depot, &c., but the quantity thus consumed is not large. A few years ago, owing to the absence of sufficient facilities for transport on the Indian railways, the conveyance of coal to Calcutta was much hindered, but this has, in some degree, been remedied.

"The consumption of Indian coal by steamers is likely to expand rapidly, for, as new steamers are built, provision is made for draught in the furnaces such as will admit of its being used more generally; and, in a measure, this will tend to the displacement of Welsh coal."

The following remarks are taken from the reports of locomotive engineers of the Ceylon Railways, which have recently largely used Indian coal:—

"In 1897 the increased expenditure was chiefly brought about by the cost of Welsh coal having jumped from an average of Rs. 18-50 per ton in 1896 to Rs. 27-62 in 1897. This tremendous increase in the price of British coal would have had a still more serious effect upon the working had it not enabled Indian coal to compete successfully with it, and during the year 8,081 tons of Indian coal were consumed at an average cost of Rs. 13.09 per ton. Indian coal, under the most favourable conditions, shows an inferiority to the best Cardiff coal of 17 per cent. on the low country main line, and on the upper main line sections, on the grades of 1 in 44, from 30 to 33 per cent. inferior. The use of this coal on these grades gave considerable trouble, as the large consumption per mile on the up journey, namely, 140 lb. per mile, left so much residue in the fireboxes after a 20-mile run that it was absolutely necessary to clean the fires to such an extent that time was invariably lost.

"The altered grate arrangements also permitted considerable quantities of burning coal to drop into the ash pans and from them on to the sleepers, which gave rise to several complaints from the permanent way staff. The coals burned were Borrea, Anthracite, Giridih, and Singareni, the most economical and suitable being Giridih; but the continued use, even on the lower sections, will to a great extent be governed by its relative cost compared to Welsh coal. At the price paid for it during the year it is very close competition with firewood.

"A saving of Rs. 113,000 was effected in the running charges by the use of Indian coal during 1898. The general adoption of Indian coal instead of Welsh coal has very considerably reduced our locomotive expenses; so much so in fact that the consumption for the year shows an increase of 3-800 lb. per train mile, yet in consequence of the cost of Indian coal (including handling) having been less by 10 per cent. per train mile, the result has been a saving of Rs. 113,000.

"In 1898 fuel consumption increased to 99 lb. per English mile and 5·30 per train mile. This increase was due to the large use of Borrea coal, which gave considerable trouble throughout the year."

The employment of Indian coal on the Indian railways is largely increasing. (See Appendix, Table IV.)

On the whole, the information as to the value of Indian coal for steamship and locomotive purposes obtained from the principal consumers is fairly satisfactory and encouraging. It is evident, however, as I have already pointed out, that better supervision must be exercised in order to secure for these purposes the most suitable coal, and greater

care taken that it does not for any reason fall below standard quality. It would probably be worth while for the colliery companies to appoint a special inspector in Calcutta for this purpose.

Methods of Mining, Labour, Prices.

In 1900 there were 271 collieries working in India, producing more than 6,000,000 tons of coal, valued at over 20,000,000 rupees.

Native labour is universally employed and the coal is generally cut by hand. In 1900 nearly 90,000 people were employed in coal-mining, the average pay for underground work being about 1¼ rupees a week. Modern machinery for haulage is being gradually introduced into the Bengal mines, and the "gin" and bucket worked by women is less commonly seen.

The mines are owned partly by joint stock companies, private individuals, and the State, generally through the railway companies.

Indian coal at the pit's mouth is probably lower in price than in any other country, often reaching 2 rupees a ton. The local wholesale selling price of Bengal coal was, in 1900, 4s. 5d. a ton, as against 4s. 2d. in the previous year. The wholesale price for imported coal in Calcutta averaged 32s. 1d. per ton. The export duty on British coal will no doubt tend still further to stimulate the coal industry of India, and to reduce still further the imports of British coal into India.

The following accounts of the mode of working in the mines (taken chiefly from the "Imperial Institute Handbook," 1893) will be of interest.

In the Bengal fields the Bengal Coal Company reported that—

"The labour is always causing trouble. There are far too few miners, and there is far too much independence. The average miner never attempts to earn more than a day's wage, although the people might work themselves up into a position of comparative comfort if they would try to. The bulk of the labour consists of Bauris and Sonthals.

"Karharbari coalfield is mainly worked by three companies—the Raniganj Coal Association, the Bengal Coal Company, and the East Indian Railway. The system here is similar to that obtaining all over Bengal. The working hours are from 6 a.m. to 6 p.m., and, perhaps, later when extra work is required. Only four days a week real work is done, and the consequence is that collieries must have a far greater number of working places than the same output in England would warrant. All the miner's family work with him, carrying or training his coal. Picks of English pattern and make are now universal, the crowbar and single pick having been ousted. The workings are on the bord and pillar system. Pillars vary from 12 feet to 40 feet square and 40 feet × 60 feet. In the shallow mines and thin seams (7 to 8 feet) the former size obtains; in the thick seams (from 12 to 20 feet) the latter. Pillars are worked in the 8-feet seam in the following manner: A 4-feet chock is placed between each pillar in the row of pillars (generally six in number) that are to come out. A chock is also placed in front of each pillar. The pillar is then attacked from the front side. When pillars are taken out, the chocks are withdrawn and the roof falls.

"The remarks on the Raniganj coalfield given below apply in some measure to the Karharbari field. On sinking, coal cutting, the miner's love of holiday, lighting of mines, &c., the description in one case is a description in the other. Payments in this coalfield are weekly on Sunday mornings, the miners resorting from the pay offices to the East Indian Railway bazaar, which was established to attract local labour, and which has done so. The labourers consist of low caste Mussulmans and Hindus, as also aborigines—Sonthals and Kols. There are some Bauris, brought from Raniganj to teach the local men how to cut coal. The local men, however, cut coal better, as they have discarded the Bauri *sabel*. Local labour is more tractable, and the Bauris are not in such requisition as formerly.

"Drainage is effectively carried out by Tangye's special and lifting and forcing pumps, worked by bob-levers from horizontal engines. The machinery is of good type, and winding and hauling are done by good engines.

"Ventilation is attended to in the deep mines, mainly by furnaces or steam-jets.

"The miners live in small villages, aggregations of huts of mud walls of bricks set in mud with thatched or tiled roof. The hut consists of one room, sometimes two, of from 6′ × 6′ to 10′ × 10′ in size. Those better off have cowsheds and granaries; these two latter with the dwelling forming three sides of a quadrangle. The larger proportion of the labourers cultivate during the rainy season, and work at the collieries only in the cold season, say, from October to June. Some of the labourers have settled down to coal-cutting as a calling, and these work constantly, always excepting Monday, which is invariably a holiday.

"Coal-cutting is paid for by contract at so much a tram or bucket. These are of various sizes. The price generally amounts to from 7 to 8 annas per ton for large, and 1½ to 1¾ annas per ton for small coal. All other work, as stone-cutting, sinking, rail-laying, &c., is paid for by daily wages.

"The coal is hand-picked into four kinds. Steam is larger than 2-inch cube, rubble larger than ¾-inch cube, smithy down to ¾-inch cube, and all smaller than that is called slack or dust. This picking or screening is done by contract, and for rubble and smithy the coolies get about 4 annas per ton. Slack is not paid for. Loading is done by hand into the

railway wagons. At the mines tipplers are used for discharging the coal from underground trams into the wagons that run into the narrow-gauge tramways."

"In a paper read before the North of England Institute of Mining and Mechanical Engineers, in 1880, Dr. Saise said with reference to mining labour at the Karharbari coalfield:—'The men are not perfectly weaned from their ordinary caste pursuits. The hold on them is not great, and any discontent is followed by migration. They pick up their beds, or rather the wives do, collect the cooking utensils, gird up their loins, and depart. Labour has been attracted to settle in the immediate vicinity by allotment of land at nominal rents on the understanding that, when cultivation is over, they shall work in the mines. The rainy season no sooner commences than the labour decreases. Men, women, and children go away to cultivate their own plots, or the plots of those to whom they are indebted, and the output drops. From the beginning of July until November the cultivation, and then the religious festivals, keep the output low. From November to June following most of the coal is raised. Cheap rice makes labour scarce, as a native will not work if he has enough to eat without it. Scarcity fills the mines to overflowing. Still the general state is "want of labour." It will probably take many years to train up a set of miners who will follow nothing else but mining as a profession."

"The following notes on the Raniganj coalfield are by Mr. T. H. Ward:—

'The Chord line of the East Indian Railway passes across this coalfield, and the collieries are clustered on either side and along the Barákar branch sidings and branches, up to six miles in length, built by private enterprise, connect most of the collieries to the main line. Here winding engines, wire-rope guides and tipplers, and the regular paraphernalia of an English colliery are fast supplanting the primitive "gin" and bucket of a few years ago. These gins were (and some are still) turned by women, 25 to 30 being employed on each gin. They kept time to a monotonous chant, which they sang as they tramped round and round.

'The sinking in the district is easy, through soft sandstones, no brickwork being required to protect the sides. Heavy water is sometimes met with.

'The coal in the east of the field is very strong and non-caking. The sandstone roof is also very strong, and comes right down into the coal. Practically no timber is required in working the coal in the manner described below. In the west of the field at Sanctoria, for instance, the coal is not so strong, though the roof is everywhere the same. From Belrooi near Sitarampore, westwards, the seams worked are all coking coals.

'The seams worked are seldom less than 10 feet, and sometimes reach 18 feet in thickness. In the Barákar Coal Company's Kumardhubi colliery and the Bengal Coal Company's Lalkdee colliery on the west of the Barákar, the enormous thickness of upwards of 80 feet has been found.

'The mine is laid out underground on the same plan throughout the district. This plan has been stereotyped all over the field, and is adopted without reference to its suitability to the different conditions obtaining in the various seams worked. Indeed it has been adopted apparently more with reference to the prejudices of the native miner than from economical considerations. Galleries are excavated to the full height of the seam, 12 feet to 16 feet in width, leaving square pillars of varying sizes to support the roof, many acres being thus often left on pillars. The native coolie insists (and he has his own way very much in this coalfield) on commencing operations at the roof, and working downwards until the full height of the seam has been excavated. His chief and dearly-prized weapon is a 'sabal' or crowbar, with a sharp point at one end. With this he smashes the coal, standing always when at work. He never groves beyond the first "cleat." Gangs of four to five men occupy each gallery. They are paid by the bucket or tram of steam coal or small delivered at the pit bottom. If any timber has to be set up in a working place a man of the carpenter class (Chútar), who is paid a daily wage, must be sent for the purpose.

'Women and children work underground, and are principally employed in carrying the small coal and dust. They are also paid by the tram or bucket. The women often take their babies, two and three months old, down the mine, taking with them also a small cot on which the child sleeps or plays while its parents are at work.

'Access to the mines is very generally by inclines opening to the surface.

'In the eastern part of the district the seams are for the most part flat, in the central and western parts the strata are often steep (the general dip being southerly), and intrusions (dykes) of trap rock become more frequent. The deepest shafts are about 250 feet, the largest part of the coal yet won being from much less depths. Some fire damp has been met with in the western part of the district. Chanch colliery (west of the Barákar) belonging to the Bengal Coal Company was abandoned some years ago after an explosion in which several men were burnt, some of whom died. At Sanctoria, also belonging to the Bengal Coal Company, some men were burnt in 1883.

'The quarries at Kumardhubi and Laikdee have already been mentioned. Thousands of tons of coal have been won from the outcrops merely of these magnificent seams, and thousands of tons remain still to be worked without indenting on their resources at any greater depth.

'The "Bauri" is the principal caste which supplies coal-cutters for the district. In some respects the Bauri colliers characteristics are amusing like those of his Western prototype. He is very fond of getting drunk, especially at week ends, and is very disinclined to go to work on Mondays. For the rest he is good-

improved and improvident. It is a difficult matter to persuade him, although he is always paid a "ticca" (contract) rate for his work and could easily increase his earnings to do more than will, with his wife's contributions, keep the household in rice and himself in drink for the day. The nearly universal and very bad custom in this district is to pay each evening for the work done during the day. The collier or cooly has often to wait about until 8 or 9 for his money. He then goes cheerfully home, and remains up half the night drinking and singing with his companions (he is very social in his habits), incomprehensibly happy with his tuneless tom-tom. In the morning he trudges back, very often 7 or 8 miles (a distance of course travelled twice a day), to work, and is down in the pit at 9 or 10 a.m. All day, in the intervals of work, he sucks the comforting hubble-bubble (hookah).

'The light which the collier carries with him is exceedingly primitive. He gets an allowance of oil in proportion to the number of trams of coal he cuts. Every morning he draws at the godown sufficient for his requirements during the day, and an allowance of cotton thread or old rags to serve for wick. This oil he burns in a "chiragh" or small piece of stone hollowed out into the shape of a boat (a piece of tile from the roof of his house is often substituted). In this he places a small quantity of oil and a portion of wick. Any oil he can save from his allowance is his perquisite, and he can carry it home. Mohawa and castor-oil are the chief oils used. Some of the mines are lighted by kerosine burnt in small tin lamps holding about two ounces, with small circular wicks. The native does not like this plan so well, as he cannot use it to rub on his body or to season his food, a purpose for which mohawa oil is used.

'The ventilation of the underground workings receives very little attention, and in most collieries none at all. The great freedom from fire damp and the lofty seams exploited have kept this question in the background. The ignorant native has not yet recognised that his health and longevity are in question, and he has besides helped much to prevent ventilation becoming a necessity by the wonderful power of endurance he has shown. This power of endurance enables him to work for hours at the bottom of a sinking shaft with water pouring over his naked body, or to work all day long and day after day in driving a "rise" gallery, perhaps hundreds of feet from any current, in an atmosphere which is fetid and laden with steam. This is a blot on the mining of the district, and ought to be speedily removed."

'At Warora, Central Provinces, where 100,000 tons per annum are wound by direct acting engines out of two shafts 200 feet deep, the system nearly approaches the English. No women work underground, and work is constant from Monday morning to Saturday night. The work time is divided into three shifts of 8 hours each. The seams, which vary from 8 to 12 feet, are worked thus: Galleries or boards and headways are driven 12 feet wide, 6 feet in height, leaving the roof coal and pillars 40 feet square. The coal is so hard that it has to be nicked and undercut, and then blasted down. The pillars are worked by splitting each from one headway to another, and then taking the far end off in slice. The roof coal comes with it.

'The colliery consists of six pits, varying in depth from 100 to 250 feet. All the pits are supplied with sidings, and connected with the Wardha State Railway by a branch line. Only two sorts of coal are vended, large coming over a screen with bars spaced 1 inch apart, and small coal passing through the screen. It is very superficially screened by women. All the coal is got by contract, from the hewing to the final loading into trucks. Three or four contractors are employed, who provide all the labour and oil, but who are provided with all tools, gunpowder, shot and shot-firers.

'The labourers are principally drawn from the North-West Provinces, and are not very plentiful. These men are allowed a *chabootra* within the boundaries of the colliery property, for which they are charged a ground rent of 3 or 4 annas per month. They also have to pay 1 anna a month per head of cattle.

'At Singareni (Hyderabad), the general system of working and the tools used are the same as in England, slight variations being allowed to suit the people. Part of the coal is got by contract, and part by sirkary labour. Underground labour has been organised under a system of eight-hour shifts, surface coolies and machines working ten hours per day. The rates of wages vary from about 5 annas per day for ordinary labour to 12 annas as earned by coal-cutters on piece-work. Machines average above 1 rupee, while superior men earn considerably more.

'Female labour is paid from 3 annas for surface, and 3½ annas for underground work. Local Teluga labour of the lower class is fairly plentiful. The superior work is done by Mohammedans of Hyderabad, or Hindustan men imported.

'At the Mohpani collieries a similar system is worked. The difficulties met with in these mines, owing to the faulted and disturbed nature of strata, are probably unequalled in India.

'Labour was one of the greatest difficulties, and progress was, and is, often impeded on this account.

'However, a great many miners who had been gradually collected, and trained in the mines, live in the immediate district, and a certain amount of labour can be imported from other districts when the demand for railway and harvest works do not interfere.

'Coal hewers work 6 to 8 hours for a shift or day's work, and earn about 6 rupees to 12 rupees per mensem.

'Mechanics, enginemen, &c., work 8 to 10 hours per day, and earn wages from 8 rupees to 20 rupees per mensem according to their craft.

'Coolies, &c., work 8 to 10 hours per day, and earn 5 rupees to 8 rupees per mensem."

A Mines Act regulating the conditions of labour in the Indian mines has recently become

law, but its provisions are not viewed altogether with favour by the owners and capitalists. One of its provisions is to require that all mine managers should hold certificates that they possess certain qualifications. This is an excellent stipulation, which no one who has the interests of coal-mining in India at heart could possibly object to on general grounds. It is, however, alleged that no facilities are provided in India by means of a properly established mining school or otherwise to enable men to acquire the necessary qualifications, and the result is that a new burden will be imposed on the industry by reason of men having to be brought from abroad to act as managers at higher wages than would be paid to properly qualified local men. I do not feel competent to say how far these objections may hold, but I am confident that great good would result from the establishment in India of a Government School of Mines and Metallurgy, in which those who intend to engage in mining and metallurgical industries could receive a thoroughly practical and efficient training in modern and scientific methods, not only in engineering and mining, but also in physics and chemistry in their applications to metallurgy.

The introduction of mechanical coal-cutting machinery, which has been already tried in a few of the Bengal mines, is no doubt the true remedy for many of the difficulties which arise from the employment of native labour for cutting by hand. By this means, too, a greater output would be secured, whilst the waste arising from the production of slack would be largely avoided.

Cutting by the compressed air system has the advantage of assisting in the ventilation of the mine, a consideration of importance, but electrically driven cutting machinery is now being adopted in other countries, especially in the United States, where the cost of coal at the pit's mouth has been so reduced in recenty ears that it is now nearly one-half of that in England (10s. 9¾d.), and is not far removed from the average price in India.

Ventilation of the mines is a subject which ought to receive greater attention in the future, whether the native is indifferent to it or not; and where fire-damp occurs, as in some of the Bengal mines, further precautions will have to be observed with reference to the use of naked lights and the lighting of fires. Many of the Indian mines fortunately are nearly free from fire-damp.

Transport.—Railway and Dock Communication.

The question of further railway communication with the various coalfields has been alluded to.

It is obvious that the successful extension of the coal industry in India must depend very largely upon the facilities afforded for railway communication with the coalfields and with the docks, and also on the dock arrangements for unloading and shipping.

In the case of a rapidly growing industry, care and discrimination are required in planning railway and dock extensions, so that they will be sufficient to meet growing requirements for many years in advance, and at the same time be readily susceptible of further extension at any time in the future.

The Bengal fields being the most important at present, have naturally taken the first place in the consideration of these questions.

The present dock arrangements at Calcutta are, in the opinion of those connected with the industry, altogether insufficient to meet the present requirements, principally with respect to railway communication and provisions for unloading. I need not fully discuss these questions here, as schemes both for additional railway and dock accommodation and unloading appliances have been now sanctioned by the Government, and will, it is hoped, prove to be satisfactory to those who look forward, in my opinion correctly, to a considerable increase in the output of the Bengal mines in the immediate future.

There is another matter intimately connected with the question of railway accommodation to which I must make some allusion. I refer to the difficulties which have arisen chiefly in Bengal between the railway companies and the colliery companies.

Grave complaints have been made, which have now reached the public press, as to the inadequate traffic arrangements of the East Indian Railway, which itself works collieries in the Bengal fields, and of the damage done to the coal industry by insufficient wagon supply and delays in traffic and high rates of transport.

As this subject is one which must necessarily be of vital importance to the development of the coal industry in Bengal, and belongs to a class of problems in the solution of which Government ought to be able to successfully intervene, I have considered it desirable to obtain the views of the Bengal colliery companies, as represented by the Indian

Mining Association in Calcutta, on the one hand, and of the officials of the East Indian Railway Company, on the other. The following is an extract from a letter, dated December, 1901, addressed to me by the Committee of the Indian Mining Association, in response to my request for information as to any difficulties which, in their opinion, at present hinder the natural growth of the industry :—

"The committee of the Indian Mining Association are of opinion—as, indeed, are all concerned with Indian coal—that the transport and distribution facilities at present provided are distinctly unsatisfactory. The chief defects may be roughly classified under three heads:—(1) a serious and constant deficiency of rolling stock on the principal coal-carrying railway—the East Indian; (2) heavy railway freight charges; and (3) inadequate and inefficient loading facilities in Calcutta—the port of shipment.

"For particulars of the first named of these difficulties the committeee would refer you to the accompanying copy of a memorial which was recently submitted to H.E. the Viceroy by this Association. Further information will be found on pages 86 to 114 of the last annual report of the committee. The facts are fully set forth in these documents; and the views of the Association as to the improvements required are stated in them. It, therefore, only remains for the committee to add that in their opinion it is the urgent duty of the Government of India to adopt such measures as are calculated properly to equip Indian coal-carrying railways with adequate transport facilities. There can be no question that such measures would tend more materially to assist in the development of the coal resources of India than any other action which might be taken by the administration. In this connection it may also be mentioned that the system of weighing in force on the East Indian Railway is defective from the point of view of coalowners. The subject is dealt with at p. 30 of the annual report referred to.

"The second difficulty stated above raises the complicated question of railway rates. In India, such rates cannot fall below or rise above certain minima and maxima rates which have been determined by statute. In the case of coal the maximum rate is 1-3rd of a pie per maund per mile, and the minimum 1-10th of a pie per maund per mile. Even if the Indian coal-carrying lines levied freight on the basis of the minimum rate, their charges would, the committee believe, be in excess of those ruling in other great coal-producing countries such as America. But at present the minimum rate is practically never reached on Indian railways. Freight charges are, in consequence, so high that, in the opinion of the committee, they act as a decided hindrance to the development of the coalfields of India. This difficulty, therefore, like that relating to rolling stock, is one which the Government should in the general interest of Indian commerce do its best to remove. Seeing that all Indian railways are practically owned by the State, the determination of the rates to be charged really rests with the Government, and only nominally with the railway administrations.

"The third point specified above is dealt with in the annual report already mentioned. At pp. 115 to 129 there are a number of papers relating to the proposed institution of mechanical coal-loading appliances at the Calcutta docks. Up to the present time all steamers, whether carrying coal or other cargo, have been loaded entirely by hand labour. Indian unskilled labourers are erratic and whimsical, and the difficulty of providing an adequate labour force whenever it may be needed is, and has always been, of a serious character. Not only, therefore, have Indian coal shippers had to contend against the inevitable slowness of hand-loading, and the loss by breakage which it entails, but they have likewise constantly had to face the possibility of a sudden and complete disorganisation of the labour staff. You will understand from the report that experimental measures having for their ultimate object the termination of this state of affairs are now being put into operation. But, in addition to the provision of adequate mechanical loading appliances, many further improvements in the terminal facilities at the port will be required if the coal trade is to be properly encouraged and developed. For the nature of these I would refer you to pp. 154 to 181 of the report above mentioned, where you will find a reprint of the evidence given in December last by a representative of this Association before a commission of enquiry into the affairs of the Calcutta Port Trust."

Having regard to the statements made in this letter as to the East Indian Railway Company, I have asked the Chairman of that Company, General Sir Richard Strachey, to make any observations with reference to the statements which might seem to him desirable. He has been good enough to send me the following important letter, dated 14th January, 1902 :—

"Your letter of the 9th inst. invites me to offer my criticisms on a letter of the Indian Mining Association, of which you send me a copy. This letter, written in reply to enquiries made by you as to the efficiency of the facilities now provided for the transport and distribution of coal in India, supplies, in some detail, a statement of the reasons of the Association for considering those facilities to be distinctly unsatisfactory. This opinion manifestly only applies to the collieries in Bengal, of which alone this Association is in a position to speak with any authority, though no doubt they are by far the most important. The defects that, in the opinion of the Association, now exist are classed under three heads :—

"(1). A serious and constant deficiency of rolling

stock on the principal coal-carrying railway—the East Indian. (2). Heavy railway freight charges. (3). Inadequate and inefficient loading facilities in Calcutta—the port of shipment.

"As to the first cause of complaint, it has no doubt to some extent been justified. But the deficiency of rolling stock, so far as it has from time to time really existed, has been due to the material difficulties of the railway in obtaining the wagons that were required; difficulties arising partly from the delay that unavoidably takes place in the construction of the wagons, the materials for which have to be obtained in England, but largely from the delay of the Government in giving their sanction to the expenditure that would be involved, and providing the necessary funds of meeting the expenditure, in both of which respects the East Indian Railway Company is wholly dependent on the action of the Government.

"In illustration of this, I may state that the Directors of this Company, having been informed in May last by the head of the chief coal exporting firm in Calcutta that they were suffering from the want of an adequate supply of wagons, immediately instructed the Company's agent in Calcutta to apply for sanction for the provision of 1,000 more wagons. To this application no reply whatever has even yet been given, after an interval of eight months, though the Board have reported the circumstances to the Secretary of State. Much the same state of things has existed for the last three or four years.

"The pressure that has been put on the carrying powers of the East Indian Railway by the rapid expansion of the coal traffic will be better appreciated from the following figures, showing the whole weight of coal dealt with year by year since 1895:—

	Tons.
1895	2,926,330
1896	3,279,379
1897	3,751,591
1898	4,210,956
1899	4,411,851
1900	5,182,801
1901 (first half of)	2,874,697

"This shows that at present the traffic in the half-year is hardly less than that of the whole year six years ago.

"During this interval the wagon stock, exclusive of brake-vans and other vehicles for special purposes, has been increased from 9,468 to 14,750, with a corresponding addition to the locomotive stock. This, moreover, has been accompanied by a steady increase in the power of the engines and the capacity of the wagons, which have thus become more effective by something like 50 per cent.

"With a business like the goods traffic of a railway, that is of a fluctuating character, and in which there will be times of great pressure and corresponding slackness, it would evidently not be possible to meet sudden exceptional demands without having a wagon stock greatly in excess of the ordinary requirements of the traffic, and there will, therefore, be unavoidable difficulty in adjusting the supply so as to meet all demands without incurring a wasteful outlay. No doubt a proper margin in excess of the average should be maintained, but with a rapidly expanding traffic, such as that indicated by the figures given, this is not easily determined, more particularly under the conditions above referred to, to which the management of the railway is subject. I do not believe that there is any railway in the world on which, from causes such as this, its customers do not, at some time or other, make complaints of the unsatisfactory manner in which their requirements are met.

"As to the system of weighing, I am aware that questions have arisen, and differences of opinion are held, but this is a matter that obviously must be left to be settled locally.

"I am, of course, not surprised at the opinion expressed as to the coal rates being excessive. But I have not any doubt that they are in fact extremely low, the average charge per ton-mile being rather less than 1-10ths of a penny, which is about 1-3rd of the ordinary English rate according to the *Statist*. I am far from saying that it might not be possible to make some further concession to the colliery owners, by equalising the rates so as to make them somewhat less sharply dependent on the mileage, the necessary charges for transport in the case of a traffic of this sort not being so immediately determined by the distance carried, as in some others. But this is a point on which I am not at present prepared to say more than that it has been under the consideration of the Board for some time past.

"It is quite erroneous to say that the coal rates are fixed by statute. The rates per maund per mile on the East Indian Railway are between 1-10th and 1½-10ths of a pie, the maximum, therefore, being less than that stated by the Association. The average rate on the East Indian Railway for the last half-year was ·13 of a pie per maund per mile, which is equal to 3·52 pies per ton mile, there being 27 maunds to the ton, and 1 pie being the 12th part of an anna, which again, at the present rate of exchange, is just equivalent to one penny.

"From a report drawn up in July last by an officer of the railway branch of the Indian Public Works Department, who visited the United States with the special object of inquiring into American methods of railway management, it appears that there are few instances of rates lower than those on the East Indian Railway, to be found in a long list of American lines, but the average appears to be slightly in favour of the East Indian Railway. Without a more complete knowledge of the circumstances of the separate lines it is not easy, however, to arrive at any very conclusive judgment on this point, involving as it does adjustments on account of differences in the

system of weights and currencies of the two countries.

"How the Association, in the face of the great expansion of the trade during the last few years, shown by the figures that have been already given, can venture to say that these rates act as a decided hindrance to the development of the coalfields of India, is truly astonishing, and the more so, considering that the market value of the shares of the colliery companies, is what was pointed out by me at the last half-yearly meeting of this Company. I now repeat the figures I then gave—

	Paid up. Rs.	Quotation. Rs.
Adjai	100	250-255
Bengal	1,000	3,150
Bengal-Nagpur	10	30¾
Borrea	100	155
Barrakar	100	125
Equitable	100	262
Katras Jheria	10	40½
New Beerbhoom ..	100	179
Reliance	100	190

"The observations of the Association to the effect that whatever difficulty there may be in the matter of the coal rates, or the supply of rolling stock, really rests with the Government, and only nominally with the railway administration, are perfectly true, and it is not the latter that stands in the way of the removal of such difficulties, so far as they exist.

"The next point referred to in the Association's letter is the dealing with the shipment of coal for export to Calcutta. With this the railway company has not been permitted to concern itself, but there can I think be little doubt that it is at present, as described by the Association, inadequate and inefficient.

"The development of the coal industry of Bengal has always been held to be an object of primary importance by the Board of the East Indian Railway Company, and, as I have had occasion to say elsewhere, it is largely to the efforts of this company that the coal trade is in its present flourishing condition.

I am glad to learn that all these questions are engaging the serious attention of the Government of India, and that there is reason to hope that more than one of the difficulties referred to may be removed.

Utilisation of Waste Coal.—Manufacture of Power Gas.

The disintegration of coal to which several Indian varieties are peculiarly liable involves a serious waste, and presents a problem which so far has not been solved. Some of this friable coal and slack has been utilised in the manufacture of briquettes and patent fuel, a plan which might be more widely followed. Another much more important purpose to which small coal could probably be put in the future is in manufacturing the particular form of "producer or water gas," known as Mond gas, for the manufacture of which a company with large capital has recently obtained Parliamentary powers to supply certain districts in the midland counties of England with the gas as a source of power for heating purposes. It is stated that the gas is to be sold at about 2d. per 1,000 feet. It is obvious that the supply of cheap gas to the large towns of India would considerably promote industrial enterprise in India, whilst at the same time an important use would be found for small coal, waste, dust, and the inferior varieties of Indian coal which are at present unutilised.

The bituminous character of much of the Indian coal would seem to render it particularly suitable for the production of heating gas. Experiments recently made with Raniganj coal have proved that this is the case. Essentially the process consists in acting on the heated "slack" with a superheated mixture of air and steam, whereby a gas is produced containing hydrogen (about 25-30 per cent.) and carbon monoxide (about 10-15 per cent.) and a smaller proportion of marsh gas, together with nitrogen and carbon dioxide. Sulphate of ammonia may be recovered as a by-product. A ton of ordinary slack furnishes about 140,000 cubic feet of gas, and yields on the large scale 90 lbs. of sulphate of ammonia. The calorific value of the gas is stated to be about 84 per cent. of that of the slack used. The gas may be used successfully for nearly all industrial heating purposes, for the manufacture of bricks, earthenware, glass and pottery, in the production of steel by the open hearth process, and in forging, welding, and annealing iron and steel. It would also be well adapted for general steam raising purposes in India and for use in gas-engines.

Concluding Remarks.

In the present paper I have sought to draw attention in this country to the wealth which India possesses in her coalfields, to the present position of Indian coal mining, and to the quality of the coal mined in the different provinces, as well as to the conditions under which mining is carried on, and to the importance of Government giving careful and sympathetic consideration to the development of an industry,

hardly out of its infancy, upon which the future industrial prosperity of India so largely rests.

I have drawn attention to the importance of railway communication being opened up with the undeveloped coalfields of Western Bengal, the Central Provinces, and Central India, and to the great advantage it would be to Madras and Southern India, where coal is scarce or non-existent, if communications were provided between this region and the coalfields of Western Bengal and the Central Provinces. A glance at the sketch map will show how large an area, especially that lying between Central India and Bengal, is at present without railway communication with the nearest supplies of coal.

I have alluded to the desirability of further information being obtained by Government with reference to the amount and quality of coal in several regions, especially in Western India and in Assam, with the view of opening up railway communication with those fields in which good and workable coal is proved to exist.

I have also pointed out the importance of greater care being taken by the collieries to secure uniformity in the quality of Indian coal. With reference to this, as well as to other difficulties, the question suggests itself as to whether an amalgamation of the numerous small coal companies (which number more than 200 in Bengal alone) would not be desirable, and be for the benefit of the coal industry as a whole.

The employment of native labour is certain to raise a number of important and delicate economic questions, which will require the greatest care in handling. The future success of coal-mining in India depends chiefly on native labour being organised with foresight and consideration, due regard being had to the general welfare of the class upon whose employment, for the present at any rate, the vital feature of cheap production depends.

Next in importance are the questions I have already touched upon, of railway rates, transport facilities, and adequate dock accommodation, all of which are now receiving consideration from Government.

I have taken the view that over and above the increasing demand for Indian coal for steamship and locomotive purposes, including its growing export trade in this connection, and apart from its increased use for domestic purposes, there must be in the near future a considerable call on the coal resources of India through the industrial utilisation of the great mineral wealth of the country, which only awaits an ample supply of good and cheap fuel. As I have already pointed out, by the establishment in India of a comprehensive Government School of Mines and Metallurgy, perhaps as an extension of the present school at Sibpur, a considerable impetus would be given to the development of the mineral resources of India. I trust that the Government of India may give careful consideration to this suggestion.

I am glad to learn that an English syndicate is now taking steps to establish iron smelting and steel manufacture on modern methods in Bengal, and I do not doubt that their example will be followed in other places as a better knowledge is gained of the quality of the coal and iron ore of other districts. Various metallurgical operations, including that of copper, brickmaking, earthenware, and pottery and glass manufacture, all seem to be likely developments in the industrial arts of India as soon as an abundant supply of cheap coal has been rendered accessible to the whole country. At the same time textile industries cannot fail to undergo considerable extension and take new directions.

I trust that the importance of the coal resources to our Indian Empire will justify the extent to which I have trespassed on your time in giving a general sketch of the present and future of the Indian coal industry in its principal bearings. Although the utilisation of water power in certain districts of India for the supply of electricity is likely to be accomplished in the near future, for many years to come coal will remain the principal source of energy.

In conclusion I must tender my thanks to those to whom I am indebted for much valuable information and assistance; to past and present officers of the Geological Survey of India; to the Steamship and Railway Companies; to the Indian Colliery Companies; to the Indian Mining Association; to Sir Richard Strachey and the East Indian Railway Company; to Col. Gardiner, R.E., Chairman of the Madras Railway Company; to Sir Edward Noel Walker, K.C.M.G., lately Colonial Secretary of Ceylon, who has procured for me much useful information respecting the employment of Indian coal in that colony; and to my assistant Mr. G. S. Blake, A.R.S.M., particularly for the assistance he has given me in preparing the illustrations to this paper.

APPENDIX.

TABLE I.—Quantity in Tons of Coal Produced in each Province.

	1895.	1896.	1897.	1898.	1899.	1900.
Burma	17,289	22,993	11,472	6,975	8,105	10,228
Assam	172,717	177,259	185,533	200,329	225,623	216,736
Bengal	2,716,155	3,037,920	3,142,497	3,622,090	4,035,265	4,978,492
North-West Provinces and Oudh	—	1,000	—	—	—	—
Rajputana	—	—	—	511	4,249	9,250
Central India	118,479	115,386	124,778	134,726	164,569	164,489
Punjab	72,493	79,017	92,792	85,862	81,835	74,083
Baluchistan	25,458	26,257	12,043	13,372	15,822	23,281
Central Provinces	122,776	141,185	131,629	149,709	156,576	172,842
Hyderabad—Nizam's Territory	292,915	262,681	365,550	394,622	401,216	469 291
Madras	1,737	—	—	—	—	—
Total	3,540,019	3,863,698	4,066,294	4,608,196	5,093,260	6,118,692

TABLE II.—Output for 1900 of Coal in British and Colonial Coalfields.

	Tons.
United Kingdom	225,181,300
India	6,118,692
New South Wales	5,507,497
Canada	5,332,197
New Zealand	1,093,990
Queensland	497,132
Victoria	211,596
West Australia	118,410
Tasmania	50,632

TABLE III.—Foreign Coal Trade of India.

	Imports. Coal, Coke, and Patent Fuel. Tons.	Exports. Coal and Coke. Tons.
1895-1896	761,996	80,923
1896-1897	494,960	136,719
1897-1898	261,739	212,855
1898-1899	358,880	327,104
1899-1900	422,376	304,586
1900-1901	127,318	541,445

TABLE IV.—Indian Railways.

	Foreign Coal consumed by railways. Tons.	Indian Coal consumed by railways Tons.
1896	108,442	1,182,051
1897	49,779	1,333,043
1898	39,004	1,422,103
1899	82,446	1,557,000
1900	54,339	1,855,610

TABLE V.—Tabulated Results of a Preliminary Examination of Indian Coals.

Indian invoice Number.	Imperial Institute Number.	Date.	Mine.	Whence received.	Remarks made in forwarding sample.	Evaporative power.	Calorific value.	Fixed carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties.	Colour of Ash.	Other characteristics of the Coal.
				ASSAM.											
*1808	7052	4 Oct. 1894	Makum	Assam Railways and Trading Company (Ledo Valley).	—	12·76	6853	53·28	1·02	54·30	45·45	1·07	Does not cake.	Palechocolate.	A glistening black coal, clean to handle, easily broken, conchoidal fracture.
6953	7082	12 Jan. 1895	Do.	Assam Railways and Trading Company, Limited.	2 cwt. Makum coal	13·42	7205	47·84	3·66	51·50	48·50	4·87	Cakes	Reddish brown.	Very dirty and dusty coal, breaks readily with irregular fracture, alternately dull and bright.
*96	1445	4 Oct. 1894	Cherrapunji	Cherrapunji Coalfield ...	—	14·34	7702	49·54	4·74	54·28	45·72	3·98	Do.	Dark red	A dull black coal, dirty, very hard, with cuboidal fracture.
*97	1446	Do.	Maoflong	Maoflong Coalfield	—	13·27	7128	49·70	2·96	52·75	47·25	3·08	Do.	Yellowish brown.	Bright and clean with fossil resin in many places.
8893	7778	2 Nov. 1895	Dickhu Valley.	Dickhu Valley Colliery, Nazira, Assam.	—	11·22	6028	51·40	2·35	53·75	46·25	3·45	Does not cake.	Dark reddish brown	A very bright coal, black as pitch, and of conchoidal fracture; intersected with dull layers.
				BALUCHISTAN.											
*93	1441	4 Oct. 1894	Khost Colliery.	Khost Colliery, Khost seam.	—	12·35	6633	49·58	5·15	54·73	45·27	4·82	Cakes	Terra-cotta	Clean, bright and hard, but disintegrating with a white efflorescence, and with evolution of sulphuretted hydrogen.
*94	1442	Do.	Do.	Khost Colliery, Killa Hakim seam.	—	12·52	6936	41·50	9·56	51·06	48·94	0·74	Do.	Yellowish brown.	Clean, bright and hard, with obtuse fracture.
				BENGAL (RANIGANJ).											
*90	1438	Do.	Kumardubhi	Barakar Coal Company, Kumardubhi Colliery.	—	12·93	6567	51·48	13·85	65·33	44·67	0·83	Do.	Grey	Layers of dull and bright coal, clean rounded fracture.
7865	7341	13 July, 1895	Do.	Barakar Coal Company ...	One box of steam coal from Kumardubhi Colliery.	12·09	6490	51·35	14·95	66·30	33·70	0·63	Do.	Dove	Dull, with bright patches, fairly tough and clean.
*1601	2865	4 Oct. 1894	Raniganj	Bengal Coal Company, Limited, Raniganj coal.	—	11·22	6028	42·05	12·35	54·40	45·60	1·58	Do.	Fawn	Bright, hard and dirty.
7094	7459	29 July, 1895	Do.	A. Whyte, Esq., Raniganj	Coal from the village of Chowrah, 4 miles east of Toposi Railway Station on the East Indian Railway, and belonging to the Raniganj series.	10·47	5621	49·59	11·15	60·74	39·26	1·47	Does not cake.	Light fawn	Dull, with bright patches, rather tough, clean.
7095	7455	Do.	Do.	Do. do.	Coal from the village Khooseree belonging to Pandra Estates, situated 8 miles N.W. of Barakar and belongs to the Lower Barakar series. In this seam a band of 2 feet very dark and carbonaceous clay divides the seam into two, the top coal is 5 ft.	12·00	6230	59·01	11·96	70·97	29·03	1·89	Cakes	Dirty fawn	A dull silky coal with bright patches, breaks easily, clean.

					6 in. in thickness, of bright appearance, the bottom coal is 6 ft. 6 in. in thickness, and is a heavier and duller looking coal.										
[illegible]	2758	25 Nov. 1896	Raghunath Chuk.	Jaganath Coal Company, Raniganj.	Raghunath Chuk coal ...	10·92	5863	45·03	14·97	60·00	40·00	0·64	Does not cake.	Greyish pink.	Alternate layers of bright and dull coal, dirty, breaks easily, with much dust.
*652	1996	14 Oct. 1895	Barakar	Barakar Iron Works ...	—	11·10	5962	53·49	18·33	71·82	28·18	0·62	Cakes	Greyish white	Dull, black, dirty, very hard.
7247	7099	28 Mar. 1896	Do.	New Barakar Coal Company, through G. Alexander, Esq.	Coal taken from an incline just being opened out, situated three miles from Barakar on the Theria Branch Railway. Taken from about 10 feet below the surface.	10·09	5410	41·80	29·25	71·05	28·95	0·80	Do.	Dirty white	Dull black coal with bright patches in places, cleaves occasionally with a silky fracture, clean.
7340	7323	25 June, 1896	Rajpur	Manager, Rajpur Coal Company, Barakar.	Coal from Rajpur Colliery, as usually obtained.	11·78	6375	55·05	18·95	74·00	26·00	0·47	Does not cake.	Do.	A dull coal with bright patches, fairly tough, conchoidal fracture.
7346	7317	26 June, 1896	Petana	Messrs. Mylne & Co., proprietors, Petana Colliery, Barakar.	Petana steam coal.	12·88	6920	54·38	10·44	64·82	35·18	0·82	Cakes	Do.	Glistening coal composed of dull and bright portion, former tough, the latter readily broken. Occurs in well-defined layers.
7366	7312	1 July, 1896	Loyabad	Manager, Barakar Coal Company.	Steam coal from Loyabad Colliery.	11·88	6380	60·54	13·04	73·58	26·42	0·87	Do.	Light grey	Exhibits a peculiar curved fracture. Part of the sample was of dull appearance and very tough, while the remainder was bright and broke readily into small fragments.
7366	7312	Do.	Do.	Do. do.	Do. (A special piece which was roughly ovoidal).	11·52	6402	55·69	18·56	74·25	25·75	0·91	Do.	Do.	
*1658	2862	4 Oct. 1894	Sodepore	Bengal Coal Company, Limited.	Sodepore coal	12·39	6655	49·95	8·48	58·43	41·57	0·27	Do.	Light yellow.	Bright, dirty, fairly hard.
*1659	2863	Do.	Liakdee	Do. do.	Liakdee coal	12·52	6721	57·70	8·02	66·32	33·68	0·53	Do.	White	Mixed dull black and glossy, the latter crumbles readily, clean.
*1660	2864	Do.	Nimcha	Do. do.	Nimcha coal	10·90	5852	42·50	14·64	57·14	42·86	0·32	Do.	Brownish yellow.	Dull and glossy laminæ, clean and hard.
8083	7453	21 Aug. 1896	Jeyramdangah.	Managing Agent, New Beerbhoom Coal Company.	Coal from Jeyramdangah, new seam.	12·67	6809	51·36	10·61	61·97	38·03	0·79	Does not cake.	Terra-cotta	Alternate dull and bright layers, breaks easily in small fragments, clean.
8082	7448	Do.	Dhadka	Do. do.	Coal from Dhadka, top seam.	12·19	6545	47·85	9·68	57·53	42·47	0·35	Cakes	Flesh colour	Alternate bright and dull layers, breaks easily in small fragments with little dust, clean.
8083	7451	Do.	Beltoli	Do. do.	Coal from Beltoli ...	13·19	7084	51·86	8·86	60·72	39·28	0·39	Do.	Do.	Dull, with many bright patches, clean.
8084	7452	Do.	Borrea	Do. do.	Coal from Borrea, fourth seam.	13·01	6985	55·92	12·30	68·22	31·78	0·95	Do.	Dirty pink	Dull, with bright patches, breaks easily in layers, clean.
7104	7097	23 Mar. 18 [illegible]	Do.	Managing Agents, Borrea Coal Company.	Salanpur coal	11·57	6215	57·31	14·86	72·17	27·83	0·75	Do.	Grey white	Dull silky coal with glistening layers and patches. Hard and brittle, very clean.
*1663	2867	4 Oct. 1894	Sanctoria	Bengal Coal Company, Limited.	Coal from Deshergbur, Sanctoria.	11·28	6380	49·41	11·29	60·70	39·30	1·03	Do.	Lemon yellow.	A glossy coal, hard, but with soft patches.
7851	7321	10 July, 1896	Searsole	Searsole and Jemehiri Collieries Searsole Rajbar.	Searsole steam coal	12·13	6512	44·25	8·87	53·12	46·88	0·33	Do.	Fawn	Alternate layers of dull and bright coal, clean, easily broken, cleaving in layers.

TABLE V.—*(continued.)*

Indian Invoice Number.	Imperial Registry Number.	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.	Evaporative Power.	Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties.	Colour of Ash.	Other characteristics of the Coal.
7852	7320	30 July, 1896	Jemehiri	Searsole and Jemehiri Collieries, Searsole, Rajbati.	Jemehiri coal	11·77	6320	44·80	10·90	55·50	44·50	0·20	Cakes	Terra-cotta	Alternate layers of dull and bright coal, hard, dusty when broken.
*1561	2668	4 Oct., 1894	Madhubpur	Bengal Coal Company, Limited.	Madhubpur coal...	10·61	5698	38·80	17·12	55·92	44·08	1·54	Do.	Brownish yellow.	A dull coal, laminated, hard, with soft patches, clean.
*1668	2672	Do.	Sanctoria	Do. do.	Sanctoria coal	11·78	6325	40·32	10·74	60·06	39·94	1·53	Do.	Yellowish grey.	A dull coal with bright patches, hard and clean.
*1665	2669	Do.	Searsole	Do. do.	Coal from Searsole, Raniganj.	10·92	5863	42·71	12·03	54·74	45·26	1·51	Do.	Fawn	A clean bright coal, cleaving in layers.
7861	7322	15 July, 1896	Barmondia	Managing Agent, Damuda Coal Company.	Coal from Barmondia Colliery	12·83	6889	48·52	8·93	57·45	42·55	0·33	Do.	Cream	Clean, bright coal, easily broken, hard, but with soft patches.
7862	7315	Do.	Luchipur	Do. do.	Coal from Luchipur Colliery.	12·29	6600	48·75	13·01	61·76	38·24	0·40	Do.	Fawn	In well-defined layers, part dull and part bright and glistening, clean, fairly tough, except that the bright layers crumble readily.
7863	7318	Do.	Ghoosick	Do. do.	Coal from Ghoosick Colliery.	11·09	5954	43·69	12·16	55·85	44·15	0·095	Do.	Light fawn	Well-defined layers of dull and bright coal, the former tough, the latter rather brittle.
7864	7316	Do.	Bharatchak	Do. do.	Coal from Bharatchak or Damuda Colliery.	12·49	6710	47·69	10·22	57·91	42·09	0·78	Do.	Fawn	Bright coal, fractures readily. Made up of a dull and bright portion. Dull portion tough, whilst the bright is readily broken.
8197	7762	Do.	Nundie	Adjai Coal Company, Limited, Nundie Colliery, Raniganj.	No. 1 Sample	12·01	6498	53·89	7·59	61·48	38·52	0·48	Does not cake.	Fawn	Alternate bright and dull layers, the dull coal being dirty to handle.
8198	7765	Do.	Do.	Do. do.	No. 2 Sample	11·41	6127	50·38	10·72	61·10	38·90	0·37	Do.	Do.	Dull slaty coal with many bright patches, rather tough, clean.
8199	7774	Do.	Kalipahari	Srikistopore Coal Company, Kalipahari.	Steam coal	11·39	6116	48·76	10·47	59·23	40·77	0·34	Do.	Reddish grey.	A bright coal, with some duller layers.
8261	7757	Do.	Patlabari	South Barakar Coal Company, Patlabari Colliery, No. 2 Seam.	—	12·41	6666	57·25	11·30	68·45	31·55	0·63	Do.	Do.	Dull coal with bright layers, easily broken with much dust, dirty to handle.
8292	7761	Do.	Seebpore	Katras-Jheria Coal Company, Limited, Churnpore, Asansole, East Indian Railway, Seebpore Colliery.	Large lump	10·86	5830	51·58	8·31	62·89	37·11	0·45	Does not cake.	Fawn	Alternate dull and bright layers, very dirty, breaks easily with much dust.
8292A	7763	25 Nov., 1896	Seebpore	Katras-Jheria Coal Company, Limited, Churnpore, Asansole, East Indian Railway, Sheebpore Colliery.	Small pieces...	10·88	5841	52·15	8·28	60·41	39·59	0·51	Does not cake.	Light fawn	Alternate dull and bright layers, breaks easily, clean

				BENGAL (KARHARBARI).											
[illegible]	[illegible]	4 Oct., 1893	Karharbari	East Indian Railway, Karharbari Colliery, Jogiland seam.	—	13·11	7040	56·45	10·77	67·22	32·78	0·51	Do.	White	Laminated, very clean, cleaves in small cubes.
[illegible]	1983	Do.	Do.	East Indian Railway, Karharbari Colliery, Lower seam.	—	12·37	6644	64·80	7·37	72·17	27·83	0·42	Does not cake.	Dark yellow	Dull, black, clean, not very hard.
*6541	1985	Do.	Do.	East Indian Railway, Karharbari Colliery, Upper seam.	—	13·01	6985	66·80	5·35	72·15	27·85	0·40	Do.	Yellowish brown.	Dull, black, hard, clean, breaks into cubes.
7314	7081	31 Jan., 1896	Do.	Manager, Giridih Colliery Company, Limited.	(Karharbari Lower Seam) from Pit Paharidih, Giridih Coalfield.	12·13	6512	58·59	14·55	73·14	26·86	0·45	Cakes	Dove	Dull, rather tough, breaks in every direction with little dust.
6817	7070	6 Jan., 1896	Girihdih	Superintendent, Bengal Coal Company, Limited.	Steam coal, Giridih	13·37	7183	60·93	9·99	70·92	29·08	0·43	Do.	Buff	Clean, but rather dusty, crumbles readily, bright in layers.
*2610	2866	Do.	Kooldeah	Do. do.	Kooldeah coal	12·39	6657	64·20	12·08	76·28	27·72	1·50	Do.	White	A dull black coal, clean and hard.
				BENGAL (JHERIA).											
8192	7768	25 Nov., 1899	Chattabad	Katras-Jheria Coal Company, Limited, Katras Collieries, Manbhum.	Chattabad, No. 12 Seam...	12·70	6820	62·17	11·38	73·55	26·45	0·85	Do.	Greyish red	A clean, rather bright coal, easily broken.
8193	7770	Do.	Moulkara	Do. do.	Moulkara, East Colliery, No. 13 Seam.	12·66	6798	62·60	10·55	73·15	26·85	0·93	Do.	Dirty white	Laminated bright coal, dirty, breaks very easily, with much dust.
8194	7769	Do.	Do.	Do. do.	Moulkara, South Colliery, No. 14 Seam.	12·42	6672	58·85	14·36	73·21	26·79	0·83	Do.	Do.	Dull coal with bright layers, clean.
8195	7771	Do.	Do.	Do. do.	Moulkara, West Colliery, No. 15 Seam.	11·84	6358	58·64	13·15	71·79	28·21	0·75	Do.	Reddish grey.	Bright coal in layers, clean.
8196	7772	Do.	Choitoodee	Do. do.	Choitoodee, No. 15 Seam...	12·64	6787	61·24	11·46	72·70	27·30	0·93	Do.	Dirty white	Bright coal in layers, breaks easily, clean.
8329	7767	Do.	Kustore	Kaniganj Coal Association, Limited, 4, Fairlie Place, Calcutta.	Coal from Kustore Colliery, Jheria.	12·41	6666	63·71	8·58	72·29	27·71	0·61	Cakes	Reddish white.	Dull coal with graphitic lustre in oval pieces, and conchoidal fracture, breaks easily in layers with some dust, clean to handle.
8725	8120	25 Feb., 1897	Koiloodee	Jheria Coal Company, Katras Collieries, Manbhum.	Koiloodee, No. 12 Seam ...	11·92	6402	60·23	15·50	76·13	23·87	0·83	Do.	Dirty white	Rather bright coal with a silky lustre, breaks easily with some dust.
8250	7766	Do.	Kustore	Kaniganj Coal Association, Limited.	Coal from Kustore Colliery, Jheria.	12·57	6644	63·21	9·14	72·35	27·65	0·50	Cakes	Do.	Dull coal with bright layers, clean.
7248	7100	28 Mar., 1896	Jheria	Bengal-Nagpur Coal Company, Limited, through George Alexander, Esq.	Coal taken from inclines at Buggutdeah in Jheria.	10·70	5747	56·35	17·88	74·23	25·77	0·90	Cakes	White	Bright, glistening coal, brittle and hard, in places has a pitchy appearance.
7249	7101	Do.	Do.	Do. do.	Coal taken from a quarry at Buggutdeah. These two samples are not only surface coal, but have been exposed to the atmosphere.	10·24	5500	54·25	24·20	78·45	21·55	0·70	Do.	Light grey	Dull black coal with bright patches in places, cleaves occasionally with a silky fracture, rather hard, fairly clean.
				BENGAL (DALTONGANJ).											
7145	7090	6 Mar., 1896	Daltonganj	Dr. Saise, through Station Master, Gya.	Daltonganj coal, Rajhira seam.	10·41	5591	62·35	14·04	76·39	23·61	0·92	Does not cake.	Yellowish brown.	Bright coal, rather hard, not very dirty, on some pieces a small amount of white deposit.

Laboratory Number.	Imperial Laboratory Number.	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.	Evaporative Power.	Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties.	Colour of Ash.	Other characteristics of the Coal.
				BURMA.											
*3531	6187	4 Oct., 1894	Letkokbin	Burma Coal Company, Limited.	From roof of seam	—	†	33·57	8·50	41·07	57·93	0·33	Does not cake.	White	Dull black, clean and hard with rounded surfaces and fracture.
*3532	6188	Do.	Do.	Do. do.	From floor of seam	—	†	3·58	68·39	†	28·05	0·11	Do.	Do.	Dull black, with glossy patches, very soft and soapy to touch, clean.
				CENTRAL INDIA.									Do.	Do.	
*250	2605	Do.	Umaria	Umaria Colliery...	—	10·04	5390	59·65	23·63	83·28	16·72	0·32			A clean dull coal with irregular cleavage, easily broken.
*382	1671	Do.	Do.	Do.	—	9·77	5247	55·97	26·60	82·57	17·43	0·43	Do.	Greyish white.	Dull, soft, clean, and contains fossilized resin
7003	7001	15 Feb., 1899	Do.	The Manager, Umaria Colliery.	Sample from No. 3 Seam, Middle area.	11·06	5910	63·63	15·99	79·62	20·38	0·76	Do.	White	Small quantities of white substance between the layers in places. Rather dirty to handle.
7004	7002	Do.	Do.	Do. do.	Sample from No. 2 Seam, Middle area.	10·14	5445	56·66	23·17	79·83	20·17	1·09	Do.	Do.	Similar to 7004.
7005	7003	Do.	Do.	Do. do.	Sample from No. 2 Seam, Northern area.	9·94	5337	45·99	14·94	60·93	39·07	1·02	Do.	Do.	Similar to 7004. Traces of iron pyrites in cleavages, rather tough.
7006	7004	Do.	Do.	Do. do.	Sample from No. 3 Seam, Northern area.	10·21	5481	50·38	14·98	65·36	34·64	1·81	Do.	Do.	Similar to 7004 and 7005, but not so dirty to handle. It also shows a silky patched appearance when cleaved.
7447	7449	22 July, 1896	Do.	Do. do.	Sample from No. 4 Seam, Northern area.	10·55	5665	43·42	21·07	61·49	35·51	1·89	Do.	Reddish white.	Tough coal of dull appearance, cleaving in layers.
7448	7450	Do.	Do.	Do. do.	Samples from No. 4 Seam, Middle area. "Information required as to their coking properties."	10·83	5819	48·99	24·28	73·27	26·73	2·03	Do.	Dirty white	Dull, with small bright patches, irregular cleavage, easily broken, with much dust, dirty.
				CENTRAL PROVINCES.											
*1638	2852	4 Oct., 1894	Mohpani	The Nerbudda Coal and Iron Company, Limited, Mohpani Coal Mine.	From No. 1 Seam	9·50	5104	42·46	24·30	66·76	33·24	0·50	Do.	Brownish yellow.	Dull, laminated, very hard, fairly clean.
8284	7775	Do.	Do.	Do. do.	Sample A	11·84	6358	49·83	8·88	58·71	41·29	0·52	Do.	Light fawn	A shaly coal, dull, with bright spots in layers, breaks easily, dirty, gives much dust.
8285	7776	Do.	Do.	Do. do.	Sample B	11·80	6336	60·64	8·33	68·97	31·03	0·47	Do.	Do.	A dull coal, very light, breaks easily, much dust, very fibrous.
8286	7777	Do.	Do.	Do. do.	Sample C	9·42	5060	50·81	11·93	62·74	37·26	1·03	Do.	Terra-cotta	A dull coal with some bright layers, breaks easily with much dust, very dirty.
*316	1665	—	Warora	Warora Colliery	—	10·30	5533	41·49	13·59	54·90	45·10	0·94	Do.	White	Dull, with bright patches, clean and rather soft.

† Does not burn readily.

[illegible]	[illegible]	—	Do.	Do.	do.	—	15·24	55·0	40·07	12·78	53·75	46·25	1·21	Do.	Do.	A clean silky coal, easily broken, cleaving in cubes.
[illegible]	[illegible]	1 Sept. 1896	Warora	Manager, Warora Colliery.		From No. 2 Pit	10·27	5514	39·96	11·86	51·82	48·18	0·98	Does not cake.	Greyish white.	Slaty dull coal with some brighter patches, rather dirty.
[illegible]	[illegible]	Do.	Do.	Do.	do.	From No. 4 Pit	9·46	5082	43·12	15·80	58·02	41·98	2·37	Do.	Do.	Same as 8130.
[illegible]	[illegible]	Do.	Do.	Do.	do.	From No. 5 Pit	9·93	5335	44·57	12·75	57·32	42·68	0·77	Do.	Dirty white	Same as 8130.
[illegible]	[illegible]	Do.	Do.	Do.	do.	From No. 1 Seam, No. 2 Pit.	9·01	4840	40·07	20·75	61·72	38·28	0·64	Do.	Slightly yellow.	Slaty dull coal with only a few bright spots, dirty, rather tough.
*1650	2853	5 Oct. 1899	Mohpani	Gadawarra		No. 2 Seam	9·91	5324	42·61	20·13	62·74	37·26	0·39	Cakes.	White.	Dirty, alternate layers of dull and very hard coal and bright coal easily broken.
*1652	2854	Do.	Do.	Do.	do.	No. 3 Seam	10·36	5566	41·00	19·65	60·65	39·35	0·44	Do.	Yellowish brown.	
*1687	2855	Do.	Do.	Do.	do.	No. 4 Seam	11·39	6116	45·35	9·23	54·58	45·42	0·43	Do.	Light yellow.	Dull, hard and clean with occasional glossy layers.
				NIZAM'S DOMINIONS.												
*87	1436	—	Singareni	Hyderabad		—	10·32	5544	43·35	12·71	56·26	43·74	0·23	Does not cake.	Yellowish brown.	Irregular fracture, extremely hard, dull, clean coal, with thin streaks of glossy coal.
7069	7068	—	Do.	Agent and General Manager, Hyderabad (Deccan), Company.		Singareni coal	10·96	5885	51·68	8·61	62·84	37·16	1·28	Cakes slightly.	Dark fawn	Very tough dull, with bright patches.
				PUNJAB.												
7070 and 7071	7083 and 7084	3 Feb. 1896	Dandot	Mining Manager, Colliery District, North-Western Railway.		Two boxes of Dandot steam coal.	11·16	5·95	38·32	13·10	51·42	48·58	1·86	Does not cake.	Reddish white	Dull, with bright patches, easily broken, clean.
7072 and 7073	7085 and 7086	Do.	Pidh	Do.	do.	Two boxes of Pidh steam coal. These are very friable and deteriorate rapidly if exposed to the air, and when in bulk are apt to fire by spontaneous combustion.	11·62	6237	30·44	10·00	49·44	50·56	3·20	Do.	Flesh colour.	Clean, rather bright, easily broken, with little dust.
7109 and 7110	7313 and 7314	25 Feb. 1896	Bhaganwala	Do.	do.	Two boxes of Bhaganwala coal.	8·98	4820	29·54	36·58	66·12	33·88	2·24	Cakes slightly	Dirty yellow.	Dull, breaks readily with irregular fracture, white substance, brown resin.
							7·95	4270	27·79	32·91	67·7	32·30	2·18	Do.	Flesh colour.	Similar to 7109.
7118	7005	15 Feb. 1890	Pidh	Do.	do.	Pidh Shale. It is believed to contain mineral oil and is known to contain gas. Precise information desired on these points.	8·32	4470	27·30	31·93	59·23	40·77	4·41	Does not cake.	Dirty white.	This shale is in layers. A resinous substance is found occasionally between the layers. Mineral oil by distillation, small. Yield of gas low, illuminating power deficient.
7131	7006	25 Feb.	Dandot	Do.	do.	Dandot Shale, the same information desired as above (Pidh Shale).	3·62	1943	12·84	60·99	78·83	26·17	2·86	Do.	Light fawn	Dull, grey black coal with soapy touch. Contains a small quantity of brown resinous matter. Mineral oil very small, yield of gas very low illuminating power, small.
7071	7317	10 April, 1896	Shahrig	Executive Engineer Shahrig District, North-Western Railway.		Takrai top seam coal from Mainway, West.	12·53	6730	38·74	11·81	50·55	49·45	1·67	Cakes.	Creamy brown.	Easily broken, a quantity of a micaceous substance between the layers.

The calorific power has been determined by means of Thompson's calorimeter, the apparatus having been previously standardised by the combustion of material of known calorific value, and the necessary corrections applied to the experimental numbers which are expressed in calories representing the number of grams of water raised 1°C. in temperature, by the combustion of 1 gram of coal.

The evaporative power is represented by the number of pounds of water at 100°C converted into steam at the same temperature by the combustion of 1 lb of coal. These numbers have been calculated from the calories by dividing by the latent heat of steam.

TABLE VI.—Results of Ultimate Analyses of Selected Indian Coals.

Indian Invoice Number.	Province and Mine.	Carbon.	Hydrogen.	Ash.	Moisture.	Sulphur.	Nitrogen, Hydrogen, &c.
	Assam:—						
1828	Makum	77·31	5·43	1·27	3·07	1·02	11·00
96	Cherrapunji	77·75	5·83	4·74	1·45	3·98	0·25
97	Maoflong...	75·05	5·17	3·23	3·15	3·08	10·32
	Baluchistan:—						
93	Khost	71·38	4·07	5·57	3·85	4·82	9·41
94	,, ...	70·58	5·55	10·64	2·46	0·74	10·03
	Bengal:—						
99	Kumardubhi	70·43	4·70	13·85	1·86	0·53	8·63
	Karharbari						
639	Lower Seam	80·75	4·32	7·37	1·23	0·42	5·91
541	Upper Seam	83·53	4·59	5·35	1·28	0·40	4·85
1658	Sodepore	72·09	4·87	10·63	3·54	0·29	10·18
1659	Liakdee	74·33	4·60	9·29	2·23	0·53	8·02
	Burma:—						
3531	Letkokbin	60·25	4·64	9·28	11·55	0·33	13·95
	Central Provinces:—						
1651	Mohpani	67·65	4·37	9·73	7·07	0·43	10·75

Key to the Sketch-Map of Indian Coalfields.

Assam—

(1) Makum .. .. Collieries.
(2) Daranggiri .. .. Prospective.
(3) Cherrapunji .. .. Worked.
(3) Lakadong .. .. Prespective.
(3) Maoflong (Maobelarkar) .. Worked.
(4) Disai, Jaipur .. .. Prospective.
(4) Nazira .. .. Colliery.

Baluchistan—

(5) Khost .. .. Collieries.
(6) Mach .. .. Prospective.
(7) Quetta .. .. Worked

Bengal—

(8) Raniganj and Barakar .. Collieries.
(9) Karharbari (Giridih) .. .. Collieries.
(10) Rajmahal .. .. 5 fields, little worked.
(11) Jheria .. .. Collieries.
(12) Bokaro, Ramgarh, Karanpura N. & S. .. Prospective.
(13) Aurunga, Hutar .. .. Prospective.
(14) Daltonganj .. .. Worked.
(17) Darjeeling, Tista R. .. .. Prospective.

Burma—

(18) Thingadaw .. .. Working.
(19) Chindwin .. .. Prospective.
(20) Lashio .. ..
(21) Thayetmyo, Henzada .. .. .. Very poor.
(22) Mergui .. ..

Central India—

(23) Umaria .. .. Colliery.
(24) Sohagpur, &c. .. .. .. Prospective.
(25) Singrowli, Bisrampur, &c. .. .. Prospective.

Central Provinces—

(26) Mohpani .. .. Colliery.
(27) Warora (Chanda, &c.) .. Colliery.
(28) Pench, Kanhan and Tawa, Shahpur, Singora, Barkoi .. Prospective.
(29) Korba .. ..
(29) Mand .. ..
(29) Raigarh-Hingir .. .. ..
(15) Eeb R. (Rampur) .. .. Prospective.
(16) Talchir .. ..

Nizam's Dominions and Madras (Godavari Valley)—

(30) Singareni .. .. Colliery.
(31) Kamarum, Cherla .. .. .. Prospective.
(31) Rajahzompalli .. .. .. Colliery.
(32) Chinnur
(33) Madavaram, Beddadanol .. .. .. Prospective.

Kashmir—

(34) Sangar Marg .. .. .. Prospective.

Punjab—

(35) Pidh and Bhaganwala .. Collieries.
(35) Dandot .. .. Colliery.
(36) Chita Pahar .. .. .. Poor.
(37) Hazara (Abbottabad) .. Poor.
(38) Bannu .. .. Poor.

Rajputana—

(39) Palana (Bikanir) .. .. .. Colliery.

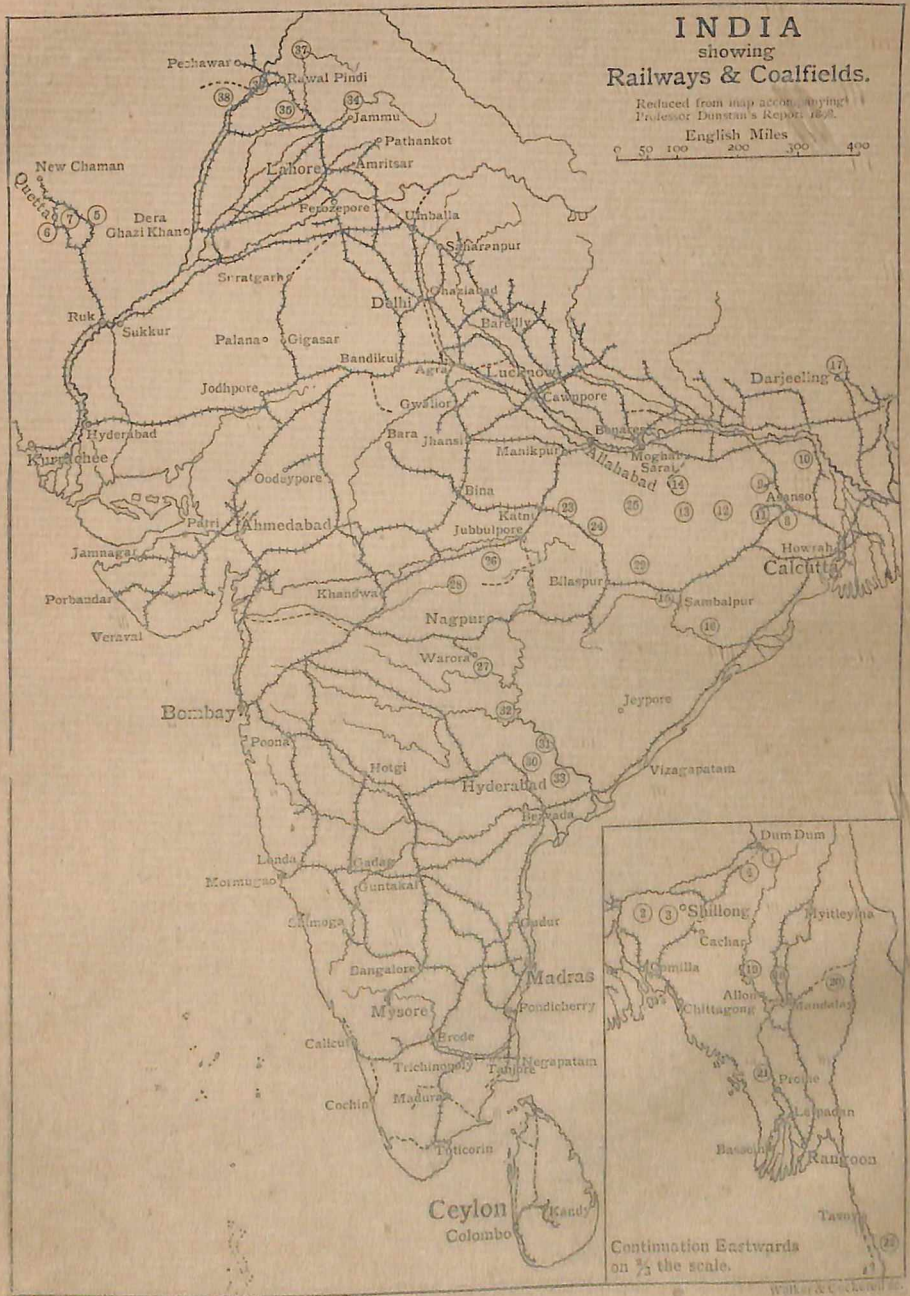

TABLE VII.—OTHER RECORDED ANALYSES OF INDIAN COALS.

Province and Mine.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur.	Specific Gravity.	Calorific Power Calories.	Evaporative Power (Calculated).	Caking Properties.	Colour of Ash.	References.
ASSAM.											
Cherrapunji	...	37·1	62·0	0·9	...	...	...	...	...	...	J. Princep.
Langrin Coalfields, Khasia Hills											
Seam No. 1	5·84	35·16	50·40	8·60	...	...	...	...	Non-caking	Pale Red	T. D. La Touche, Records of G.S., xvii. 1884.
Seam No. 2	3·02	39·58	50·80	6·60	...	...	...	...	Cakes.	Red	
Daranggiri, Khasia Hills											
No. 1 (7 ft. 6 in. Seam)	11·5	33·1	47·7	7·7	...	...	...	...	...	...	La Touche, Rec. G. S., xv. 1882.
No. 2 (Nengja Stream 3 ft. 6 in. Seam)	6·2	39·4	51·8	2·6	...	...	...	...	...	...	
Khasia Hills											
Maobelarkar	3·4	39·6	55·2	1·8	...	...	...	...	...	...	Rec. G.S., viii.
Average of 27 analyses of Assam Coal	...	36·2	60·0	3·8	...	...	...	...	...	...	Ball's Geology.
Chittagong, A	...	38·0	36·5	25·5	...	...	...	...	...	...	----
,, B	...	35·8	25·9	38·3							
Assam Coal	...	44·98	53·42	1·60	2·52	...	...	13·99	...	...	T. H. Ward, Handbook.
Makum	...	46·5	53·0	2·0	...	...	...	...	...	...	Handbook; F. R. Mallet. 1876.
Do. (average)	...	23·18	75·70	1·12	...	...	...	...	...	...	
BALUCHISTAN.											
Khost Colliery	2·20	40·56	47·48	9·76	...	...	...	...	Cakes, forms light coke.	Grey.	
Sharigh	3·56	42·60	40·12	13·72	...	...	...	...	Cakes.	Grey.	
Harnai, No. 1 (2 miles S.W.)	8·12	37·64	51·04	3·20	...	...	...	...	Sinters slightly.	Dark brown	
Do. No. 2	8·60	34·84	49·36	7·00	...	...	...	...	Sinters slightly.	Dark red.	
BENGAL.											
Raniganj.											
(Gangootiya) Sanctoria	3·20	32·63	54·9	9·25	·55	...	...	...	Fairly hard coke.	Brown.	Bengal Nagpore Coal Co., 1901.
Bhuggutdih.											
No. 11 Seam	·70	21·55	63·20	14·55	·79	1·40	...	...	Hardcoke	White.	
No. 12 Seam	·50	22·45	62·05	15·00	·82	1·39	...	...	Fairly hard coke.	White.	
No. 13 Seam	(·72)	27·46	62·80	10·34	·80	1·38	...	...	Hardcoke	Greyish	
Dhadka	...	42·47	47·85	9·68	...	...	6415	...	Cakes.	...	New Beerbhoom Coal Co., 1901.
Belrooi	...	39·28	51·86	8·86	...	...	7081	...	Cakes.	...	
Borrea	...	31·78	55·02	12·30	...	...	6985	...	Cakes.	...	
Joyramdangah	...	38·03	51·36	10·61	...	...	6860	...	Cakes.	...	Damuda Coal Co., 1901.
Barmondia	...	32·45	54·05	13·55	...	...	6886	...	Cakes.	...	
Luchipur	...	31·30	57·00	8·65	...	...	6600	...	Cakes.	...	
Nursemuda	...	33·05	45·25	15·60	...	...	...	...	Cakes.	...	
Desherghur	2·64	37·57	50·75	9·04							
Barakar	1·02	31·08	57·27	8·81	...	...	...	...	...	...	W. C. Anderson.
Ghusick	1·35	24·11	61·72	12·82							
Chota Dhemo	1·30	37·00	48·49	11·21							
Average of 31	...	30·63	53·9	15·17	...	...	...	...	...	...	Handbook 1900, P. N. Bose.
North Bengal Coal Company. Upper Seam	...	14·29	74·31	10·43	0·47	...	...	...	...	...	Dr. Saise; Handbook.
Aliporo (average)	...	20·81	66·86	14·03	1·36	...	...	12·80	...	...	T. H. Ward.
Barakar	...	27·04	64·20	7·27	1·56	...	...	...			
Dhadka	...	32·75	49·01	7·04	...	...	...	...	...	...	T. H. Ward.
Borrea	...	24·27	60·70	10·03	...	...	...	12·35			
Belrooi	...	30·25	53·70	9·50	...	...	...	12·40			
Average of 16	...	32·08	51·08	16·27	...	...	...	...	...	...	Mem. Geol Survey.
Good Specimen	...	37·30	51·80	10·70	...	...	...	...	...	...	
Karharbari.											
Lower Seam	...	25·00	60·85	9·15	0·42	1·35	...	13·20	Cakes.	Fawn.	
Do.	...	30·63	57·81	11·67	0·52	1·37	...	12·03		White.	Dr. Saise. Proc. N. of England Inst. M.E, XXX.
Do.	...	28·80	61·67	9·53	0·83	1·34	...	13·20	Cakes.	Fawn.	
Upper Seam	...	25·30	60·30	13·00	0·57	1·33	...	12·60	do.	White.	
Bhadua Seam	...	25·17	61·03	13·80	0·20	1·40	...	12·40	do.	Grey.	
Do.	...	20·40	61·32	18·08	...	1·43	...	11·46	...	Grey.	
Average	...	24·51	63·66	12·33	0·66	1·38	...	12·15	...	...	
Khunduda Seam (Giridih coal)	...	28·56	50·70	20·72	...	...	...	11·60	...	...	
Bengal Coal Company	...	29·84	56·30	14·16	...	...	...	...	...	...	
Jheria Coalfield.											
Ladna	1·60	25·00	63·10	7·80	·47	...	...	...	Cakes.	...	Turner, Marsden, and Co., 1901.
Do.	1·00	28·80	64·20	7·00	·45	...	...	13·82	Cakes.	...	
Do.	1·72	29·08	58·85	10·35	·70	...	...	13·12	Cakes.	...	
Do.	1·40	27·86	59·28	11·41	...	...	...	...	...	...	W. C. Anderson.
Kusunda	1·40	29·16	58·13	13·81	...	...	...	...	...	...	Do.

TABLE VII.—*Continued.*

Province and Mine.	Moisture.	Volatile Matter.	Fixed Carbon	Ash.	Sulphur.	Specific Gravity.	Calorific Power Calories.	Evaporative Power (Calculated).	Caking Properties.	Colour of Ash.	References.
No. 13 Seam (Jamooni)	..	28·29	58·24	13·47	...	...	...	...	Cakes.		T. H. Ward, 1892. Rec. XXV.
No. 13 Seam (Perghabad)	...	29·80	60·00	10·20	...	...	...	14.30	Cakes.	..	
No. 12 Seam (Ekra)	...	26·28	61·36	12·36	...	...	...	...	Non-caking.	...	
No. 17 Seam (Seetanalla)	...	32·19	57·58	10·23	...	...	...	...	Cakes.	..	Dr. Saise.
Palamow (average)	...	31·77	56·49	11·74	...	...	...	...	Non-caking.	...	
Karanpura ,, ...	...	27·0	64·5	8·5	...	...	...	...	...	...	Ball's Geology.
Aurunga ,, ...	6·7	23·2	36·5	27·3	...	...	...	...	...	...	Mem. XV., 12, 111.
Hutar ,, ...	5·05	28·0	55·35	10·7	...	...	...	...	...	...	
Daltonganj ,, ...	3·45	21·05	64·8	10·7	...	...	...	..	...	...	
Bisrampur											
Rehr River...	(5·5)	38·2	57·7	4·1	...	...	...	...	...	...	Rec VI., 1873.
Pasang River	...	37·0	56·2	6·8							
Darjiling Class A.											
Lisu Valley...	14·54	8·86	63·96	12·64							
Do. (minus water)	...	10·37	74·84	14·79							Bose. Rec. XXIII., p. 255, 1890.
Lisu Valley...	4·72	22·16	60·24	12·88	...	...	...	...	...	...	
Do.	3·28	20·60	60·12	16·00							
Average 8, Assay Class A & B ..	...	22·94	59·56	17·42							
BURMA.											
Murray Coal Company	...	36·44	50·0	13·36	...	...	...	13·06			
Shwebo (Burma Company), seven outcrops:—											
Lwindaw	18·42	32·10	47·62	1·86	...	...	...	12 8	Non-caking.	Pale buff	
Ketsobin, No. 1	12·60	37·22	41·72	8·46	...	...	...	10·4	do.	do.	
Do. No. 2...	0·52	20·84	21·56	39·08	...	...	...	6·3	do.	do.	...
Letkokbin, No. 1	11·94	37·68	36·22	14·16	...	...	...	10·5	do.	do.	
Do. No. 2...	0·16	34·24	24·28	32·32	...	...	...	8·1	do.	do.	
Chadouk	8 14	31·04	24·26	35·36	...	...	...	7·5	do.	do.	
Kodaung	9 10	33·32	35·88	21·70	...	...	...	6·7	do.	do.	
Letkokbin Seam, top coal	12 45	33·85	46·60	7·10							
Do. bottom coal	10·02	36·25	38·80	14·90							
Kyetsobin Outcrop, top coal	5·62	42 73	44·20	7·45							
Do. bottom coal ..	8·55	40·60	36 05	14·23							
Kadaung	6·27	33·03	36·85	23·90							Handbook.
Luindaha	11·42	29 98	36·10	22·50	...	...	...		...	...	
Upper Chindwin (average of 11) ...	10·14	34 59	49·05	5·30							
Mergui, Great Tenasserim River { A .. B .. C	15·29	30 08	30·80	23 86							
	10·80	27·36	42·52	19·32							
	11·34	36·40	43·27	8·99							Review of Mineral Production, 1900.
Kale Creek Coal, Chindwin Valley .	...	37 60	59·29	3·11	...	...	...	...	...	...	
Letkokbin	...	40·81	55·71	3 48							
CENTRAL INDIA.											
Umaria	(5·46)	25·17	63 71	8·12							
Korar	5 04	12·56	65·48	16·92							
Johilla	...	36 61	55·93	7·43							
Do.	...	15 60	52·77	11·63							
Umaria	...	28 40	60·70	10·90							Hughes, Mem. XXI., 1885.
Do.	...	29·40	60·90	12 70	...	...	...		...	...	
Sohagpur	5·8	29·5	55·0	9.7							
Do. Nandnah Seam ...	...	23·84	62 50	13·66							
Do. do.	...	26 55	62 89	10·56							
Do. Bhalmuri Seam	6·7	28·2	59·6	5·5							
Kurasia, 13 ft. 6 in. ,, ...	(2 2)	29·15	64·65	6·20							
Do. 6 ft. 6 in. ,, ...	(6·84)	32·43	59·95	7·62							
Sohagpur.											
Amlai Seam	5·2	22·2	57·2	15·4							G. F. Reader, Geol. Rep., 1892 to 1900.
Sone Seam	...	27·4	61·0	11·6							
CENTRAL PROVINCES.											
Mohpani	...	12to22	57to67	10to15	1·66						Handbook.
Warora, large coal	...	40·0	45·0	14·4							
Do. slack coal	...	39 4	45·8	14 8							Ball's Geology.
Do.	...	40·4	43·4	14 2							
Chugus (average of 16)	...	33·19	45·61	20·03							Handbook.
Warora (average)	...	48 16	42 85	8 99	0·840	...	...		...	...	Ball's Geology.
Pisgaon	...	10·2	63 1	15·7	...	...	...		...	...	Handbook.
Johilla (1882) not worked	...	28 50	57·95	13 55							
NIZAM'S DOMINIONS.											
Singareni, A	...	22·0	62 4	15·60							
Do. B	...	23·0	60·0	17·00							
Do.	...	12 0	59·0	19·00							
Do.	...	23 10	58·0	10·14	1·90						
PUNJAB.											
Quetta coal (North-West Frontier	...	12·08	51 80	4·09	...	...	...	...	...	...	Handbook.
RAJPUTANA.											
Palana	8 20	14·72	30·28	9·60				13·58			Rec. XXX. p. 124.

TABLE VIII.—Typical British Coals.

	Volatile Matter.	Fixed Carbon.	Ash.	Moisture.	Sulphur.	Calorific Value.		References.
Glamorganshire	10·4	86·4	3·2	...	.62	8444	...	Mr. Reddrop, L. & N.W. Ry. Co
Monmouthshire	17·5	76·4	0 1	...	·74	8327	...	
Staffordshire	34·5	62·7	2·8	...	1·33	7978	...	
Lancashire	32·0	59·9	7·5	...	0·62	7552	...	
Scotch (main)	35·84	53·79	1·28	9·09	...	7590	...	W. C. Anderson.

TABLE IX.—Analyses of Indian Coal and Coke.

	Volatile Matter.	Fixed Carbon.	Ash.	Moisture.	Sulphur.	Calorific Value.		References.
Giridih—								
Unwashed coal	26 0	60·6	13·0	...	0·4	...	...	
Washed coal	30·2	60·24	9·56	...	...	...	...	
Coke (from do.)	...	86·07	12·0	0·40	0·03	...	Hard and dense.	
Sanctoria—								
Unwashed coal	38·00	40·57	12·00	...	0·43	...	...	
Washed coal	...	...	11 5	...	...	...	...	
Coke (from do.)	...	81·57	17·25	0·70	0·48	...	Light and porous.	R. H. Mahon.
Kenwadih—								
Unwashed coal	23·5	63·5	12·5	...	0·50	...	...	
Washed coal	...	...	9·45	...	...	...	...	
Coke (from do.)	...	82 05	16·10	0·40	0·85	...	Hard and dense.	
Kustore —								
Unwashed coal	24·05	60·1	15·10	...	0·75	...	...	
Coke (from washed coal)	...	82·15	16 70	0 33	0·82	...	Hard and dense.	

DISCUSSION.

Mr. F. R. Upcott, C.S.I. (Government Director of Indian Railway Companies) thought a glance at the diagrams exhibited by Professor Dunstan would indicate that the peculiarity of the coalfields in India was their distance from great cities and towns where manufactories were carried on. In that connection, the question of the transport and handling of coal was really the keynote of the proper utilisation of coal in India. He thought he could, in a more homely manner, illustrate the respective values of Indian coal, by the following illustration. A coal-scuttle full of Giridhi coal would boil a certain amount of water; while eight-tenths of a scuttle full of Welsh coal, one-half of a scuttle of patent fuel, a scuttle and a-half full of Barakar coal, two scuttles of lignite coal, and two and a-half scuttles of wood, would respectively produce the same result. At the present time, Bengal coal was mostly used in India. Coal of a very inferior quality sometimes was used on the railways; in fact, when he was in the North of India, a few months ago, a North-Western driver, who had been fined on account of his train being late, appealed to him in the following pathetic manner: "How can I run my train to proper time, if I am given coal that smells like a drain, and burns like a flint?" The consumption of coal might be classed under several heads. First, there were the flour, cotton, glass, and jute mills, which required coal to work their machinery. Secondly, there was the production of power in railways and steamers. Thirdly, the manufacture of iron and steel, glass, lime and bricks. Fourthly, export; and he supposed that Calcutta would always remain the place from which coal was shipped on account of that port being nearest to the big mines. Lastly, there was the possible domestic use of coal. Those who had lived in India knew that the natives would not cook their food with coal, but used wood and charcoal. Lord Curzon, in addressing the tea planters said:—"Why do not you teach some of the 300,000,000 natives of India to drink tea; and thereby obtain a new market for your produce?" He (Mr. Upcott) did not see why the many millions in India should not be taught to use coal for cooking purposes. If that were done, an enormous development would take place in the coal consumption, but to carry out such a plan, the coal must be brought within the natives' reach. Professor Dunstan had spoken of the necessity for cheaper and better means for transport. The present rate for transport was one farthing, or less, per ton per mile. Speaking as a private individual, he thought that the railways should be allowed a free hand to reduce the rates below that figure if they chose to do so. Similarly, in regard to the size and type of rolling stock for coal transport, the railway companies ought to be, as they probably were, the judges of what was best for their own requirements. It must be remembered, however, that the position of the collieries in India was entirely different from that of the collieries in England. In this country the mines were a very short distance from the sea-board, and speaking generally, the loaded trucks were run from the mines down an incline to the ships. The trucks, which had a capacity of eight or ten tons, were put straight into a lift, by means of which the coal was tipped into the steamer's hold straight away, there being plenty of vessels ready to be loaded, and no scarcity of wagons. In India, there were some railways which had direct connection with the sea-board, and could carry coal very much cheaper than

other lines as long as import traffic was also possible. With reference to what was sometimes said as to the inability of the Government to provide trucks, he happened to be at one of the Indian coal pits when he saw a very large amount of coal on the bank waiting to be carried away, and a gentleman who was with him remarked: "Here is an instance of insufficient trucks." He (Mr. Upcott) thereupon asked the manager of the mine why he did not get trucks for the coal. The reply was: "If I wanted trucks I could get them to-morrow." It appeared that the reason why the coal had not been transported was that it had been bought for shipment on board steamers as bunker coal. The steamers had not arrived at Calcutta, and it was cheaper to leave the coal at the pits' mouth than to have it sent to the Calcutta docks and lifted again. With regard to the question of the manufacture of iron and steel, which would no doubt very shortly attain very large proportions, the earlier efforts did not succeed because those interested in the matter tried to bring the coal to the ore. He had recently had an opportunity of going over the Dowlais Works, which were situated quite close to the collieries, and he there saw ore coming into the works from Spain. If the iron and steel industry of India was to be developed it was essential that the ore should be taken to the districts where coking coal was most abundant. Although he might perhaps be called a pessimist, he thought a great deal ought to be done in the direction of carrying coal at very much cheaper rates. With electrical enterprise springing up all around them, he thought it behoved the railway companies to do all they could to foster the distribution and the consumption of coal by lowering the rates as much as possible, and by using every possible appliance to minimise labour.

Mr. Bennett H. Brough thought that the facts brought forward by the reader in his interesting paper, clearly showed that in the matter of fuel, India would soon be independent of English supplies, and in view of the occurrence of coking coal to which he had drawn attention, this might eventually be the case in the matter of iron. This was a somewhat depressing outlook for the British iron and coal masters. As to the future of the Indian export trade, Professor Dunstan took, he thought, too optimistic a view. The exports, which did not exceed 9 per cent. of the output, were insignificant, and were hardly likely to increase, owing to Japanese and Australian competition. The Japanese and Australian coal more closely resembled true coal measure coal than did the Indian coal of recent geological age. The Australian competition was especially noteworthy. Australian coal was even sent to Europe, and recent statistics showed that Germany last year received nearly twice as much coal from Australia as from the United States, notwithstanding the sensational newspaper notices of American competition in the German coal trade. He also disagreed with Professor Dunstan as to the suitability of mechanical coal cutters for use in India. These machines answered admirably in the United States, where labour costs were excessive. In India, however, where one-third of the coal-miners were women, the cost of labour was insignificant, and might almost be neglected. The coal cost 4½ times more to the consumer than it did at the mine, the difference being due to the cost of transport, storing, and the excessive profit of the middleman. It was in this direction that economy was desirable. A point that Professor Dunstan had not emphasised was the liability of certain Indian coals to spontaneous combustion. At Warora, for example, according to Mr. R. W. Clarke, in a recent paper read before the Institute of Mining Engineers, 70 per cent. of the coalfield had been lost by fire, and walled off. Should similar conditions obtain elsewhere, the cost of mining would be increased. On the whole, he thought it unlikely that Indian supplies would ever be drawn upon by other nations whose coal deposits were in process of depletion.

Mr. T. H. Holland (Indian Geological Survey) disagreed with Mr. Brough's suggestion that the tendency to spontaneous combustion was more pronounced in India than elsewhere, and referred to the accidental causes of the few cases known. He denied also the probability of Australian competition being able at any future time to displace the Indian exports to the coast ports of the Indian Ocean. On the contrary, the increased strictures on coloured labour in Australia tends to insure the stability of the Indian coal industry, whilst further labour troubles in Europe will, except for special and restricted requirements, practically wipe out the small and gradually diminishing imports of European coals into India. The rise in the Indian coal industry followed most definitely the great colliers' strike of 1893, and any assistance given by Government agencies has been of microscopic value compared to the friendly offices of the labour leaders and trades' unions at home. Prosperity in Indian coal has come to stay; of that fact, the Government may assure themselves when considering the claims for further expenditure in railway facilities from the coalfields to the ports. He pointed out that the weak feature of Professor Dunstan's analyses arose from the past and present system of sampling the coal seams. With a non-expert agency for collecting specimens, the chances are about even for and against the analyses being representative, whilst assistance by interested experts must always be viewed with suspicion by those who know the natural weaknesses of human nature. The laminated character of the Gondwana coals accentuated the value of uniform sampling, and researches in future could be made of real value only by utilising an unprejudiced expert organisation such as we have in the Geological Survey of India, which, working in direct correspondence with an institution like the Imperial Institute, would yield results infinitely more valuable than the sum of the researches of the two institutions working independently. Analyses are of no value

correlated with data as to the physical characters, proportion, quantity, and situation of the coal seams sampled. He pointed out that the reference to the anthracitic character of the Darjeeling coal would be, unless qualified, misleading. This coal possessed a higher percentage of fixed carbon than the Gondwana coals of the peninsula; but this was due, not to original superiority, but to secondary loss of the hydrocarbons, a change which naturally resulted in the proportionate increase of the other constituents, ash included. In acknowledging the great services Professor Dunstan had rendered to Indian economic mineralogy, the speaker suggested, as an additional subject for research, the possible occurrence of vanadium in the ashes of Indian coal. This metal, the wide distribution of which has only recently been noticed, has been found, amongst other unexpected places, in the ash of Gondwana coals in Australia and Argentina.

Mr. J. D. REES, C.I.E., questioned the propriety of introducing into Indian mining legislation principles found necessary in this country. As a member of the select committee of the Viceroy's council upon the Mining Bill, he had inspected the Bengal coal mines, and he found that there was hardly any need for any such regulations. The coolies working in those mines with their wives and children were among the happiest labouring people in the world. There was no danger from fire-damp, and accidents of any kind were extremely rare. Many natives of Bengal had been induced to discard agriculture for employment in collieries, and this was a great advantage to the country. After hearing the Chairman's speech in the House of Commons, two nights ago, he was inclined to think that Lord George Hamilton, as the head of the administrative machine of India, thought that they had gone quite as far as was wise, in imposing upon the people of India the superfluous services of an expensive civilisation. It seemed to him, that if the Bill had been postponed a little longer, and the inquiry as to the condition of the people had come on a little sooner, the measure might not have been passed. It would be interesting to know why there was no fire-damp in the coal mines of Bengal, whereas, in South Wales, miners went down in fear and trembling with their safety lamps. In Bengal the natives lit a fire below and cooked their food. When he was travelling in the Bengal coal district he discovered that the coolies were to some extent beginning to use coal in the immediate vicinity of the mines for firing and cooking. That was another proof that in India caste was no obstacle to inducing people to adopt any custom if they were let alone and not crushed by a cast-iron system. At present it was easy for coal mines to get labour, but unwise legislation might frighten people away. He had noticed on the diagrams that the coal from Glamorganshire, which had the highest calorific value of any coal in England, and the coal from Cherrapunjee, which had the highest calorific value of any coal in India, came from relatively the most rainy districts of their respective countries. Had that anything to do with the quality of the coal? He agreed with the previous speaker that the use of machinery for cutting coal would possibly not pay in India; he would let the people cut coal in their own way. On the other hand, he had observed in the goldfields in Mysore, where the air-drill was used for cutting exceedingly hard quartz, that the drills were used in a most skilful manner without the slightest difficulty by the natives. The more the people of India were let alone the more readily they would take to such occupations, and the more that diversity of occupation and improvement in the condition of the natives would be brought about which everyone desired.

Lieut.-General Sir RICHARD STRACHEY, G.C.S.I., F.R.S. said that the East Indian Railway during the year 1900 carried 5,000,000 tons of the 6,000,000 tons of coal produced in India during that year. It might, therefore, be said that practically the East Indian Railway was the great carrier of coal in India. It was quite certain that the future use of coal in India would depend upon the cost of transport and the improvement in transport. Roughly speaking, the cost of Bengal coal was about two rupees a ton, which was the present minimum charge for the carriage of coal over about 130 miles. Coal exported by sea would have to be carried about 150 miles, for which the charge would be about 2½ rupees per ton. To Umballa the distance would be about 900 miles, and the charge rather more than 14 rupees per ton. From that it would be seen to what extent the use of coal was likely to be possible generally. Whether or not it was possible to reduce the charge for carriage very considerably was a matter well worthy of consideration. He confessed his own opinion was that it could be reduced; and he thought that if the suggestion which Mr. Upcott made was carried out, and the East Indian Railway was allowed to manage its own business, the whole of the traffic arrangements would be greatly improved, and the cost of transport considerably reduced.

The CHAIRMAN said Professor Dunstan's valuable paper, together with the discussion, had particularly interested him, because it was his business every year to make a statement to the House of Commons with regard to the financial and material condition of India. The figures which influenced him most in preparing that estimate last year dealt with the development of the coal industry in India, and had been quoted that afternoon. He was anxious to be informed on such high authority whether or not that sudden development was a mere spurt or whether it was likely to be sustained in the future. After hearing Mr. Holland, who held a very responsible position in the Geological Survey of India and was a very high authority, and other gentlemen speak on the subject, he thought they must all go away with the opinion

that the coal industry was for the future likely to develop, whether as rapidly as in the past remained to be seen. Putting on one side the question of export trade, he thought it was pretty clear that India could produce coal enough for its own consumption and of a quality which, at the price, was likely to keep all other coal out of the country. He thought there was no more important statement made by the reader of the paper than that concerned in the communication sent to him by a steam navigation company, namely, that during the sixty years' existence of the company they had always used Indian coal, the amount which they consumed in the previous year amounting to over a million tons. He thought that was most conclusive evidence, so far as the supply of Indian coal for navigation purposes was concerned. Certain suggestions had been made as to how the coal industry could be expanded, and mention had been made of the obstacles which might retard that expansion. He was glad that the proposals the reader of the paper made to the Indian Government were of a moderate character. Professor Dunstan had ventured to hope that the Government would establish a School of Mines, and had urged that attention should be given to the study and investigation of economic geology. He (the Chairman) was glad to say that Indian finance was very good. Notwithstanding all the complaints of poverty, India, for the last two or three years, had had surpluses which made the mouth of the Chancellor of the Exchequer in this country water, and it was their bounden duty, as these surpluses seemed likely to continue, to try and utilise them to the advantage of native industry and the development of the country's resources. Sir Richard Strachey had expressed the opinion that the cost of transport in India could be reduced. One method by which he suggested that reduction should be brought about was that the East Indian Railway Company should be allowed to do as it liked. He would not go into any of the controversies between the East Indian Company and the Government, beyond saying that Sir Richard Strachey was the veteran pioneer of many enterprises to which he had laid his hand, all of which had succeeded, and that he might congratulate himself on having been for so many years the chairman of probably one of the most powerful and best paying railway enterprises that the world had ever seen. At the same time, coal was very attractive; and once people got possession of a coalfield they liked to keep all other people off. The Indian Government was bound in the future to see that every reasonable railway access was given to the great coalfields of India, for the coal of which there was likely to be a large demand. He thought it was undoubted that the carrying capacities of the railways running into Calcutta had been overtaxed, and it was clear that their carrying power must for the future be considerably increased. The Indian Government had come to the conclusion that in their future railway policy it was their business to make the first charge upon capital for the proper equipment of all lines which were in running order rather than to scatter their capital in multiplying lines less efficiently equipped; and to that policy they would adhere. A conference had recently been held, not on the same subject, but somewhat germane to it, of railway engineers at Calcutta. He thought the unquestionable result of that conference would be that the locomotives in India for the future would be more powerful and heavier than they were now, capable of drawing greater loads. He could not help thinking, with regard to the conveyance of freight in India, that something might be learned from their American cousins on the other side of the water, who had contrived to reduce the cost of freight to a very low figure. He thought it should be their policy to diminish the cost of freight in India, because in proportion as the traffic was increased and developed the State could afford to make reductions in the charges hitherto imposed. He wished to say a word in connection with the legislation which had recently been passed dealing with the mining industry in India. He quite agreed with Mr. Rees's remarks that the Government must not attempt to apply European ideas or European standards, which might be in force in England, to another country where wholly different customs prevailed. All industrial legislation in England passed through two processes. It was violently opposed by the masters to whom it was applied, but as soon as it became law, so impressed were they with its superlative merits, that their one object was to apply it as rapidly as possible to every other competitor in other parts of the British Empire. So long as he was in the India Office that policy could not succeed. They were bound to take all reasonable precautions to see that due care was taken of the lives and limbs of those who were engaged in the mining industry at home; but at the same time it must be remembered that wholly different systems and customs were in force elsewhere. They should not in any way attempt to interfere with the natives who could work in the mines, in which they had been accustomed to work for generations past,—work which was congenial to them, and in no sense in excess of their strength. As to the recent Mining Act, it was a compromise. As originally introduced, he thought it went too far. It was modified in Lord Curzon's Council, and he had not heard that any objections had been raised to it since it had been in operation. In conclusion, he proposed a most hearty vote of thanks to Professor Dunstan for his valuable paper.

Professor DUNSTAN, in reply, said, with reference to the competition between Japanese and Australian coals on the one hand, and Indian coal on the other, that the question was fully dealt with in parts of the paper he had not had time to read. He had obtained a great deal of information from the Calcutta firms on that subject. It was very largely a question of price, and the general opinion was that India ought to be able to hold most, if not all, of the Eastern trade. With regard to the question of coal-cutting,

his impression was that, apart from cheap labour, the very great waste occasioned by cutting the coal by hand would be obviated by the use of machinery, whilst the output would be greatly increased. So far the natives had been extremely skilful in using such machinery. The liability to spontaneous combustion of Warora coal was well known to him, but it was a matter of comparative unimportance so far as Indian coal generally was concerned. With regard to Mr. Holland's remarks, the selection of the samples examined was undertaken by the Government of India. The matter was placed in the hands of colliery companies, who were requested by the Reporter on Economic Products to send representative samples of their seams. From what he had seen of more recent analyses of Indian coal it looked as though they were on the whole a fair average set of specimens. He would be only too pleased to co-operate directly with the Geological Survey in making a further examination of selected specimens of coal from different districts, and then no doubt they would be able to state the quality of different parts of the same seam. With reference to Darjeeling coal, the analysis he referred to was not his own, but that of Mr. Mallet, of the Geological Survey, who had found in one specimen as much as 80 per cent. of fixed carbon with as little as 10 per cent. of ash. He (Professor Dunstan) would be glad to receive further information on the subject, and to examine specimens of the coal in question which had been mentioned as deserving further enquiry. Mr. Holland had raised an interesting question respecting vanadium. He had not examined the ash of Indian coal for this element, but Professor Hartley, of Dublin, had recently been examining a large number of minerals for vanadium. If Indian coal had not been included, he should be ready to supply Professor Hartley with specimens for that purpose. Mr. Rees had referred to the Mines Act. He (Professor Dunstan) had merely drawn attention to the subject, and had expressed an opinion in favour of caution in making such regulations which he was glad to find the Chairman fully recognised in the very important pronouncement he had made on this matter. He could not offer a satisfactory explanation of the fact that Indian coal, as a rule, was free from fire-damp; but the chemical constituents of Indian coal were probably not the same as those of English and Welsh. The matter had never been investigated, and it would require a considerable amount of chemical and geological research to settle it. With regard to the rainfall of South Wales and Assam, and the heating power of their coal, he did not think there could be any real connection between the two facts.

Sir GEORGE BIRDWOOD, K.C.I.E., in moving a vote of thanks to the Chairman, said that before submitting the motion to the meeting, he would like to make a few remarks on the paper, with particular reference to the discussion on it. The paper, which was one of great ability and practical utility, was also an impressive illustration of the admirable work now being done under the indomitable administration of Sir Frederick Abel, both in the Scientific and Technical, and the Commercial Intelligence Departments of the Imperial Institute, the results of which were equally enjoyed by India, the Colonies, and the United Kingdom; and at a cost which was, at least to India, comparatively insignificant. Professor Wyndham Dunstan had during the past ten years examined a very large number of Indian natural products of all kinds in regular, current, casual, or speculative demand; and had not only determined their chemical constitution but reported on their commercial value, work which can nowhere be so advantageously ascertained as in London. The speaker expressed the hope that when the Imperial Institute was reorganised—if he might apply so serious a word to what would be merely a formal change—as a Government Department, under the direct responsibility of the Board of Trade, that the technical and scientific side of the Institute might be extended and developed still further, if only so far as India and the Colonies were concerned, whatever the Treasury might refuse to do for the United Kingdom in its drooping commercial competition with the Continent of Europe and the United States of America. He would offer no detailed criticism of the masterly paper that had been read to them; but he had been much struck by the discrepancy between the tabular chemical statement of the relative values of British and Indian coals, and the statements of their comparative practical values as reported by the engineers of Indian steamships, railways, and factories. It seemed desirable, therefore, that there should be a continuous chemical examination, extending over a series of years, of those Indian coals, which were constantly varying in character, in order that their average value might be more or less closely determined; otherwise these chemical statements became practically worthless, if not absolutely misleading and mischievous. As to what Mr. Upcott said of the desirability of inducing the natives of India to use coal for fuel, and, again, tea for drink; why on earth should they drink tea, when the rice water they habitually drink is so much better for them and so much cheaper? And why should they use coal when wood is so much better for their open fires, and so much pleasanter and, again, so much cheaper? The wood collected by one man or woman about Bombay villages in three hours would last a native family from four to seven days, according to its size. He was delighted to hear of the improving prospects of Indian coal as the result of the constant strikes among our colliers at home. It was an object-lesson for both sides, the benefit of which would certainly not be thrown away on the keen-witted people of India. Passing now to his immediate duty, he would have wished, considering the high position and personal distinction of the Chairman, that the moving of the vote of thanks to his lordship had been entrusted to some one more worthy to

Summit it to that influential meeting. But he had one excuse for accepting the honour of acting as their spokesman on the occasion. Of the thirty years he had himself been employed at the India Office on special duties connected with the exploitation of Indian natural products at exhibitions, and in other ways, twelve had been served under Lord George Hamilton, and, therefore, with the exception of General Sir Richard Strachey, who they were all so pleased and proud to have among them that afternoon, he was probably better able than any one else to testify, not merely to the official, but to the spontaneous personal interest which his lordship had always taken in the economic well-being of India, and not only in the material, but in the moral advancement of the country. He (Sir G. Birdwood) was struck by this from the first year, 1873 or 1874, of his service under his lordship, who, from the very beginning had extended his confidence to him, and he could say, emphatically, that he never knew anyone more seriously and solicitously concerned in all that tended to promote the security and wealth, and health and happiness, and the pride and glory of the great historical people of India. Lord George Hamilton had already presided at lectures given before the Indian Section of the Society,—by Sir Charles Elliott in 1897, by Sir Mountstuart Elphinstone Grant Duff in 1898, and Mr. Athelstane Baines in 1900; and to-day, the occasion of the reading of Professor Wyndham Dunstan's invaluable and interesting paper, his lordship filled the chair for the fourth time in five years. He, therefore, most cordially moved the vote of thanks.

The vote of thanks was then carried unanimously.

Lieut.-Colonel R. GARDINER, R.E. (Chairman of the Madras Railway), writes:—

The details placed before his audience by Professor Dunstan satisfactorily established the position that India has within its limits a practically inexhaustible supply of coal of varying quality, but which, taken all round, is quite good enough for the generation of power for the various commercial purposes for which the provision of such power economically is a *sine qua non*. A point, however, which must have impressed itself on the attention of those who examined closely the maps exhibited, and followed carefully the details regarding the various coalfields, was that the bulk of the supply is concentrated in Bengal and the Central Provinces, and this concentration when the immense area, practically all India, to be supplied therefrom is taken into account, brings out the importance of the transportation question as connected with this most interesting subject.

North of the readily followed dividing line formed by the Great Indian Peninsula and East Indian Railways running from Bombay to Allahabad, west and east across the centre of India, there is practically no coal of real commercial value as yet known, nor is it likely in view of the extensive geological knowledge of India which now exists that any will be discovered which would be of more than local interest. All Northern India, Western and Southern Bombay, and the Madras Presidency, have to look towards the coal deposits of Bengal and the Central Provinces for their indigenous supply of an article on which so much of their future industrial development depends, and the expansion of the coal industry so located and the provision of adequate lines of communication therewith becomes, therefore, a matter of the gravest interest to these vast and important portions of the Indian Empire.

The development of the Bengal coalfields both industrially and in the matter of transport, as the figures and other details given by the Professor satisfactorily demonstrated, is making satisfactory, it may even be said rapid, progress. The areas over which coal getting has actually commenced, are being rapidly covered by collieries with modern equipment, and the district is conveniently served by two important railways,—the East Indian Railway, and its younger and energetic rival, the Bengal Nagpur Railway. There is little doubt, that between these two railways, the Bengal fields will be well served; not so promptly, or so satisfactorily, as would be the case if greater liberty of action was accorded to the Indian railway companies, in the matter of foreseeing and providing in advance, for developments of traffic, but still discounting such disadvantages, it may safely be said they will in the end be well served by these two great companies.

Professor Dunstan has indicated the general directions in which the further opening up of the immense coal deposits, in the area bounded on the north and east by the East Indian Railway system, and on the west and south by the Bengal Nagpur Railway, might best be pursued, and I endorse most strongly his recommendation that increased attention be given to the practical geological investigation of the mineral resources of India.

In carrying out the surveys necessary for determining the best means of developing the still unexplored fields, practical geological and engineering investigations should go hand in hand, and a systematic exhaustive geological and engineering examination of the best routes to be adopted should be made, either directly by Government or through the agency of the railway companies directly interested in the development of the area concerned.

What is required at the outset, is comparatively inexpensive reconnaissance investigations, the engineers being assisted by practical geological experts. Expensive location surveys may well be deferred until the actual construction of any definite portion of line is about to be undertaken. A knowledge of the approximate routes to be followed by the new railway lines of the near future, and information regarding such geological details as would be collected during the preliminary surveys, and the Government might deem it desirable to publish, would be of the greatest service to private enterprise, and doubtless

lead to the early opening up of new coalfields, and possibly of other mineral industries over this huge district, which is known to contain many valuable descriptions of mineral wealth.

As Professor Dunstan has pointed out in this valuable paper it is further most desirable, especially in the interests of Southern India, that the fields lying on the western side of the Central Provinces should have similar and early attention, and that either by a specially deputed Government staff or through the agency of the railways interested, the whole of the country from Itarsi on the north to the mouth of the Godavery on the south, shown on the Professor's map to be dotted over with coalfields, should be carefully reconnoitred by qualified engineers, assisted by practical geological experts. Coal would naturally be given the first place in such investigations, both on account of its importance for general purposes, and having in view its being a primary necessity for successful metallurgical operations; but at the same time, the other mineral resources of the districts traversed should be thoroughly examined. The country, speaking broadly, is known to be rich in minerals, and is probably waiting only for means of transport to give a start to their extensive development by private enterprise.

In his references to the railway communication question, which no one will fail to admit is a most important feature for consideration in connection with the subject of his paper, Professor Dunstan has briefly noticed the unsatisfactory state of the connections with Southern India.

An inspection of the railway map of India shows that between the Madras Presidency and the Central Province coalfields, from which it must apparently look, in the main, for its coal supply of the future, there is a vast belt of country bounded by the Great Indian Peninsula and Nizam's system of railways on the west, along the north and east by the Bengal Nagpur Railway, and on the south by the new East Coast Railway, absolutely devoid of cross communication, or practically, except along its boundaries, of any railways whatever. The length of this belt lying east and west is some 600 miles, and the width north and south varies, from some 400 miles at the west end, to 100 miles at the east, so that it covers the enormous area of not less than 150,000 square miles. I might enlarge here on the importance of providing this huge district with the security from famine that railways afford, with the administrative facilities that they supply, and the extent to which they foster and develop all the resources of the country which they traverse, but the point I desire specially to make now, in connection with the coal supply question, is the want of this cross communication. The absence of direct railway communication between the Madras Presidency and the rest of India other than Bombay has, I believe, had much to do with the isolation of the former and the comparative smallness of the intercourse and trade between that Presidency and India generally. This isolation has been partly broken down by the gradual opening out within the last few years of the railway east coast route between Calcutta and Madras, but Madras still wants and badly wants north and south communication with all Upper India *viâ* the Central Provinces.

This serious defect in the railway communications in general, and of the coal transport requirements in particular, of the Southern Presidency, could be remedied at once by two projects, to which I propose now to refer,—projects, both of which, are, I believe, capable of realisation in the immediate future, without inflicting practically any serious risk or liability on the finances of India, if only reasonable encouragement is given to private enterprise.

The first I will refer to, as the project has already taken a concrete form, is the proposed Raipur Vizianagram Railway. It would traverse the eastern part of the great railless (if I may coin the word) belt, to which I have referred, and by means of its proposed branch from Sointilla to Sonpur, which would doubtless be connected up with the Bengal Railway, *viâ* Sambalpur, would give an excellent railway connection with the coalfields of Bengal, and the Eastern Central Provinces.

The second project is for a great north and south railway to run from Itarsi through Nagpur down the Godavery Valley, and join up there with the East Coast Railway running into Madras. This new line would probably eventually extend still further to the northward through Jabalpur to Jhansi, and have in other directions connections with the Great Indian Peninsula Railway at Warora and with the Nizam's railway system at Warangal. Such a line would traverse completely the western part of the railless belt, and meet all the varied requirements of this district. Looked at from our present special standpoint it would afford facilities for the opening up of the Shahpur and Pench coalfields north of Nagpur, and the series of fields shown by Professor Dunstan to the south thereof, all of which would be on or in close proximity to its probable alignment, and bring them into close touch with the Madras Presidency.

The former project (the proposed Raipur Vizianagram Railway) has been already surveyed and detailed estimates of its cost prepared. Last year for a time it appeared in the Government list as a scheme to be taken up as soon as funds permitted. Financial considerations are believed, however, to have now relegated it to a back seat in the Government programme. Private enterprise has come forward and offered to carry through the scheme, but private enterprise in connection with Indian railways is not altogether plain sailing. Railways can only be built in India with Government permission, according to Government requirements, on an alignment approved by Government and subject to all sorts of Government rights, control, and general supervision. Under such circumstances private enterprise in connection with railways must always be a more or less joint stock concern with Government, and private en-

enterprise cannot get along without active sympathy and support from Government such as one partner receives from another partner in any successful business. No amount of public declarations on the subject can adequately supply such a requirement. In return for the rights and advantages which Government secures, it may well give a reasonable modicum of assistance, and it may further, I submit, judiciously adjust the form of that assistance to suit the conditions of the case, and not bind itself by hard and fast red tape regulations which, however suitable for some cases, may be fatal in others.

That the Government terms and attitude towards private enterprise can be modified and rendered far more acceptable, without any practical increase in the financial responsibility involved, I fully believe, and am confident that if some desire to smooth difficulties and encourage such enterprise were shown, there would soon be an important expansion of it, to the great advantage of our Indian Empire in many respects.

Before leaving this part of the subject I would like to refer to a portion of the remarks with which Lord George Hamilton wound up the discussion, and which seem to me to emphasize the importance of the private enterprise question to which I have referred. His lordship informed the meeting that the Indian Government had come to the conclusion that as regards their future railway policy they must make the first charge upon the capital funds available, the proper equipment of all lines that are in running order rather than scatter the capital in multiplying lines less efficiently equipped. Clearly this is not a cheerful prospect for those advocating additions to the present railway system of India, unless private enterprise is really encouraged to step in to supplement the Government programme. The meeting of the requirements of the great revenue producing lines to enable them to pour still larger contributions into the Imperial treasury, is certainly most desirable, but this is capital outlay that is directly and immediately reproductive, and the provision of it should not be allowed to check, as there seems every reason to fear it will check, the railway development of the country generally and through it industrial progress of all kinds. As has been urged more than once the treatment of the capital required for immediately reproductive works such as the expansion of a paying business, needs to be placed on a different footing from the provision of capital required for new projects which in the ordinary course must require a few years to develop.

My remarks on the aspects of the case touched on in the foregoing have taken up so much space that I must curtail what I have to say regarding the other points dealt with in this very interesting paper and the discussion which followed. The supply of labour for the collieries is not such an easy matter as it seemed to be considered by some of the speakers. The expansion of the coal industry in Bengal has been exceedingly rapid, and the consequent demand for a special kind of labour very great. That the demand will create a supply there is little doubt, but Indian labour, as indeed free labour all the world over, requires careful handling by people used to the customs of a country, and legislation in regard to it requires to move slowly and cautiously. No one will hesitate to approve of proper regulations for protecting the health and life of the workers provided you do not interfere unnecessarily with the old-established customs of the people. The remarks by Lord George Hamilton on this point, containing as they did a very clear indication of his views and policy, will, I feel assured, be received with approval by those associated with the industry in India.

The establishment of a School of Mines for India is clearly a move in the right direction, but too much must not be expected from it all at once. It must be borne in mind that the educated native is most unwilling to work with his hands, other than at clerical or similar employment, and this must be got over before you will get him to take to the training necessary to turn out good captains and submanagers of mines and eventually mine managers. Sir Richard Strachey, if he had had the time and cared to enlarge on the subject, could have told the meeting that in this matter, as in others, the East Indian Railway has not been behindhand. Some years back it placed its services at the disposal of Government for the training of engineering students from the Sibpur Engineering College at its Giridih mines, but those coming forward for the same were few in number, though the Bengal Government did what they could to foster the scheme.

A few words as regards railway freight rates. Indian railways have good reason for being fairly satisfied with the position they have attained to so far in the matter of their freight rates, the lowness of which compares favourably with those generally prevailing in any country, but I fully believe they can still go much lower, especially in connection with mineral traffic drawn by powerful engines in heavy trains with a high percentage of paying load such as can be got by the gradual elimination of all but well-designed modern rolling stock. When these changes have been carried through we shall see rates becoming customary that should have a marked effect on the coal-using industries situated at long distances from the coal-producing centres. For the coal export trade improved facilities will doubtless be given at Calcutta and possibly elsewhere, but though I have always held that Bengal coal should rank high in outside markets east of Suez, I rather question whether any very great expansion over the figures of the present (so-called) export trade can be looked for, partly, as I believe, that before long cheaper inland transportation rates will deprive this trade, of a portion at any rate, of the present sea-borne supplies taken at some of the Indian ports, and partly because we cannot shut our eyes to the increased competition it is likely to have to encounter as other sources of supply are opened up in the further East.