9-3-97 B.11

9.1.24 II

Public Works (1897) Department.

G.O., No. 351875

DATED 16th December 1897

[Despatch Abstract.]

Iron Ore: Pros Resume Dept's request for the issue of Orders for the deputation of a Subordinate for conducting the necessary blasting operations in Salem, in connection with the selection of two tons of — required for shipment to England. Comp'd to S.E. IV Circ. for necessary action!

Stats 16/12/97

[P. W. 25. 1,000—30-11-97.]

Indexed. 7/1

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

Public Works (1897) Department.

CURRENT No. 12076

B/ N: 3518 W 16.12.97

From The Revenue Department,

Order

Communicate to
the Inspecting Engr. IV Circle
who will at once depute
a competent officer
who has had experience of such work
subordinate to conduct
the boaring operations
that will be necessary.
2. The name of the
officer subordinate should
be reported to the Collector
of Salem and to the Chief
Engineer.

Cy

CTMS 16/12/97.

2 Hd Asst 17/12/97

I.S. IV Circle

Rev. dept 17/12/97

No. 1007.

Dated 3rd December 1897

Received 16.12.97

Registered

Enclosures 6

Spare copies

SUBJECT.

Passing orders on the subject of the despatch to Messrs. Bolchow Vaughan and Co. of a sample of Salem Iron ore and Indian Coal for the purpose of determining by experimental manufacture the value and cost of production of pig iron made from Indian ore with Indian Coke.

BACK PAPERS.

No.	Date.

FURTHER PAPERS.

No.	Date.

Government {1897} of Madras.

REVENUE.

Recd. } 1897. *Enclosures*

Regd. } *Spare copies*

G.O., No. 221, 30th March 1897.

MARCH.

Pig-iron.

Agreeing with the Board of Revenue in considering that it is desirable to despatch to Messrs. Bolchow, Vaughan and Co. of Middlesborough-on-Tees, a consignment of Salem ore and Bengal coal for the purpose of determining, by actual experiment, the value and cost of production of — made from Indian ore with Indian coke.

GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

Read—the following Proceedings of the Board of Revenue (Land Revenue), No. 24, dated 19th January 1897 :—

Read—the following Government Order, Mis. No. 127, Revenue, dated 9th January 1897 :—

Read—the following letter from the Government of India, Department of Revenue and Agriculture, dated 3rd December 1896, No. 4371/36–9 :—

In continuation of my letter, No. 2283, dated 26th August 1896, I am directed to forward, for the information of His Excellency the Governor, a copy of Military Department endorsement, No. 4915-D., dated 5th October 1896 and enclosures, being a report and letter by Major R. H. Mahon, R.A., on the question of working the Salem iron ores successfully. In this connection I am to refer to my letter, No. 2283, dated the 26th August 1896, to which a reply is still awaited.

Enclosure No.1.

Memorandum from Major E. G. BARROW, Officiating Deputy Secretary to the Government of India, Military Department, to the Secretary to the Government of India, dated Simla, 5th October 1896, No. 4915-D.

* From the Director-General of Ordnance in India, No. 2042-E., dated 21st September 1896, and enclosures.

Transferred * for favour of such action as may be considered necessary.

Enclosure No. 2.

From Major-General A. WALKER, Director-General of Ordnance in India, to the Secretary to the Government of India, Military Department, dated Simla, the 21st September 1896, No. 2042-E.

With reference to Military Department Memorandum, No. 4287-D., dated 28th August 1896, forwarding a Despatch from Her Majesty's Secretary of State, No. 75, dated 2nd July 1896, for record, I have the honour to submit a report and letter by Major R. H. Mahon, R.A., Superintendent, Foundry and Shell Factory, Cossipore, on the question of working the Salem iron ores successfully. The report and letter might be sent to the Madras Government and the Secretary of State for India. The day must come when these Salem ores will be put on the market, and any capitalist who may undertake the manufacture of iron and steel from these ores will, in my opinion, reap a rich harvest.

Enclosure No. 3.

From Major R. H. MAHON, R.A., Superintendent, Foundry and Shell Factory, Cossipore, dated Simla, the 17th September 1896.

I have read with interest the papers enclosed under the Right Honourable the Secretary of State's Revenue Despatch † No. 75, dated 2nd July 1896.

† *F. 36, S. 3.*

Mr. Head has dealt very effectively with a scheme having for its basis the export of Indian ores to England, but it would not appear that any proposal to export ores having a 200-mile railway lead, *plus* a 7,000-mile sea lead, by way of so expensive a route as the Suez Canal, would have any chance of success against Spanish ores quarried on the coast with 1,000 miles of sea lead, closely competing shipping companies and more suitable ore, or against Swedish ores, with rather greater leads.

It may be added to the statement made by Mr. Head that even should the Spanish Government place an export duty on ores, which is said to be probable as a result of recent events in Cuba, the immediate result would be to bring first other European ores, and then American ores, into competition, and to increase the output of the Cleveland mines. It is not at present within reasonable probabilities that any state of the European markets would enable Indian ore to compete.

It is equally futile to expect an iron industry, in the proper acceptation of the term, to grow from any scheme for using charcoal fuel only. Iron made by such means is adapted for special purposes and commands a special price, but for railway work and ship building, as well as for general trade purposes upon which it is indispensable that a country intending to foster its iron manufactures should rely, such iron would be altogether unsuitable. In no country and under no conceivable circumstances could charcoal fuel form anything but a small adjunct to that required for the iron industry proper.

It may be laid down as an axiom that entry into the iron and steel trade proper, without reference to special irons or steels, necessitates plant of the most modern description worked on an extensive scale. It may be of interest to note that the new blast furnaces of the Edgar-Thomson works are turning out 11,000 tons of pig iron monthly per furnace, while English practice, which has a strong tendency to follow the American, at present is best represented at Dowlais with 1,250 tons per week per furnace. And the question may be asked, would it be possible to compete with such outturns as these, having the reduction in general charges consequent on large business, with any outturn necessarily limited by the small supply of fuel available, 5,000 tons per annum as stated by the author, costing Rs. 24 per ton, as against about Rs. 11 or less, the value of the fuel in England and America. If a demand for tin plates, rolled sheets for pens, steel for cutlery, special steels for tools, and pig iron for special castings were likely to arise in India, the erection of a charcoal furnace might be justified, but to commence with such, leaving the great industries, which absorb $\frac{99}{100}$ lb. of the iron and steel of the world, untouched, would be the reverse of business-like.

Mr. Head dismisses the subject of the manufacture of iron with coke fuel in a few lines. But I submit that a further and closer attention on lines of more accurate local knowledge would repay the labour, and on this subject there are already valuable papers contributed by Mr. Gilchrist, F.R.S., and Mr. Mannaberg, a perusal of which, even though not dealing directly with Salem ores, would lead to useful results.

In regard to the detail of Mr. Head's report, I observe, for your information, that the cost of "collecting, mining, quarrying and picking" at Rs. 1¼ per ton (page 8—9 in Board's Proceedings, No. 361, dated 23rd September 1896, table No. 2) is probably too low. In my own paper on the subject I have taken 4*s.* per ton (= Rs. 3-4). I think Mr. Head is misled by the *present* cost of picking *surface* deposits, quarrying must, however, be soon resorted to which will be more costly. My figures are taken from average results at Bilbao mines, the working of which resembles that which will be used at Salem. On the other hand, 1*s.* per ton taken by me is an ample charge for loading, if proper appliances are arranged.

Mr. Head assumes a rate of 3 pies per ton mile, Salem, Madras : this is decidedly too low. At present the rate would be 6¾ pies. But in my paper I have taken ~~3·9~~, say, 4 pies per ton mile, this being the coal rate in Bengal. It is not probable that 3 pies (= ·22*d.*) could ever be attained. 3·9

With proper appliances I think loading at Madras may be reduced to 6*d.*, say, 7 annas per ton.

Probably Government would be content with a smaller seigniorage than 6 annas per ton assumed by Mr. Head. I have neglected this item, and I make the cost of Salem ore f. o. b., Madras 9*s.* 4*d.* per ton against 8*s.* 6¼*d.* I think the higher figure is the more correct.

In the cost of charcoal Mr. Head assumes Rs. 24 per ton which is not below the mark, and one ton as required per ton of iron : in his estimate, however, on page 24—21 in Board's Proceedings, No. 361, dated 23rd September 1896, clauses "*b*" and "*c*" he is certainly wrong in assuming 20 cwt. of Indian coke as sufficient per ton of pig iron. Nor is the cost per ton of Barrakur coke delivered in Madras correct.

In the matter of labour (table 11, page 18—17 in Board's Proceedings, No 361, dated 23rd September 1896), Mr. Head has adopted so high a figure, Rs. 17, that I think he must have followed Mr. Maylor's figures without full consideration. In 1858 the cost in labour appears to have amounted to Rs. 15 per ton (page 12, table No. 6), but if the enterprise is to be successful at all, the method of working would bear so little resemblance to the working in 1858 that the labour expended at that time must be reconsidered.

The most recent statistics (1896) show labour, including everything in connection with the blast furnace from unloading the ores to loading up the pig iron (excluding establishment charges), to be 24 pence per ton as a minimum rising to 30 pence for hematite iron, whilst establishment charges vary from 3 pence to 4 pence extra in England. Rs. 2¾ to Rs. 3½ was the estimate of Mr. Mannaberg at Barrakur (see also page 15, section IV of my report). Taking the highest figures (for England) we have 2*s.* 10*d.* = Rs. 2-4 against Rs. 21 for wages, salaries and establishment estimated by Mr. Head ! I can see no reason why the English price should be *exceeded*.

If the plant is planned on a suitable scale, one might, indeed, expect the reverse. My figures refer to coke-worked furnaces. I have no statistics before me here relating to charcoal iron, but it is impossible to imagine such a difference to exist. Mr. Head's high estimate may, perhaps, be governed by the small scale of the plant he had in view.

Page 18 (17 in Board's Proceedings, No. 361, dated 23rd September 1896).

The item "agent at port" Rs. 1¼ per ton is unnecessary and should be included in establishment charges.

Page 18 (17 in Board's Proceedings, No. 361, dated 23rd September 1896).

The item "stores and renewals" should not exceed 3s. (see bottom of page 15, my paper).

In the States this item is 2s. 10¼d. = say, Rs. 2-6.

In several points I observe that Mr. Head's calculations and opinions confirm what I wrote in 1894. In this paper I have made some corrections as I have found the railway lead, Salem to Madras, was wrongly stated at 240 miles. I have also added capital charges (wrongly included at first in general charges) in connection with the freight steamers, thus raising the cost of carriage per ton from Rs. 3 to Rs. 4½, and it may be noted that this rate only takes into consideration a small part of the utility of steamers on the outward voyage.

I append a statement in the form of Mr. Head's table 11, page 18—17 in Board's Proceedings, No. 361, dated 23rd September 1896, applicable to the Calcutta site—

	Rs.	A.	P.
Iron ore f. o. b., Madras, 1 ton 16 cwt. @ Rs. 8	14	6	5
Madras to Calcutta @ Rs. 4½ per ton	8	1	7
Coke fuel, 25 cwt. @ Rs. 13 per ton	16	4	0
Limestones, 10 cwt. @ Rs. 4-6-4	2	3	2
Stores renewals and sundries	2	9	6
Wages, salaries, establishment	2	6	5
Total ...	45	15	1

or £2-13-6 (see also page 15, Section V, my paper). Suitable hematite pig iron could not, at the present moment, be landed under £3-5-0.

Reviewing my paper again after a lapse of 2½ years, I am unable to find serious flaws in it, and the advantage derived from reading and criticising Mr. Head's report tends to confirm my opinion that, properly conducted and on a suitable scale, an iron work at Calcutta should be able to produce hematite iron suitable for all ordinary steel making at a price between £2-12-0 and £2-16-0 per ton.

The energy and enterprise that would be required in the manager of a concern, mining its own ore, fuel and fluxes, transforming the fuel to coke on approved principles, carrying and transferring with the latest appliances, and finally smelting, converting and rolling the products to rails and sections on a scale suitable to the demand, opens up a prospect to a capable individual which might excite enthusiasm in the least sanguine.

I have only to add that the proposal to send 300 tons of Salem ore to Messrs. Balchow, Vaughan & Co. should, I think, have the warmest support. If, after experimenting with the ore, that firm could be induced to take up the question of local manufacture either with or without Government assistance or guarantee, no more competent or enterprising iron-masters could be found, they having wide experience not only in acid steel making but also in the basic processes which would be applicable to the ores of Bengal.

P.S.—If the despatch of 300 tons of ore is approved, I recommend that 600 tons of Bengal coal, of a quality equal to the Sanctoria coal, may also be despatched to Messrs. Balchow, Vaughan, to be coked by them on principles most suitable to the coal and used in the reductions of the ore. By such means only can a reliable forecast of the quantity of fuel and flux be made, and further information of value in reference to the suitable size of blast furnace obtained.

MANUFACTURE OF IRON AND STEEL IN INDIA.

REPORT BY MAJOR MAHON, R.A.,

SUPERINTENDENT, FOUNDRY AND SHELL FACTORY, COSSIPORE.

DATED COSSIPORE THE 5TH MAY 1894.

		Page as given in the original.	Page as now printed.
SECTION I.	—The question of site	1—4	7—10
,, II.	—Extent and nature of trade	4,5	10
,, III.	—Nature and cost of raw material	5—10	10—15
,, IV.	—Labour and cost, also total cost	10	15
,, V.	—The ultimate cost of pig iron	10, 11	15—16
,, VI.	—The capital required	11, 12	16—17

Note.—I have selected throughout for general comparison the cost of manufacturing Hematite iron in the West of England, as exponent of the best English practice; and at Pittsburgh, United States of America, as exponent of the best American practice.

Note.—The figures representing price are in most cases in shillings and pence, exchange being taken at 1s. 2d.

Enclosure No. 4.

SECTION I.

THE QUESTION OF SITE.

In this country I regard contiguity to the seaboard practically essential. Not only is it improbable that juxtaposition of ores, fuel and flux is likely to be found in any one place of a suitable nature for Bessemer * work, but it is improbable that any successful works operated on a large scale could work profitably at an inland site in this country, at least until the lapse of a great number of years, when competition between different railways, canals, or other means of transit ensure low freight.

It may be argued that carriage landward may be ultimately necessary, but it must be remembered that in this country no landward position is central to a large area of supply, and when the radius, within which profitable freight is possible, is satisfied, production must be checked by the supplies coming from more favourably situated sources. A seaward site on the contrary is enabled to tap landward communications from many points, as also to open up new communications with other countries.

On the other hand, the fact must not be lost sight of that it takes from $3\frac{1}{4}$ to 5 tons of material to turn out one ton of pig iron, depending on the richness of the material used; and one of the main questions in deciding on site is the cost of conveyance of raw material to the works *versus* the cost of conveying finished material from the works. But this is not the only question; proximity of suitable labour and healthiness is an important point, especially in this country.

Examination of existing instances will help a decision.

In Great Britain the most favourably situated districts—the Black Band Field of Scotland and the Cleveland districts of the east coast of England—are perhaps the most notable instances † of works so situated as to draw all their material from the immediate neighbourhood, but in neither of these is the ore suitable for the production of Bessemer iron, and in both, for this purpose, importation either of ore or fuel is necessary.

The main areas of the occurrence of Bessemer ores are—

The Bilbao District, Northern Spain,
The Island of Elba,
The Cumberland and North Lancashire Districts,
The Lake Superior region in America,
In India, the Salem District.

See also note at the end of Section III.

At Bilbao the small works of Messrs. Ybarra are worked almost entirely from coke imported from the Durham District about 1,000 miles distant, while the greater part of the ore raised is exported to English works there to be worked in greater or less contiguity to the fuel.

In Cumberland and Lancashire the ores are worked entirely with coke brought from the Durham Fields.

In America the greater part of the ores are conveyed distances of 650 to 1,000 miles to the works situated in Pennsylvania and the North Eastern States, and worked with coke from the Connelsville coal.

We have here instances in which ore is brought to fuel and fuel to ore; the site in each case being governed by proximity to one or other, and also very largely by its proximity to a trading centre. It is, however, evidently possible, and is in fact frequently the case, that a work may be situated at a place intermediate between the ore and fuel.

In England the great iron work centres are on the Tyne, Tees, Clyde, Mersey, or at seaports, as Cardiff, Newport, Swansea,—or at the centres of a network of railways as Sheffield. In America the neighbourhood of Pittsburgh and Chicago with their immense convergence of railways are instances of inland situations.

In India the want of a convergent railway site practically reduces the question to a choice of seaboard or at least water approached situations. And in this respect the coast of the Bay of Bengal appears to offer the greatest advantages.

Some statistics on the cost of assembling materials at different centres will be useful.

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* By Bessemer ore or Bessemer iron is meant ore fit for steel making and containing a maximum of ·04 per cent. phosphorous.

† Almost the only instances.

	Pence per ton per mile.
United States, distances of 101=150 miles	·436
Do. distances of 630 miles	·226
United Kingdom, distances of 101=150	·650
India, distances of 240 miles	*·5
United States, distances of 1,000 miles, partly by rail, partly by water	
Europe, Spanish coast to Tyne	·128
India, Madras coast to Calcutta	·07
India, Salem to Calcutta	†·07

the total distance being about 1,090 miles from Salem to Calcutta.

At Pittsburgh and the West of England, both using hematite ore, the cost of production is as under:—

	Quantity used per ton of pig iron.		s. d.	s. d.
Prime cost of ore at mine	35·8 cwt.	@	~~8-6~~	11-7¾
Coke	21·0 „	@	7-9·33	8-2
Limestones	10 „	@	1-4·5	0-8¼
Conveyance of material—				
Ores	to Pittsburgh.	@	10-1½	... 18-2
Coke		@	5-3	... ~~5-6~~
Limestone		@	1-8	... 0-10
Labour		...	...	... 5-9
Other charges		...	...	... 3-0
				2-13-9

West coast of England—

				£	s.	d.
Prime cost of Ore 37-1 cwts. @ 8-0						
Coke 21 „	@	8-11½	... ...	0	14	10
Lime 10 „	@	1-10½	... ...	0	9	5
Conveyance Ore @ 1-2	...	...	... ...	0	1	0
Coke @ 7-3¼	...	...	... ...	0	2	2
Lime @ 1-0	...	...	... ...	0	7	8
Labour	...	...	... ...	0	0	6
Other charges	...	...	... ...	0	2	9
			Total ...	0	2	0
				2	0	4

And similarly examined approximately for India (*established near Calcutta*).

				£	s.	d.
Prime cost	Ore 36 cwts.	@	4-8	0	8	5
„	Coke 25 „	@	7-8½	0	9	7½
„	Lime 10 „	@	1-0	0	0	6
	s. d.					
Conveyance	Ore @ 12-5	...	... ...	1	2	4
	Coke @ 5-1	...	... ...	0	7	4
	Lime @ 4-1	...	... ...	0	2	0½
	Labour ...	...	... ...	0	2	0
	Other charges	...	... ...	0	2	6
			Total ...	2	15	9

If the steel works were established at Girideh, the cost might be shown to be considerably higher.

In other words, to establish the works near the fuel and convey the other material thither appears to be more costly than an intermediate site.

These figures show that the cost of conveyance and the distances over which the raw material is brought do not greatly differ in this country and the United States. It also shows that the intermediate position of Calcutta would be more profitable than the immediate neighbourhood of the coal. While a very important item referred to more extensively below renders the neighbourhood of Calcutta preferable to the neighbourhood of the ore, *i.e.*, Salem, Madras. (But see note on Salem.)

s. d. 1-2

* Exchange 1s.=1 R., calculated from 6·75 pies per ton mile.

† See calculation of freight.

The items susceptible of reduction are—

(1) The prime cost of coke.
(2) The conveyance of ore.

The former being reduced by the coking and coal works being within the same ownership as the steel works; and the latter by the vessels, especially built for the trade, being owned by the Company for the *export of coal to Madras* and the import of ore on the return journey. There is little doubt but that the profits on the export of coal to Madras would go far to reduce the cost of bringing up the ores on the return journey. And the advantage of being able to carry an item of such prime necessity on the outward voyage is the deciding factor in the site of the Indian steel works. I cannot suggest any other site from which coal could be cheaply shipped to Madras on the outward voyages.

Taking the foregoing into consideration, I believe the neighbourhood of Calcutta is the most advantageous situation. And it would appear probable that the advantages offered by Port Canning, and the probability that, together with its existing appliances, it would be obtained advantageously, leads me to point to it as the best site.

The only other place on the Bay of Bengal which could apparently compete would be the neighbourhood of Cocanada, working the Singareni Fields, but the want of facilities for transit and the fact that all the district is a century behind the Bengal area leads me to neglect it in favour of Calcutta.

Note.—The neighbourhood of Masulipatam on the Madras coast is a site which would have advantages which should certainly be considered.

It has practically the same market as the Calcutta site.

Could be connected by rail with the Singareni Field.

The difficulties and expenses can hardly, however, be calculated, as the east coast ports are closed frequently during monsoon weather. The country is but little opened up, and the coking quality of Singareni coal is doubtful.

The question should, however, be carefully gone into before pitching on the Calcutta site, of which these notes take detailed notice.

NOTE ON THE SALEM SITE.

The cost of the assembled materials appears to be—			£ s. d.
Ore @	s. d. 4 6	per ton	0 8 1½
Lime @	1 6	„ „	0 0 9
Coke (as under)			1 15 10
		Total ..	2 4 8½
Coke.—25 cwts. at Calcutta			0 16 10
Calcutta to Madras			0 5 0
Madras to Salem			0 12 0
Handling 3 times			0 2 0
		Total ..	1 15 10
The resultant cost of the pig at Salem is then—			2 4 8½
Material			0 5 10
Labour, &c.		Total ..	2 10 6½

But as 90 per cent. of the finished product would require transportation to the coast, an additional 10 shillings must be added before it can be compared with the cost of the pig at the Calcutta site: the result is £3-0-6½ and is unfavourable.

But the question is evidently one of the price of coke, and calculation shows that, if the price can be reduced to a total of 28 shillings per ton of pig iron, the Salem site would not be impossible, although advantage would still lie with Calcutta as a trading centre with facilities for shipment.

To the extent, however, that it remains uncertain whether a coking coal will be ultimately procured in the neighbourhood of Salem, the establishment of the works at Calcutta contains an element of hazard. The point is one regarding which the promoters should well satisfy themselves.

ADDITIONAL NOTE ON SINGARENI.

According to the terms of the scheme put forward for establishing steel works in the neighbourhood of the Singareni Fields, the conveyance cost of the finished product is put at—

	s. d.
From works to Gódávari, 182 miles by rail, say	4 3
Gódávari to Cocanada, 50 miles by boat, say	4 1
including handling on shipboard in harbour.	

The pig iron being estimated to cost as under:—

		Rs. A. P.
40 cwts. iron stone @ Rs. 3 per ton		6 0 0
40 „ coal @ „ 4 „ „		8 0 0
15 „ limestone @ „ 2 „ „		1 8 0
Labour		2 0 0
Stores		1 4 0
Office		1 4 0
	Total ..	20 0 0

or at 1/2 say £1-3-4
or at coast say £1-11-8

In this scheme it is proposed to work on the anthracitic method—that is, using raw coal of an anthracitic nature instead of coke.

This method has been used with some success in America, in the neighbourhood of the well-known Pennsylvanian anthracite which contains from 87·127 to 90·685 of fixed carbon, but the mechanical difficulties met with have caused a very large reduction of the output of iron made in this way.

In 1880 the output of iron smelted by anthracite was 1,807,651 tons; in 1890 this had fallen to 279,184 tons, and it is also stated that in the Northern States only one furnace continued on this method in 1889 out of 66 formerly at work.

Moreover, it is in the last degree unlikely that the Singareni coal contains anything near the same quantity of fixed carbon that is contained in the anthracite alluded to.

For this reason it may be most reasonably assumed that coke * will have to be brought from Bengal at an all-round tare, including conveyance, of not less than 30/ per ton, or for 25 cwts. say 37½, which would bring up the price of the finished product on the coast to £3–1–6, a price which would not compete with the rates at the proposed site.

SECTION II.

THE EXTENT AND NATURE OF TRADE.

In this country, as in most others, the railways must be the main support of any steel and iron works, and the growing tendency of the Great Indian Railways to be their own manufacturers is a factor in the question that must not be neglected. In England the railway directorate is very largely composed of men interested in the production of manufactured iron and steel, and this has resulted in but a small amount of manufacture being undertaken by the railways themselves; in at least one railway (the Midland) the interest against steel-making was so strong as to cause its abandonment even after erection of furnaces. In India no such interest is likely to come into play, and there is nothing to prevent the Railway Companies from competing against any individual establishment which might be started.

The best means to take is to prepare for manufacture on a scale and with a completeness of apparatus which would enable the material to be turned out cheaper than it could be made by the Railway Company or imported. An instance of the possibility in securing trade as a monopoly by the reduction of cost of outturn is given by the results of the great Carnegie steel works of Pennsylvania. This Company having completed their works on a scale of unequalled perfection have reduced the price of their rails by 4 dollars per ton; cutting out the profit at which the best equipped of the remaining works in America can work and securing a practical monopoly of orders within a very large radius.

The manufacture of rails themselves is the chief production. In this country there are undoubtedly immense possibilities. Given a stable currency and a consequent great inflow of European capital and enterprise, the railway system must grow largely. It at present consists of some 20,000 miles of rails, and a moderate estimate would give 250,000 tons as the requirement annually. Say 600 tons per week, this would not be more than would be required to give full occupation to a rail mill of moderately large size.

angle bar,

The manufacture of ~~angle-bar~~, rod, galvanised sheet, plate, wire†, beams, girders, pipes nails, screws, amounts to about 200,000 tons more as judged by the amount at present imported.

Given therefore the possibility of placing at any point of the coast line or in any Eastern country any of the above detailed items at a lower rate than the same can be imported from Europe, there seems to be sufficient trade for 500,000 tons of finished iron and steel annually, which is amply sufficient for a complete works on a large scale in full work. Moreover, this estimate is likely to increase rather than the reverse for many years to come.

In the United States of America, with a population of 62 millions, it is not unusual for 10,000 miles of new rails to be laid in a year.

In India, with a population 4 times greater, barely 500 miles of new rails are at present laid annually.

The production of rails in the United States of America amounts to over one million of tons annually, and in the United Kingdom about 400,000 tons.

fine

The average life of a steel rail in India with low speeds and small traffic may be taken at the outside at fifteen years, which alone would give a production of 160,000 tons annually (at 120 tons per mile) without extensions. Extension to the extent of 500 miles only, which must be enormously exceeded sooner or later, gives 60,000 tons more. It is reasonable to count on 250,000 tons of annual requirement within the next ~~five~~ years.

SECTION III.

THE NATURE OF THE MATERIAL REQUIRED AND OBTAINABLE, AND ITS COST.

(*a*) *The Ore.*—Appended is a table showing the approximate constitution of ordinary hematites from the chief centres:—

—	Furness ores.	Whitehaven.	Spanish.	Salem.
Iron	60·5—66	66·6—68·7	54·6—56	67·76
Phosphorus	TR.	TR.	TR.	TR.
Sulphuric Acid	·11	·09	·01—·03	TR.
Residue, chiefly silicious	5—14	1·5—4	10—10½	4·72

* Assuming as appears to be the case that the Singareni coal is non-coking.

† 6,000 miles alone would be taken annually by the Telegraph Department.

The working of hematite ores in the blast furnace, specially for the production of Bessemer iron, often present considerable difficulties. As a rule, the hematite furnaces in the English districts are smaller than those working on the Cleveland and other non-hematitic irons. The Cumberland hematites contain very little alumina, and in consequence the slag found is trouble-some to deal with. To avoid this, it is customary to mix a proportion of aluminous Irish ores, the best of which from Red Bay contains about 20½ per cent. of Al_2O_3. From 3 to 4 cwts. are required.

There is little doubt, but that the magnetite of Salem would require similar treatment owing to the quartsose nature of the gangue. There would, however, be no difficulty in obtaining aluminous ore for the purpose of mixing with it.

In this respect the red and brown hematites of Spain, though probably on the whole poorer in iron than the English or Salem hematites, are much sought after on account of the facilities they offer for the extraction of iron.

The main consideration in the mining of Bessemer ores, *viz.*, freedom from phosphorous, very greatly reduces the available quantity.

In England an average output of 14 millions of tons of ores contains only 12½ per cent. fit for acid steel manufacture, the total make of Bessemer pig being only 17 per cent. of the production of 7½ millions of tons.

The richest deposits are those of the Furness and Whitehaven districts, of which the analysis is given above, the Park, Roanhead and Askham mines in the Furness District being mined at from 12 to 70 fathoms in depth.

The Lake Superior mines are worked at depths of from 100 to 120 fathoms.

The Spanish ores are quarried in the open on the hill sides.

The methods possible in the Salem district will be very similar to the latter.

The cost of collecting iron ore in the United States is estimated at—

	£	s.	d.
Labour	0	4	3¾
Officials	0	0	2½
Stores and repairs	0	1	6
Taxes	0	0	1¾
Interest and depreciation and insurance	0	0	6
Royalty	0	0	10¼
Total ...	0	7	6¼

In Lancashire and Cumberland the cost of raising and collecting is put at 7/ and 8/, respectively.

In Spain the labour in quarrying is from 1/ to 2/6 per ton, the ore being delivered in ship in Bilbao river at 7/ per ton.

The ore is carried from the mines about 1¼ miles to the sea by complete system of wire tram-lines, inclined planes and railways or combinations of all three. Some 700,000 tons are, however, still carried annually by bullock cart at a cost of *s.* 2/1 to *s.* 2/9 per ton.

It would appear then that the cost of the raised ore at Bilbao mines is from *s.* 3/6 to *s.* 4/ at the quarries.

Of the 2¼ millions of tons raised, 70 per cent. is exported to England, the cost in the Tyne being *s.* 12/ to *s.* 12/6 (at present * about *s.* 13/).

A consideration of the foregoing leads to the estimate that, with complete appliances for conveying the ore from the Salem quarries to the railway, which is situated at the foot of the hills, the cost of ore placed in trucks should be somewhat less than the cost on ship in Bilbao.

8
4/-

Say ~~4~~ for raising and collecting and *s.* 1/ for loading or *s.* 5/ per ton in truck. And work on a larger scale should reduce this to *s.* 4/8 per ton or *s.* 8/5 per 36 cwts.

The cost of conveyance of ore to various works from mines may be taken as under:—

		£	s.	d.
Cumberland works local @ 1*s.* 2*d.*	36 cwts. cost	0	2	2
Middlesborough (from Bilbao) 9*s.*	do.	0	16	2
Pittsburgh at 10*s.* 1½*d.* (Lake Superior)	do.	0	18	2
Calcutta (Salem)	do.	1 to 0	2 to 19	4 to 0½

see note, page 9.

The latter item of cost, which is one of the most important in the whole problem, is calculated as follows:—

Railway freight, Salem to Madras, 200 miles—the Company at present offers to convey at 6·75 pies per ton per mile, a total of Rs. 7–0–6 for the distance and calculated at 1/2*d.* per rupee: this equals ·5*d.* per ton mile. The freight in the United States comes to about ·436 and

* 1896.

in England to ·650. There seems no immediate probability that the rate would be reduced below the sum named; it is possible, however, that the Madras railway not being well off for freight and the traffic in ore being probably a large one would reduce the cost to ·4*d.* per mile. The more so as coal is now carried on Bengal railways at ·28*d.* per ton mile.

Calculated at this rate (·4*d.* per mile), cost of conveyance to Madras is *s.* 6/8 per ton.

The onward transit to the works in Calcutta must be unquestionably by steamers belonging to the Company; and an arrangement must subsist between the Company and the Madras railways by which Bengal coal is delivered for their consumption.

It is probable that steamers of moderate size, capable of carrying 2,000 tons of cargo, would be found the best for the trade, to lie up to the Madras jetties and to navigate the Mutlah river at all stages of tide. Larger steamers might, however, be found economical.

For purposes of calculation assume a 2,000-ton steam vessel—

		Rs.
Monthly cost of crew	...	8,000
,, of coal	...	8,000
,, of sundry stores	...	1,500
,, of repairs	...	1,500
,, of port dues	...	1,000
,, of pilotage	...	1,200
,, of sundries	...	800
	Total ...	22,000
Interest and depreciation at 14 per cent. of "block"	...	5,000
	Grand Total ...	27,000

Assuming 36 voyages per annum and a carriage of 72,000 tons of ore inwards and, say, 15,000 tons of coal outward per ship used, also assuming a profit of Re. 1 per ton of coal up to 150,000 tons landed in Madras, the cost runs out to Rs. 4-8 per ton of ore brought to Calcutta.

This rate would enable best Bengal coal costing on truck at the mine —

say Rs. 2.
at Port, say Rs. 6¼ per ton.
at Madras, say Rs. 10¾ per ton.
to be sold at Rs. 11¾ per ton.

In support of this calculation it is believed that market in Madras would be found as under:—

	Rs.
Madras Railway consumption, tons 50,000, average present cost.	12·39 per ton.
South Indian Railway consumption, tons 65,000, average cost ...	15·03 ,,
Foreign lines and public, tons 35,000, average cost (landed on West coast), English coal	16
Singareni coal on Southern Mahratta Railway	Rs. 10 1 6

It would therefore appear inside the possibilites to place Bengal coal which is to English coal as ·85 : 1·125 at Rs. 11¾, or even more.

Singareni coal would undoubtedly compete close at all events for the foreign line traffic, but this coal is said at present to cost Rs. 6 per ton on truck at pit, and has a long railway lead to nearest foreign railway.

Assuming therefore Rs. 4½ per ton as the cost of carriage of ore from port of Madras to port of Calcutta or 5*s.* 3*d.* per ton, plus handling charges at 6*d.*, the cost of transfer from Salem to Calcutta amounts to 12*s.* 6*d.* * or 22*s.* 4*d.* per 36 cwts.

Note.—Should a traffic of 700,000 tons of ore be taken over the Madras line, the ore would no doubt be carried at the same rate as coal in Bengal—say 4 pies per ton mile—and the conveyance of ore would reduce to 10*s.* 7*d.* † or 19*s.* ½*d.* per 36 cwts. from Salem to Calcutta.

	s.	*d.*
* Rail ...	6	8
Handling ...	0	6
Sea ...	5	3
Total ...	12	5

	s.	*d.*
† Rail ...	4	10
Handling ...	0	6
Sea ...	5	3
Total ...	10	7

Coke.—There is no more important problem in the whole question than that of procuring coke, not only of proper quality, but also at a reasonable cost. And it is most unfortunate that at present no coal is worked in India which can be said to be a thoroughly good coking coal.

The approximate constitution of the better known cokes is—

	Sulphur.	Ash.	Volatile.	Carbon.
Durham	·7	5·0	·92	93·38
English Ordinary	·8	5·45	5·4	88·69
Connelsville, U. S. A.	1·0	10 to 12	...	88
Indian (Damuda)	·51	14·63	10·18	75·19

From this it appears that, though the Indian coke is remarkably free from sulphur, a fact that would have a beneficial effect on the pig iron, it is considerably lower in carbon. It is doubtful whether this sample is the best coke obtainable, but it is probably representative; and its value, other things being equal, is ·83, coke of 90 per cent. carbon being taken as unity.

The cost of raising bituminous coal is as under :—

United States	*s.* 4-3·77
Great Britain	*s.* 4-8·22
India	*s.* 2-4 to 3-7·2
And the cost of coke at the ovens—	
United States, average	*s.* 7-9·33
Great Britain ,, ...	*s.* 8-11·5
India (say)	*s.* 7-8·4

This is made up per ton of coke—

	Coal.	Cost.	Labour.	Sundry.	Total.
	cwt.				
United States	33·86	6-0	1-6·44	0-2·68	7-9·3
Great Britain	33·02	6-8·25	1-7	0-8	8-11·5
India	38·0	5-8·4	1-0	1-0	7-8·4

The cost of conveyance to the blast furnace is—

	cwts.			
Pitsburgh (Connelsville)	21	@ *s.* 5-3		*s.* 5-6
Cumberland (Durham)	21	@ *s.* 7-3¼		*s.* 7-7¾
India (Giridih) 210 miles ... at 2·7 pies ... per ton mile ...	25	@ *s.* 5-1		*s.* 7-4¼

The ultimate cost at the blast furnace is—

	cwts.		
United States	21	... ...	*s.* 13-7·2
Cumberland	20	... ...	*s.* 17-0·5
India	25	... ...	*s.* 16-11¾

The Connelsville coking coal of Pennsylvania is composed—

Water	1·26
Volatile	30·107
Carbon	57·616
Sulphur	·784
Ash	8·233

English Durham coking coal is—

Volatile	26·00
Carbon	66·21
Sulphur	1·69
Ash	5·96
Water	1·13

And Indian is as under—

	Damuda.	Sanctoria.
Volatile	40·57	40·07
Carbon	48·04	48·48
Ash	11·39	11·45
Sulphur	·3	·3

In the question of hardness, Indian coke fails considerably, although it is at the outset a denser and heavier coke than English, the weight of a cubic foot of each being approximately—

	lb.
English	50·8
Indian	52·3

The crushing weight, which is an important consideration in connection with the size and burden of the blast furnace, is in favour of English coke by nearly 2 to 1. The Indian coke having a poor coherency, to what extent this would be improved by coking on a large scale and on scientific principles cannot at present be determined. The crushing weight actually found per square inch is—

	lb.
English, about	500
Indian „	~~025~~ 250

These figures can, however, only be taken as comparative owing to the difficulty of determining when disintegration commences. In the United States a series of experiments showed the weight of coke to vary from 42 to 55 lb. per cubic foot and to crush under 200 to 281 lb. per square inch. Tested by these figures, the performance of Indian coke may be regarded as fair.

It is not improbable that manufactured under best conditions a fair blast furnace coke would be produced, but it would not be safe to count on a less expenditure than 25 cwts. per ton, and even this only under best conditions of ore and flux, both of which may be counted on.

Limestone.—It is rare in European or American blast furnace practice to find the selected site without good limestone in the immediate neighbourhood. The South Stafford and vicinage of Glasgow are, however, exceptions, and in consequence the limestone used at these places cost 5*s.* per ton at the works.

In the States the average cost is per ton—

Labour.	Stores, taxes, &c.	Total cost.
1-1·65	0-2·95	*s.* 1-4·6

In Cumberland the figures are—

Labour.	Stores, taxes, &c.	Total cost.
1-1	0-5½	*s.* 1-6½

The cost of conveyance reckoned at 10 cwts. per ton of pig is—

	Rs.	A.	P.
United States, 10 cwts., @ *s.* 1-8	0	0	10
Cumberland 10 do. @ *s.* 1-0	0	0	6

The average composition of English (Stainton) stone is—

	Per cent.
Carbonate of lime	95
Magnesium carb	4·2
Silica	·6
Iron, Aluminium, &c.	·3

In the case of the Indian steel works at the selected site, unfortunately limestone does not exist, and the problem will be to place a suitable limestone at the works at a "possible" price.

The landward limestones may be at once neglected, as the cost of carriage would amount, even in the case of the nearest, to over 6*s.* per ton.

It appears, however, that by a well organised system the limestones of the Arakan Coast could be placed at the works at a cost which would make its use feasible. The island of Ramri, distant about 400 miles, is, so far as I am at present aware, the nearest source, but it is more than probable that the hilly ranges of the northern coast of Burma would be found to yield a supply closer at hand.

The Ramri limestone appears to be well suited to the purpose, and is available in inexhaustible quantities. At a place called Bamni, somewhat further south on the same coast, an even better stone is procurable. The analysis of both is given—

	Ramri.	Bamni.
Carbonate	94·4	96·4
Magnesia Carbonate	·5	...
Iron, &c., and metal	5·1	3·1

Of this stone, 10 cwts. per ton may be taken.

The cost of getting and loading of the large quantity required is assumed at 1-0 per ton, proper appliances being provided.

The carriage by water the whole way should not exceed Rs. 3½ per ton, or, say, 4*s.* 1*d.*, total at the furnaces 5*s.* 1*d.*

We have then in comparison—

		Cwts. per ton of pig at 10 cwts.
United States	@ 3*s.* 0·6	1*s.* 6*d.*
Cumberland	@ 2*s.* 10·5	1*s.* 6*d.*
India	@ 5*s.* 1	2-6·5

resultant cost of material.

Examination of the foregoing shows cost of raw material at furnaces to be, including raising and conveying—

	Ore.	Fuel.	Lime.	Total.
United States	1 9 10	0 13 8	0 1 6	2 5 0
Cumberland	0 17 0	0 17 1	0 1 6	1 15 7
India	1 10 9	0 16 11¾	0 2 6½	2 10 3
or see note	1 7 5½	0 16 11¾	0 2 6½	2 6 11¾

Note.—Analysis of some of the purer Indian ores is as under, but it is doubtful if any of them would be available in sufficient quantity without admixtures of impure ores, and, so far as I can see at present, the importation of Salem ore is a necessity.

Red hematite from Aguria iron	59·6	Phos.	07·8	Sul. ·08
Iron Sand from Jherria iron	68·97	,,	·03	,, ·06
Iron stone from Purulia	46·5	,,	·02	,, ·02
Iron ore from Wun	49·8	,,	·04	,, ·04

SECTION IV.

The Labour and cost, also sundries.

The mean labour per ton of pig in the United States is given over a very large number of examples at—

	s.	*s.*
Labour	7-11	8-4½
Officials, &c.	0-5½	

In England the figures are—

	s.	*s.*
Labour	2-9½	2-11¾
Officials	0-2¾	

In India the cost of wages was estimated for the Barrakur Steel Works project at—

Rupees 3½ to Rs. 2¾ per ton, including officials, or *s.* 4–1 to 3–0½. But it is scarcely conceivable that in a large works in full employment and using the most modern appliances the cost of labour should exceed that in England. It should even be somewhat less. It may be assumed at—

s. 2-11-¾ per ton of pig iron.

Sundry charges, including stores, repairs and taxes are given at—

States	2-10¼
Britain	1- 9¼

The former figure would be the safest to assume in this country.

SECTION V.

The ultimate cost of pig iron.

The foregoing shows ultimate cost of pig iron to be—

	Material.	Labour, &c.	Total.
United States	2 5 0	0 11 2¾	2 16 2¾
England	1 15 7	0 4 9	2 0 4
Indian { From	2 6 11¾	0 5 10	2 12 9¾
Indian { To	2 10 3	0 5 10	2 16 1

From the above it is clear that competition from the States is out of the question. It might, at first sight, be considered that English hematite should easily compete in the States with the local production. But an import duty of 28*s.* per ton, in addition to freight, more than squares the balance, and leaves the American pig iron a clear field for home consumption.

The *selling* prices of English hematite iron are given below :—

1890	32-0 to 49-4		
1891	53-3 „ 47-1		
1892	57-6 „ 60-0	F. O. B. Cumberland ports.	
1893	46-6 „ 44-7		
1896	60-0 „ 70-0		

The minimum price may be taken at 45/-, and freight to India is unlikely in any year to fall below 10/-; deliveries ex-ship in Indian ports would be therefore :—

		£.	s.	d.
English hematite (minimum)		2	15	0
Indian „		2	16	1
	Calcutta ...	to 2	12	9
	Bombay ...	2	18	9

And in taking the above rates for English pig it must be noted that they are minimum, whereas in India they are average.

A more average comparison would be; India as above—

	£
England	3

Taking one year with another, the rates of delivery of pig iron would apparently allow competition with English pig of similar quality in any port of India, and considerable profit in Eastern India.

A small import duty on English pig would settle the question undoubtedly in favour of Indian pig.

Note.—The distances over which the materials have to be carried to works in various sites may be given as under :—

—	Ore.	Fuel.	Limestone.
England, West coast	Adjacent ..	100	Adjacent.
Do. East coast	850 miles ..	200	Do.
States, Pittsburgh	1,000 miles ..	70	Do.
India, Port Canning	1,090 miles ..	240	400

SECTION VI.

The Capital Required.

Since an Indian steel works will be within a freight distance of 15*s.* to 20*s.* per ton of the cheapest and most perfectly equipped iron-producing country in the world, and will be moreover weighted by sundry charges due to distances and assembling of materials, it may be premised that it would be utterly futile to commence any commercial concern unless on a large scale and with all the most modern appliances. Any supposition that the works might commence 'small' and grow from its profits would most infallibly produce only failure and disappointment. A bold and complete programme carried out unflinchingly by a powerful Company with ample capital could alone hope for success, and, as has already been stated, it must be on a scale large enough to prevent the formation of other concerns, causing sub-division of orders.

The margin in favour of profitable working is too small to allow of dependence on intermediate agencies, as collieries, shipping agents, iron mines, &c., and the Company must be prepared to own its coal, ore, limestone, ships, &c., as well as the steel works itself and all the appliances connected.

The extent of the plant—concessions to be sought—depends on the outturn; and this again depends, to a geat extent, on the possibility of a return trade to the port of Madras for the outward vessels.

Undoubtedly it is a question of serious moment, not only to be limited in the extent to which inward supplies can be profitably carried, but also to have the element of uncertainty as to the extent of the market available for outward freight.

In the foregoing it has been assumed that for every 72,000 tons of inward ore freight 15,000 tons of outward coal could be carried to a maximum of 150,000 tons. The ore supply is thus limited to 720,000 tons annually, equivalent to about 420,000 tons of pig iron.

This places the supply of coke at 525,000 tons annually, and limestone at 210,000 tons annually.

The capital registered of a few of the best known iron and steel companies is appended—

	£
(1) Barrow Hematite Steel Company	1,528,275
(2) John Brown & Co., Sheffield	1,340,000
(3) Bolchow, Vaughan & Co., Middlesborough	3,218,380
(4) Steel Company of Scotland	495,600

Of these, No. 1, in addition to the iron and steel works, own their own iron mines and limestone, but no coal.

No. 2, I believe, own their own coal and limestone, but no ore.

No. 3 are owners of all these, but import their hematite ores from Spain.

No. 4 are simply iron and steel makers, depending on external supply for raw material.

Again No. 1 comprises sixteen blast furnaces, producing a weekly average of 6,000 tons, or, say, 300,000 tons annually.

No. 3 have at their Eston Works seven blast furnaces, with a production of 3,500 tons weekly.

No. 2 have at Grimthorpe three blast furnaces, producing about 1,000 tons of pig weekly.

A few figures from American blast furnace practice will show the enormous difference between an average outturn in England and America, and, though attention has been directed very largely in England lately to the possibility of getting more out per furnace, there are still many experienced managers who hold that the high pressure of blast and rapid wear of linings produced by the over-production in American furnaces does not pay.

At the Edgar Thompson Steel Works are nine furnaces, of which eight are on Bessemer iron, having a total weekly production of 10,850 tons. In 1892 these works produced—

	Tons.
Pig iron	850,000
Bessemer ingots	533,000
„ rails	425,000

The outturn required is therefore about half that of the last-named works and approximately equal in extent to the Barrow Hematite Works, and it may be assumed that a capital of not less than 1½ millions would be necessary to set up the necessary works and to acquire the land and concessions in coal and iron. The purchase of the shipping necessary would be at least £250,000 additional.

In a future note I should propose, if necessary, to detail the plant and its cost, but this seems unnecessary at present. I do not think it at all probable that a less sum than 1¾ millions sterling would suffice to place the works in a position to compete with imported iron and steel, but more precise figures would require enquiry from a directorate authorized and prepared to treat for concessions. The mere detail of cost of plant could be easily put on paper, if necessary.

Order—Mis. No. 127, Revenue, dated 9th January 1897.

Communicated to the Board of Revenue in continuation of Government Order, No. 3697, Revenue, dated 10th September 1896.

(True Extract.)

(Signed) G. STOKES,
Ag. Secretary to Government.

To the Board of Revenue (Land Revenue).

Resolution—No. 24, dated 19th January 1897.

In Government Order, No. 3506, dated 1st September 1896, Government called on the Board to make a careful examination of the figures and arguments contained in Mr. Jeremiah Head's memorandum on the practicability of conducting an iron industry at or near Salem, and report whether, in the Board's opinion, it was desirable to send a consignment of 300 tons of Salem iron ore to England for experimental purposes.

2. Mr. Head concluded his memorandum with a summary of eight conclusions, and in its Proceedings, No. 361, dated 23rd September 1896, the Board pointed out that further discussion was required before the fourth, fifth, sixth and eighth conclusions could be accepted, and called for further information for the purpose.

3. The first and second conclusions are mere statements of fact which call for no discussion.

4. The third conclusion seems to the Board to have been satisfactorily established by Mr. Head.

5. There remains the seventh, which is really the most important of all, but as the Board was not in possession of information which would enable it to deal with the subject when issuing its resolution above quoted, it was left over for consideration later on, and Government was requested to place the papers at the disposal of the press and to invite free discussion. This recommendation was accepted by Government in its Order, No. 666, Revenue, dated 24th November 1896.

6. The Board has now received from Government a letter from the Government of India, forwarding for information a report and letter by Major Mahon, R.A., on the question of working the Salem iron ores successfully, and after perusing these papers, the Board is satisfied that no further discussion need be awaited before deciding that Mr. Head's unfavourable seventh conclusion cannot be accepted, without a practical experiment on a large scale. If by such an experiment it is shown that the Salem magnetite ore which is admittedly of exceptional purity, can produce when smelted with coke made from Barrakur coal, a Bessemer iron which can compete as regards quality with imported hematite, it is probable that the cost of making it locally will be far from prohibitive.

7. The conclusion in question was stated by Mr. Head in the following terms:—

"That the substitution for charcoal of Singareni coal at Kanjamalai or at Madras, or of Barrakur coal at the latter place, would not improve the chances of success."

8. In its former resolution quoted above, the Board has given *primâ facie* reasons for believing that charcoal iron could be manufactured at Kanjamalai at a much lower figure than that assumed by Mr. Head, but as pointed out by Major Mahon, charcoal fuel can never form anything but a small adjunct to that required for an iron industry for general trade purposes, and whatever may be the conclusion eventually arrived at with reference to the manufacture of iron at Kanjamalai with charcoal fuel, it is necessary to investigate independently the practicability of working Indian iron with Indian coke.

9. From the information available it would seem that Singareni coal will not coke, and investigation may therefore for the present be limited to the practicability of working Salem (or perhaps Kurnool) ore with Barrakur coke.

10. Some of Major Mahon's figures are, perhaps, open to criticism. For instance, it is not certain that the Madras Railway could carry iron ore at 4 pies per ton, but, on the other hand, it is probable that ore could be mined at Kanjamalai cheaper than at Bilbao, and, on the whole, the Board sees no reason to reject the estimate of Rs. 45–15–1 given by Major Mahon as the cost of putting Salem iron on the Calcutta market. His criticisms on some of Mr. Head's figures are very similar to those made in Board's Proceedings, No. 361, dated 23rd September 1896.

11. The rate of exchange assumed by Major Mahon (*1s. 2d.*) is probably more favourable than can be relied on in future, but even if it be taken at *1s. 4d.*—a rate which is never likely to be materially exceeded under the present currency laws—it seems to the Board that a good *primâ facie* case has been made out for the assumption that an Indian iron, suitable for all ordinary steel-making, can be produced at a rate which will compare favourably with that at which hematite iron can be imported.

12. The matter being one of such momentous importance to the well-being of the country, the Board considers that there should not be any hesitation about the immediate adoption of Major Mahon's recommendation that 300 tons of Salem iron ore and 600 tons of Bengal coal, of a quality equal to Sanctoria coal, should be at once ordered to be despatched to Messrs. Bolchow, Vaughan & Co. of Middlesborough-on-Tees, in view

to an experimental manufacture, which will enable a definite estimate to be made of the value of the pig iron which can be made from Indian ore with Indian coke and the cost at which it can be made. It is observed that the Secretary of State in his letter of the 2nd July 1896, No. 10, has accepted Sir Frederick Abel's opinion that any experiment of the kind may well be entrusted to that firm which has expressed its readiness to undertake it. With reference to the possible need for the admixture of a proportion of an aluminous ore, referred to at the bottom of page 7, it might be as well also to send home a certain quantity of a suitable aluminous Indian ore. Major Mahon might be asked for advice on the point.

13. The Agent of the Madras Railway will be asked to favour the Board with a report as to the lowest rate at which Salem iron ore could be conveyed to Madras in very large quantities. The amount taken by Mr. Head as sufficient for working at a minimum railway freight is 500,000 tons *per annum*. So high a figure need not be considered for the present, but it may be remarked that this would not produce much more than one-half of Major Mahon's estimate of the annual demand in eastern countries which could be supplied from successful local iron works. It is presumed that the rate of 6 pies per ton per mile given in the Agent's letter of the 12th November 1896, No. 8579/11163, referred only to the small quantities under discussion in the Board's Proceedings to which his letter was a reply.

14. In discussing the question of the most advantageous site for iron works, Major Mahon expresses himself in favour of the neighbourhood of Calcutta, but on this point a final decision can probably be arrived at only after receipt of the results of the proposed experimental manufacture, without which information it is impossible to make definite estimates of the different items of cost.

15. If the Kurnool hematite iron ore, with regard to which Government has ordered an investigation in Government Order, Mis. No. 4864, dated 30th November 1896, is found to be satisfactory both as regards quantity and quality, it is possible that a suitable site would be found at Bezwada, which, after the completion of the East Coast Railway, will be an important convergent railway site, with short canal communication to the port of Masulipatam. To works on this site it would also probably be possible to supply limestone flux from the Palnad taluk more cheaply than it could be brought to Calcutta from the coast of Arakan.

(True Copy and Extract.)

(Signed) R. C. C. CARR,
Secretary.

To the Secretary to Government, Revenue Department.
" Collectors of Salem and Kurnool.
" Agent and Manager, Madras Railway.
" Settlement Department.
" Forest Branch.
" Trades Association.
" Secretary, Chamber of Commerce.
" Superintendent, Government Central Museum.

Order—No. 221, Revenue, dated 30th March 1897.

Miscellaneous.

The Government agrees with the Board in considering that it is desirable to despatch to Messrs. Bolchow, Vaughan and Co. of Middlesborough-on-Tees, a consignment of Salem ore and Bengal coal for the purpose of determining, by actual experiment, the value and cost of production of pig-iron made from Indian ore with Indian coke. The Government of India will accordingly be addressed on the subject and the Board of Revenue will be requested in the meantime to ascertain the cost of collecting the necessary quantity of iron ore

and conveying it to Middlesborough, and further to make such arrangements as may be practicable in order to secure the early despatch of the consignment in the event of the proposal being approved by the Government of India.

(True Extract.)

(Signed) G. STOKES,
Ag. Secretary to Government.

To the Board of Revenue (Land Revenue).

Exd .Shaik Karim.

100 Copies.

Government {1897} of Madras.

REVENUE.

Recd. } 1897. *Enclosures*

Regd. *Spare copies*

G.O., No. 846, 6th October 1897.

OCTOBER.

Geological investigation in the Madras Presidency.

Passing orders on the question of the continuance of the investigation of the corundum areas of Salem and Coimbatore, the investigation of Kurnool ores, and the inspection of mica mines in Nellore.

GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

Read—again the following G.O., Mis. No. 4864, Revenue, dated 30th November 1896 :—

Read—the following Proceedings of the Board of Revenue (Land Revenue), Forest Mis. No. 1441, dated 2nd November 1896 :—

Read—again Proceedings of the Board of Revenue (Land Revenue), No. 361, dated 23rd September 1896.

Resolution—Forest Mis. No. 1441, dated 2nd November 1896.

In the Proceedings read above, the Board has confined its remarks to the Salem iron with regard to which reports have been received, but there are other iron fields in the Presidency which require investigation, and the Board would specially mention Kurnool, where a very large quantity of charcoal could probably be obtained from the Nallamalai reserved forests which are traversed by the Bellary-Kistna railway.

2. The Board would therefore recommend that Mr. Middlemiss be directed to collect specimens of the best Kurnool ores to be sent home to the Imperial Institute for analysis similar to those made of Salem ore and quoted at page 10 of the Proceedings read above. The ore at Rudravaram, on the borders of the Nallamalai forests, and not far from the line of rail, is understood to be of excellent quality.

3. The Conservator of Forests, Northern Circle, is requested to submit a report with regard to the charcoal supply available in Kurnool near the line of rail similar to that called for from the Conservator, Central Circle, in paragraph 4 (2) of Board's Proceedings, No. 361, dated 23rd September 1896. The cost of an annual supply of 5,000 tons and of 10,000 tons should be separately considered.

(True Extract.)

(Signed) R. C. C. CARR,
Ag. Secretary.

To the Secretary to Government, Revenue Department.
„ Conservator of Forests, Northern Circle, with Board's Proceedings, No. 361, dated 23rd September 1896.
„ Conservator of Forests, Central Circle.

Order—Mis. No. 4864, Revenue, dated 30th November 1896.

As recommended by the Board of Revenue Mr. Middlemiss will be requested to pay a visit to the Kurnool district to collect specimens of the best iron ores found there and to send them to the Imperial Institute for analysis.

(True Extract.)

(Signed) G. STOKES,
Ag. Secretary to Government.

To the Board of Revenue (Land Revenue).
„ the Board of Revenue (Revenue Settlement, Land Records and Agriculture).
„ C. S. Middlemiss, Esq.

Read—again G.O., Mis. No. 5338, Revenue, dated 24th December 1896.

Abstract.—Communicating to the Board letter from the Superintendent, Geological Survey of India, with the request that the necessary instructions might be issued to the Kurnool Collector to render every assistance to Mr. Middlemiss in the prosecution of his investigations in regard to the collection of specimens of iron ore found in the district.

Read—again G.O., Mis. No. 1747, Revenue, dated 1st April 1897.

Abstract.—Communicating to the Board of Revenue letter from the Superintendent, Geological Survey of India, stating that no opportunity offered during the past cold weather field season of visiting Kurnool for the purpose of collecting specimens of iron ores and that such a step would have been inadvisable inasmuch as the Director had deprecated any investigation of these ores until the question of the Salem iron ores is settled.

Read—again G.O., Mis. No. 2387, Revenue, dated 12th May 1897.

Abstract.—Recording, with remark, Board's Proceedings on letter from the Superintendent, Geological Survey, regarding collection of specimens of Kurnool iron ores for the Imperial Institute, and considering that it is of importance that the investigation of the Kurnool iron ores should be proceeded with without delay.

Read—again G.O., Mis. No. 2578, Revenue, dated 20th May 1897.

Abstract.—Recording Board's Proceedings recording, with remark, letter from the Superintendent, Geological Survey of India, proposing to visit Kurnool for investigation of iron ores at the close of the recess.

Read—the following Proceedings of the Board of Revenue (Land Revenue), Mis. No. 1836, dated 19th May 1897 :—

Read—the following letter from C. S. MIDDLEMISS, Esq., B.A., Superintendent, Geological Survey of India, Ootacamund, to the Secretary to the Commissioners of Land Revenue, Madras, dated 10th May 1897, No. 25-S.—R. :—

In continuation of my No. 11-R.S. of 24th April 1897, I have the honour to append a copy of the letter from the Officiating Director, Geological Survey of India, for your information and guidance.

Enclosure.

From R. D. OLDHAM, Esq., Officiating Director, Geological Survey of India, to the Superintendent, Geological Survey of India, dated Calcutta, 5th May 1897.

In acknowledging receipt of your No. 12-R.S. of the 25th April I have the honour to point out to you that your action, in entering into correspondence with the Government of Madras on a subject regarding which you have not been put in communication with them, and in expressing your opinion to them on a matter which involves a change in the sanctioned and proposed programmes of work of the department, is irregular and inconvenient.

2. As regards your present application for permission to spend from two weeks to a month in the investigation of the Kurnool iron ores during the next working season, I have to inform you that I cannot find in the papers before me any reason for modifying my previously-expressed opinion that it would be inadvisable to interrupt the work you are at present engaged on and am consequently unable to sanction your proposal.

3. For your future guidance, I have to request that you will be good enough to immediately refer to this office, without entering into further correspondence on the subject, any demand made on you by the Government of Madras, which would in any way interrupt the work on which you or any member of the department placed under your control are engaged under the instructions or with the approval of this office.

4. This instruction should not, however, be interpreted as prohibiting you from rendering the Government of Madras all assistance in your power, by affording them information or advice on any question they may submit to you, so far as this can be done without interruption to your appointed work.

Resolution—Mis. No. 1836, dated 19th May 1897.

Recorded.

(True Copies and Extract.)

(Signed) R. C. C. CARR,
Secretary.

To the Secretary to Government, Revenue Department,
with reference to its Order, Mis. No. 2387, dated 12th May 1897.

Read—again G.O., Mis. No. 2160, Revenue, dated 29th April 1897.

Abstract.—Forwarding to the Board of Revenue, for remarks, letter from Mr. Middlemiss, Superintendent, Geological Survey of India, forwarding a report on the trial excavations for corundum near Palakod, Salem district.

Read—again the following G.O., Mis. No. 2586, Revenue, dated 20th May 1897:—

Read—the following letter from R. D. OLDHAM, Esq., Officiating Director, Geological Survey of India, to the Secretary to the Government of Madras, Revenue Department, dated Calcutta, 11th May 1897, No. 357:—

With reference to the enclosed report on some trial excavations for corundum near Palakod, Salem district, by Mr. Middlemiss, I have the honour to request that I may be informed as soon as possible of the intentions of your Government in the matter of the continuance of the investigation of the corundum of Salem and Coimbatore districts.

2. I would recommend that, in addition to continuing work on the Paparapatti band, some other locality be investigated, the exact locality to be decided by you in consultation with Mr. Middlemiss. Should this be decided on and arrangements made by you for the execution of the work, I am prepared to recommend to the Government of India the deputation of a departmental subordinate to assist Mr. Middlemiss in the supervision of the operations.

Enclosures.

Report on some trial excavations for Corundum near Palakod, Salem district, by C. S. MIDDLEMISS, Esq., B.A., Geological Survey of India.

Introduction.

1. My preliminary reports [1] on the corundum-bearing beds in the Salem and Coimbatore districts having shown that a practical trial as to the richness and value of the deposits was advisable, it was decided, after consultation with the Government of Madras, that the executive part of the work should be carried out by the Public Works Department under the supervision of the Sub-divisional Officer of the Public Works Department for the Tiruppattúr Circle, whilst the sites to be tested and the general conduct of the operations should be superintended by myself, with the help of a native assistant geologist, Mr. S. Sethurama Rau, B.A., who would personally and continuously watch the operations and carry out instructions furnished by me.

2. I chose first a site in some waste land near the village of Erranahalli, and about 2½ miles south-west-by-south of Palakod, the nearest large town. The position was one among a number of outcrops of the corundum-bearing band, now known as the Paparappatti band. This will in future be referred to as No. 1 working. As soon as the necessary formalities had been complied with and the preparations completed, experiments were started in November 1896 and continued until 15th March 1897.

3. Before going any further it will be well to state what was already known concerning these corundum occurrences. On my first visiting them in 1894 the only information then available was that corundum occurred near Pennagaram in the Dharmapuri taluk, as shown by the presence of specimens in the Madras Museum, thus labelled, sent by the local authorities. Since then details were from time to time gathered by my survey, so that up to the time of the opening of the pits at working No. 1 the information stood as follows:—

[1] Reports to the Government of Madras, the first of which was reprinted with slight alterations in Records, G.S., I., Vol. XXIX, pt. 2, 1896, pp. 43—46.

(a) The actual matrix of the corundum in this band was known to be in the form of lenticles in a gneiss, among which biotite was prominent as the dark mineral. Such of these lenticles as had actually been seen *in situ* were, however, small, the largest being 3 feet by 1 foot.

(b) That larger lenticles occurred in the alluvium covered plain near Paparappatti and on the hillsides to the west, was, however, inferred from large blocks having been found in the surface debris.

(c) It was known from the presence of old shallow trenches and pits in the alluvium and surface rock that corundum had been dug at some previous time from this neighbourhood. Local information, and the exposure of corundum for sale in the surrounding market towns, also made it certain that corundum was at that time being occasionally gathered.

(d) It was also evident that, in a general way, the strike of the rock bands containing the corundum was with the strike of the country, namely, about north by east and it was supposed from the slightly different character of some of the corundum occurrences and also from their position that more than one parallel band of the rock existed.

(e) The position of all the corundum occurrences was as indicated on the accompanying plan, from which it will be seen that the Paparappatti band extends (but with some notable gaps) from Donnakuttahalli near the Cauvery river to Chintalakuttai village, near Rayakottai, a distance of nearly 40 miles.

4. The general object of the practical work which I was now endeavouring to carry out was, as stated in the Annual Report of the Geological Survey for 1896, namely—"The excavations, or quarries as they will be, are intended to show the thickness of the corundum-bearing bands, and whether they are continuous or occur as lenticular patches. A fair average sample of the rock extracted, of sufficient size to give a trustworthy estimate of the richness of the rock, is to be carefully cleaned by hand and the proportion of corundum to matrix determined by weighing."

5. The nature of the work resolved itself into—

(a) Preliminary clearing of the ground of jungle.
(b) Digging of trenches until the corundum-bearing rock was exposed.
(c) Blasting and quarrying the matrix-rock.
(d) Breaking up the lumps with wedges and hammers into sizes suitable for demolition by hand.
(e) Cleaning the corundum by hand and weighing.
(f) Excavations to show continuity or otherwise of the rock matrix.

Geological Details.

6. A brief outline only will here be given regarding the petrology of the neighbourhood of the workings, inasmuch as many details still require working out. I may mention, however, in particular that in addition to biotite in the fundamental rock in which the lenticles occur there is at this place much hypersthene also present, which together with felspar, quartz and iron-ores makes up a biotite-hypersthene granulitic gneiss, and which is therefore mineralogically a passage between the ordinary charnockite series and the Hosur biotite gneiss. It is finely, and not very distinctly foliated, the strike being generally between north and south and north-north-east and south-south-west. The dip of the foliation planes is generally steep, approaching the vertical in most available sections, but the amount and nature of the folds indicated by such dips are never definite enough to allow of a sectional representation of them.

7. Occurring sparingly as adventitious veins and veinlets in this gneissic rock, and palpably younger in age than it, come a coarse flesh-pink and white, rather coarse pegmatite, and some trap dykes. These veins and dykes, though sometimes following the foliation, also occur completely irregularly. Some of the gneiss also presents the character which has been called "trap-shotten," a feature peculiar in itself and too complicated to be described in this note.

8. The actual matrix of the corundum in the workings was found, as anticipated from my previous observations, to be in the form of lenticles in the gneissic rock. These lenticles are symmetrically shaped and are easily recognised by their external shell of rock very rich in biotite, and by the paler-coloured central parts which are less rich in ferro-magnesian minerals. The exact mineralogical composition of these lenticles is still under investigation, and both it and the origin of the lenticles offer problems whose solution will not be attempted here. In size the lenticles vary from the very small ones referred to in my previous report up to such as the one broken up at No. 1 working, which measured 13 feet long, by 8 feet broad and 9 feet

deep; the shape being that of an ellipsoid with three unequal axes. A plan showing the excavations at No. 1 working and in the vicinity (see Plate) will sufficiently make clear the disposition, shape and size of the three lenticles which have so far been exposed in the course of the work, and will indicate the degree of probability attaching to the statement, which I think is a correct one, that these lenticles are really dispersed in a bed, layer, or plane, and that therefore they have the same general continuity as any other rock band. In support of this it may be mentioned that half a mile west-south-west of Gollahalli subsequent trial trenches exposed a large lenticle, along the same line of strike, and identical in composition with the three already referred to. This lenticle on partial exposure measured 15 feet long by 8 feet broad.

As these lenticles were originally only indicated at the surface of the ground by the presence of fragments of corundum and matrix-rock and by old shallow excavations, and as prospecting in the neighbourhood has revealed a great number of similar indications (roughly represented by the crosses on the map), it seems to me only reasonable to conclude that a detailed examination of the neighbourhood foot by foot and a judicious series of cross trenches would expose more lenticles of the same kind along the present line or along other parallel lines. At the present moment there must be about 20 tons of matrix left at working No. 1, and about as much in the third lenticle, whilst the Gollahalli lenticle will probably yield 60 tons or more; so that about 100 tons of matrix-rock are now ready to hand.

9. The corundum in the matrix-rock occurs in well shaped crystals which in this particular locality are of a dark purplish-grey colour. As described in my previous paper, they are surrounded by a pale pink shell of orthoclase from which they break out sharp and clean like a kernel from its shell. Their forms are elongated barrel shaped combinations of the hexagonal prism and pyramid. The size of the crystals varie considerably, but may be said to be definitely limited in the following way. The largest crystal found in the broken up lenticle was 7 inches × 2 inches, whilst the smallest sizes of which any account need be taken are $\frac{1}{2}$ inch by $\frac{1}{4}$ inch. An average size for the crystals in this lenticle I should estimate at 2 inches × $\frac{3}{4}$ inch.

The corundum seems to be quite pure throughout the lenticle, but in the course of the excavation Mr. Sethurama Rau found that a layer of the outer disintegrated rock near the upper site of the lenticle yielded a number of dark nearly black lumps or nodules of hercynite mixed with corundum. Sometimes a central core of corundum was surrounded by a shell of hercynite. The latter is in a crystalline-granular state, and has probably grown in a concretionary way round pieces of corundum as nuclei. Unfortunately none of these concretions were found actually in solid rock, but inasmuch as none are present in the main mass of the lenticle, it is probable that they came from the outer crust of it where ferro-magnesian minerals are more thickly grouped.

Proportion of corundum in the rock.

10. One of the chief objects, or rather the chief object, of the practical investigation of these rocks, was to determine by careful weighings the proportion of corundum in the matrix-rock. To attain this end the broken-up rock was weighed as it was given out to the coolies, and the resulting corundum was collected at the end of each day and also weighed. This was done every day and a regular account kept.

The total results as given me by Mr. T. Ramanujam Pillay, Sub-divisional Officer, Public Works Department, in charge of the work are—

722 cwts. of matrix-rock yielded 2,845 lb. of corundum, or 3·5 per cent. nearly.

This total is considerably lower than the percentage obtained from the first weighing of the first ton of matrix, which gave, as quoted in the Annual Report—

1 ton of matrix-rock yielded 150 lb. of corundum, or 6·7 per cent. nearly.

From enquiry, and a study of the daily returns of the weighings, the difference seems to be accounted for in the following two ways. In the first place, when the original big lenticle was blasted, a great many of the larger crystals of corundum broke away and fell out, and they were straightway included in the first weighings. Secondly, all parts of the lenticle were not equally rich, and the richer parts appear to have been selected first. As a third reason it is possible that a certain amount of pilfering may have taken place from the exposed heaps of matrix-rock as time went on. It seems safest to take the total percentage on the whole work as giving probably the nearest approach to a true average, because so long as hand work alone is used in cleaning the corundum, if loss occurs either by pilfering or carelessness, such would also be likely to occur in actual mining operations.

Cost of the operations.

11. Although a small experiment carried on as this one has been is more likely to be more expensive than one worked on a larger scale as a paying concern, yet I give below the actual costs as offering some evidence under this head.

The figures given first below apply to the work done to the first two lenticles of matrix-rock at working No. 1, which supplied all the rock broken up and weighed. These figures also were furnished me by the Sub-divisional officer—

	Rs.	A.	P.
Clearing ground of jungle, about	20	0	0
Earthwork at the quarry, digging trenches, &c.	71	5	0
Blasting	11	9	0
Breaking matrix-rock and sorting 722 cwts. @ As. 2–6 per cwt.	112	6	0
Cleaning the above @ As. 2–6 per cwt.	112	6	0
Sundries —boxes, bags, cartage	35	0	0
Erection of sheds for workmen	22	8	0
Total ...	385	2	0

or As. 8–7 per cwt. of broken rock, *i.e.*, As. 8–7 per 3·9 lb. of cleaned corundum.

Further, it was found that $1\frac{1}{2}$ men at $3\frac{1}{2}$ annas were able to break 1 cwt. of matrix-rock and clean corundum from it.

12. The cost of making other excavations, exposing other lenticles, trial trenches here and at Gollahalli and near Paparappatti was Rs. 354.

13. From the figures given in paragraph 11 it will be seen that the two items of greatest expense are those for breaking out and cleaning the corundum by hand (namely Rs. 112–5–0 × 2). It is clear, therefore, that if the extraction of corundum is attempted on a large scale, the adoption of machinery for crushing and washing the corundum, as a substitute for hand-work, would be a desideratum.

Further experiments contemplated.

14. Work for the present had to be closed on 15th March. Meanwhile samples of the corundum and matrix will be sent to firms in India and England for testing and valuation. Should their reports be favourable, and the percentage of mineral to matrix deemed not prohibitive, I shall hope to make further trial exacavations at other places along the Paparappatti band of outcrops.

Order—Mis. No. 2586, Revenue, dated 20th May 1897.

Referred to the Board of Revenue for early report in continuation of G.O., No. 2160, dated 29th April 1897.

(True Extract.)

(Signed) G. STOKES,
Ag. Secretary to Government.

To the Board of Revenue (Revenue Settlement, Land Records and Agriculture), with enclosures to be returned.

Read—again the following G.O., Mis. No. 2816, Revenue, dated 3rd June 1897 :—

Read—the following Proceedings of the Board of Revenue (Revenue Settlement, Land Records and Agriculture), Mis. No. 3151, dated 5th May 1897 :—

Read—again the following Proceedings of the Board of Revenue (Revenue Settlement, Land Records and Agriculture), Mis. No. 1798, dated 10th March 1897 :—

Read—the following letter from the Collector of Nellore, to the Secretary to the Commissioner of Revenue Settlement, and Director of the Department of Land Records and Agriculture, dated 15th January 1897, No. 117-Ver. :—

With reference to Board's Proceedings, Mis. No. 117, dated 6th instant, I have the honour to submit herewith a copy of Mr. Scott's letter, No 2706-Ver., dated 17th July last, with a copy of its enclosure, and to observe that they were originally forwarded through Mr. Middlemiss who has probably not sent them on to the Board.

Enclosure.

From E. SCOTT, Esq., Acting Collector of Nellore, to the Secretary to the Board of Revenue (Revenue Settlement, Land Records and Agriculture, through C. S. MIDDLEMISS, Esq., Deputy Superintendent, Geological Survey of India), dated 17th July 1896, No. 2706-Ver.

With reference to Board's Proceedings, Nos. 130 and 208, dated 20th May and 12th July 1895, respectively, I have the honour to forward herewith a note, together with a sketch-map in modification, so far as this district is concerned, of the information given on pages 3 and 4 of Board's Proceedings, No. 806-Sett., dated 24th December 1892, regarding the minerals—mica and garnet.

2. There is nothing more to be said about other minerals beyond what is given in the statement forwarded with this office, No. 2606-Ver., dated 13th June 1892, printed in the Board's Proceedings above quoted.

Mica.—This mineral occurs in fairly large quantities in the Rapur taluk, chiefly in the villages of Utukur, Sydapuram, Chaganam, Tummalatalapur and Padalakur and to a less extent in Turimerla and Birdavolu; in Nallapalem and Prabhagiripatnam, Atmakur taluk; Chennur and Mangalapur, Gudur taluk; and in a few villages in the Kavali taluk; also in some villages in the Venkataghiri zemindari bordering the Rapur taluk and Pamur in the Kálahasti zemindari. Since 1895 the industry has gradually developed. Formerly, only the very best transparent mica was exported, but now it appears that the black and brown stained (caused by the spread of manganese-ore and iron between the planes of cleavage) and ripple-marked mica are also exported chiefly to London. The best mine in the district is situated about 18 miles south by west of Nellore in the village of Podalakur (Inukurti). It was worked by Mr. E. H. Sargent and relinquished by him at the expiration of two years. Subsequently, a native of the district applied for the land and it has been granted to him on a two-years' lease. The mine still yields a large quantity of clear mica

The price of mica varies according to size and quality. Small plates, measuring one or two inches square, sell at home for a penny per lb. This size is generally got from tarlings and refuse heaps—while average size plates sell from 7 to 8 shillings per lb., and plates $10'' \times 10''$ at 12 to 15 shillings per lb.

Garnets.—One of the accessory minerals is found in small quantities with tourmaline and apatite in a few mines situated in the villages of Sydapuram and Chaganam. It is, however, of no commercial value. Locally, the mineral is reduced to a powder mixed with lac and formed into wheels for grinding knives, &c.

(Signed) J. H. B. BROUGHAM.

Resolution—Mis. No. 1798, dated 10th March 1897.

Recorded.

2. With reference to the Collector's remarks about mica, the attention of Mr. Middlemiss will be invited to paragraph 4 of Board's Proceedings, No. 3116, dated 24th June 1896, and paragraph 1 of G.O., No. 3072, dated 1st August 1896, thereon, from which it will be seen that the Board's proposal that the mica mines in Nellore should be inspected and reported on by Mr. Anderson who was then expected to come to this Presidency, was approved by Government. Owing, however, to Mr. Anderson's resignation, the Board observes that Mr. Middlemiss' term of service in this Presidency has been extended till 1900. He is requested to report what arrangements have been made by him to inspect the mica mines in Nellore. The mica industry, which is one of daily increasing importance, will be greatly helped, if, after inspection, he can offer any suggestions to improve the mode of extraction and preparation. He is also requested to state whether he knows of any process for the utilization of mica-waste by compressing it into plates or otherwise.

3. The Board learns with surprise that the spotted mica is being exported. It is believed that this is useless for electrical purposes for which the chief demand has arisen.

(True Copy and Extract.)

(Signed) R. V. SRINIVASIAR.
Secretary.

To C. S. Middlemiss, Esq, Superintendent, Geological Survey of India.
Copy to the Collector of Nellore.

Read—also the following letter from the Superintendent, Geological Survey of India, to the Secretary to the Commissioner of Revenue Settlement, Land Records and Agriculture, dated 19th March 1897, No. 155 S.—R.:—

In reply to the Board's Proceedings, Mis. No. 1798 of 10th March 1897, Resolution 2, I have the honour to observe that the extension of my term of deputation to Madras till 1900 was not consequent on Mr. Anderson's resignation (see letter from Director, Geological Survey of India, to the Government of India, Revenue and Agriculture, No. 1962, dated 19th September 1896, paragraph 3), and that therefore work proposed for Mr. Anderson (except the investigation of the corundum deposits for which special arrangements were made by the Director) does not necessarily devolve on me.

I have the honour to observe further that, as I am primarily engaged on the Coimbatore and Salem districts, the sanction of my Director is necessary for any important work outside of those districts. The superintending of the corundum workings has taken all the time I could spare from the regular survey work.

In consequence of the above, no steps have been taken by me to investigate the mica of Nellore.

With reference to the queries about the utilization of mica-waste and "spotted mica" (paragraphs 2 and 3), I have the honour to refer the Board to the Mica Handbook (Imperial Institute Series No. 19), and I also append some remarks by Mr. Holland in this connection.

"Mica waste in a compressed form has been used in the manufacture of insulators on telegraph poles (Handbook, page 4).

"Other uses of mica-waste are given on page 5. Since the Handbook was written, specimens have been shown me in Calcutta by a Mr. Jones of Howrah of sheets intended as non-conducting boiler covers and made of mica-waste cemented with clay and moulded into curved sheets. Mr. Jones stated his intention to apply for a patent for the substance so manufactured. Mica-waste has been used also as a basis for soap in Bengal.

"Apparently, one of the difficulties against the use of mica-waste for the above purposes was the power required to grind it into a powder; but lately, such of this difficulty has been removed by heating the mica and throwing it into cold water, the irregular contraction following the sudden chilling, splitting the cleavage bundles into minute films.

"The stained mica of Nellore was not in favour, because in the London market the specialists, who value the lots previous to sale, were in the habit of giving points for—

(1) Elasticity of the plates.
(2) Transparency.
(3) Freedom from crumplings.
(4) Do. from inclusions of foreign matter.

"These were considered desirable characters, evidently because most of the mica was formerly used as fine screens, peep-holes in furnaces and other places where transparency is essential. During recent years, however, the rapid exhaustion of the American mines has driven the utilizers of mica to turn their attention to what was formerly regarded as valueless. Beyond the survival of market prejudice, there appears to be no theoretical reason for objecting to the stained mica of Utkur (Vutukur) in Nellore. The minute isolated films of iron-ore ought to have no deleterious effect on the straps used in dynamos. I have seen large sheets of it which in all other respects are superior to the best which Sargent turned out at Inukurti. I am consequently not surprised to learn that the market prejudice has been broken down as a result of the increased demand for mica and that the stained mica of Nellore is now being used."

Resolution—Mis. No. 3151, dated 5th May 1897.

The papers will be submitted for the orders of Government.

2. In paragraph 4 of its Proceedings, No. 3116, dated 24th June 1896, the Board suggested that Mr. Anderson, the Mining Specialist, whom it was then proposed to post for geological work in this Presidency, should, in addition to his other work, be asked to inspect and report on the mica-mining industry in Nellore. This suggestion was approved by Government in its order, No. 3072, dated 1st August 1896. Mr. Anderson, however, subsequently resigned, and it has been arranged that Mr. Middlemiss, whose term of service in this Presidency was to expire in October 1897,

should continue to work till 1900. On a reference made to Mr. Middlemiss as to what arrangements he had made to inspect the mica mines in Nellore, that officer states that the work proposed for Mr. Anderson does not necessarily devolve upon him, that the superintendence of corundum workings in Salem and Coimbatore districts has taken all the time which he could spare from his regular survey work, and that the sanction of the Director of Geological Survey is necessary for his undertaking any important work outside those districts.

(True Copy and Extract.)

(Signed) R. V. SRINIVASIAR,
Secretary.

To the Secretary to Government, Revenue Department, with papers.

Order—Mis. No. 2816, Revenue, dated 3rd June 1897.

The Board is requested to expedite the report called for in G.O., No. 2586, dated 20th May 1897.

(True Extract.)

(Signed) G. STOKES,
Ag. Secretary to Government.

To the Board of Revenue (Revenue Settlement, Land Records and Agriculture).

Read—also Proceedings of the Board of Revenue (Land Revenue), Madras, dated 23rd June 1897, Mis. No. 2275.

Abstract.—Submitting to Government Salem Collector's report regarding collection and transport of 300 tons of Kanjamalai iron-ore and recommending that Mr. Middlemiss may be deputed to visit the locality and point out the kind of ore required and the place where it can be most conveniently obtained.

Read—the following Proceedings of the Board of Revenue (Revenue Settlement, Land Records and Agriculture), Mis. No. 5078, dated 9th July 1897:—

Read—again endorsement from the Acting Secretary to Government, dated Ootacamund, 29th April 1897, Mis. No. 2160-Rev., and Board's Proceedings, Mis. No. 3550, dated 20th May 1897 thereon, requesting certain firms to report the market price of corundum per cwt.

Read—also the following letter from Messrs. ARBUTHNOT & Co., Madras, to the Secretary to the Commissioner of Revenue Settlement, Land Records and Agriculture, dated 28th May 1897:—

In reply to your memo., Mis. No. 3550, dated 20th instant, regarding corundum, we have the honour to inform you that there are two qualities, viz., No. 1 and No. 2. The present market price of the former is Rs. 4 per cwt., and of the latter Rs. 2 per cwt. delivered into godown here.

Resolution—Mis. No. 5078, dated 9th July 1897.

In returning the report forwarded with the endorsement read above, the Board begs to state that it learns from Messrs. Arbuthnot & Co. that the market price of corundum of the best quality, delivered into the godown at Madras, is Rs. 4 per cwt.

In Mr. Middlemiss' experiment, the cost of 1 cwt. was over Rs. 19.

Making every allowance for extra expenses due to the small scale of the experiment, it would appear that the Salem corundum cannot be extracted by hand at a cost which would admit of its being sold at a profit.

(True Copy and Extract.)

(Signed) R. V. SRINIVASIAR,
Secretary.

To the Secretary to Government, Revenue Department.

Read—also the following letter from R. D. OLDHAM, Esq., Officiating Director, Geological Survey of India, to the Secretary to the Government of Madras, Revenue Department, dated Calcutta, 6th July 1897, No. 594:—

I have received through Mr. C. S. Middlemiss, Superintendent of the Geological Survey of India, a copy of the Proceedings and Resolution of the Board of Revenue, Mis. No. 1428, dated 14th April 1897, with reference to which I would ask your consideration of the following.

2. The programme of work of the officers of the Geological Survey of India is settled annually by the Government of India after consideration of the proposals made by the Director, and any serious change in it which may afterwards be desirable requires the sanction of the Government of India, which sanction would usually be granted on the recommendation of the Director.

3. In these circumstances, you will perceive that the course adopted by the Board of Revenue in communicating their desires to Mr. Middlemiss instead of to the Director of the Geological Survey must, to say the least, lead to delay.

4. In the present matter, I am unable to recommend the diversion of Mr. Middlemiss from the work on which he is at present engaged, as I am at present unaware of, precisely, what is desired by your Government.

5. Should this be merely the collection of samples of iron ore, the work could be done through your Revenue officials, but, if a detailed examination of the geological relations and mode of occurrence of the ores is required, this is an undertaking which will occupy a considerable part, at least, of a working season and will have to be provided for in the programme of work of the department. I would consequently request that I may be favoured, at as early a date as possible, with a full statement of the desires of your Government and whatever information may have already been collected bearing on the matter you wish to be investigated.

6. I would, however, point out that Mr. Middlemiss has already on hand both the survey of the Salem and Coimbatore districts and the special investigation of their corundum resources, and would deprecate his transfer from there, unless for a matter of great importance and urgency. The investigation of the Kurnool iron ores may come under this designation, but, at present, in the absence of any special information, I would not be disposed to regard it as such. This is in no way due, as your Board of Revenue seems to consider, to Mr. Head's report, but to the fact that arrangements have been made for a trial shipment of ore from Salem to England. Whatever may be the result of this experiment, there can be no doubt that it will throw considerable light on the value of the ore and indirectly afford great assistance in any further investigations, and for this reason, if it be not outweighed by others, of which I have no knowledge, I would urge the postponement of further special investigations of iron ores in Madras till after the receipt of the report on the trial of the Salem iron ores.

7. I would also request that, in all cases where your Government desires any special geological investigation, for which provision has not already been made, the application may, in the first instance, be made to this office, and not to the officer deputed to Madras. You will, at all times, find this department ready to render you every possible assistance, but, as the disposition of the officers of the Geological Survey is subject to the decision of the Government of India, you will find it more expeditious to communicate with me direct than through the officer of the Geological Survey who

happens to be working in Madras. When the carrying out of any special investigation is finally decided on, he will be placed in communication with you and the arrangement of details left to him.

8. As a further reason for application being made direct to this office, I would point out that experience shows that it is not infrequently possible to meet the desire of Local Governments for information on special subjects by a reference to the records of this department without incurring the expense and delay of deputing an officer to make a special investigation.

Order—No. 846, Revenue, dated 6th October 1897.

Miscellaneous.

In 1893, the Government resolved to institute a systematic mineralogical survey of this Presidency with a view to the discovery and allocation of those mineral products which would be likely to prove of economic value. The importance of such a survey was urged on the Government of India and that Government was asked to sanction the appointment of a skilled petrologist for the purpose. After some correspondence, however, it was decided that an officer of the Geological Survey of India should be deputed to this Presidency to conduct a practical enquiry.

2. Mr. Middlemiss, the officer deputed for the purpose, has been engaged since his arrival mainly in the investigation of the corundum deposits in Salem. In 1896, arrangements were made for the employment of a mining specialist, Mr. Anderson, to practically determine the value of the corundum deposits discovered and described by Mr. Middlemiss. Mr. Anderson, however, resigned his appointment later in the year and the task of extracting and valuing the corundum was undertaken by Mr. Middlemiss with the help of a subordinate of the Public Works Department.

3. The results of Mr. Middlemiss' experiments are given in his report printed above. It is observed that the cost of excavating and cleaning 2,845 lb. of corundum was Rs. 385-2-0. The cost of 1 cwt. of cleaned corundum was, therefore, Rs. 15-2-7. The current market price of corundum is reported in the Board's Proceedings read above to be Rs. 4 per cwt. delivered in Madras. This price, however, is possibly that of corundum gathered from the surface and not thoroughly cleaned. Before giving a definite opinion therefore on the possibility of working the corundum deposits in Salem on a large scale with commercial success, the Government will await the report promised by Mr. Middlemiss on the results of the valuation and testing of the corundum extracted by him.

4. The Government, however, ~~are~~ is decidedly of opinion that the results of the experiments made do not justify the continuance for the present of Mr. Middlemiss' investigations in Salem and Coimbatore and that his further employment in those districts would, with reference to the object of his deputation to this Presidency, be a waste of time. The Director of the Geological Survey Department will be informed accordingly with reference to the first of his letters read above.

5. In the second of his letters read above, the Director asks for a statement of the wishes of this Government as to future geologieal investigations in this Presidency.

6. With reference to the question of working the iron ores of Salem, this Government has recommended to the Government of India the proposal to ascertain by actual experiment the cost of working Salem iron with Barrakur coal. Should the proposal be accepted, it will be necessary to extract 300 tons of the Salem ore, and the Government would be glad to avail itself of Mr. Middlemiss' services in selecting the ore. Until the experiment is tried, the possibility of working the Salem ores profitably cannot be definitely affirmed or denied. In the meantime the Government considers it of the highest importance that ores supposed to be valuable lying nearer to the coal fields should be as thoroughly investigated as those of Salem have been. In the first of the papers read above, the importance of investigating the Kurnool iron ores has

been well represented by the Board. The Government considers that Mr. Middlemiss should be deputed to Kurnool without delay for the purpose of surveying and describing these ores.

7. With reference to the Board's suggestion that the mica mines in Nellore should be inspected by an expert in order that improvements might be suggested in the mode of extraction and preparation of the mica for the market, the Director of the Geological Survey will be asked to depute Mr. Holland for the purpose of reporting on the industry which is assuming large dimensions.

(True Extract.)

(Signed) G. STOKES,
Ag. Secretary to Government.

To the Board of Revenue (Revenue Settlement, Land Records and Agriculture).
„ the „ (Land Revenue).

Ed. W. D'Mos.

70 Copies.

24/9/97

From the Superintendent, Bengal Coal Company, (Limited)

Calcutta.

To

The Secretary to the Board of Revenue, Govt. of Madras.

Salem iron-ore.

Sir,

With reference to the Board's decision to send home 300 tons of this ore and 600 tons Bengal coal for the ~~purposing~~ purpose of determining by actual experiment, the value and cost of production of pig iron made from Salem ore with Indian coke, I have the honour to state that this Company would be willing to supply the coal required -either from our Sanctoria or Giridih Colliery - at cost price f.o.b. Calcutta. Would you be good enough to communicate our proposal to the Government of India and favour us with your instructions in the matter?

I have &c.

(Signed) C. W. Gray,

Superintendent.

(True Copy)

Ag. Under Secretary to Govt. 3.12.97

Proceedings of the Board of Revenue
(Land Revenue)

No. 3720 Imo, dy 2nd Oct. 1897.

Read letter from the Superintendent, Bengal
coal Co. Limited. Calcutta, dated 24th
September 1897.

Resolution.

Submitted for the orders of Govern-
-ment with reference to its order dated 30 June
1897, No. 221.

2. Government has already been in-
-ed in Board's Proceedings No. 2275, dated 21
June 1897 that the Board has no one on
its orders who is competent to colle t
despatch the iron ore and in suppo
of its proposal that Mr. Middlemiss
be deputed to point out the ore re
it would now suggest that some off
with the necessary qualifications should
be placed on special duty for the
purpose of seeing the whole of this
important experiment carried thro
to a satisfactory conclusion. As pa
the selection of the coal to be sent from

Govt

No. 3720

proceeded no further than has the selection
the are.

(True Extract)
R.C.Lean
Secretary

(True Copy)

Secretary
Ag Under Secy to Govt.

Copy of a telegram dated the 16th September 1897 from the Government of India in the Department of Revenue and Agriculture to the Secretary of State for India.

Your Revenue Despatch no. 76, 2nd July 1896, Salem iron ores. Government of Madras propose sending home consignment of Indian ore and coal for trial. We strongly recommend that Major Mahon, Superintendent of Cossipore Gun Foundry and Shell Factory, should be sent from India for a period of four months and a half from 1st October next to watch ~~trial~~ trial and report fully on whole subject. Probable expenditure about 6,500 rupees. Do you consent?

Copy of Telegram.

From London.

From Secretary of State for India.

To Simla.

To Viceroy.

London, the 6th October 1897.

Your telegram of the 16th September last. Salem ore and Indian coal. Bolchow Vaughan suggest/ two tons each should be sent from India for purpose of preliminary experiment with detailed statement of information required in absence impossible to state whether their works suitable for

experiments

experiments . If you agree to act accordingly. Deputation
of Major Mahon might be postponed.

(True copy)

Ag. Under Secy to Govt.

97

No.52 C.& I.

Government of India.

PUBLIC WORKS DEPARTMENT.

(Civil Works)

Coal and Iron.

To

The Secretary to the Government of Madras,

Revenue Department.

Simla, the 5th November 1897.

Sir,

In acknowledging the receipt of your letter No. 222 dated the 30th March 1897 and Memoranda Nos. 228 A., and 3025 A., dated, respectively, the 1st and14th April 1897 to the address of the Government of India, Revenue and Agricultural Department, I am directed to forward, for information, the accompanying copy of a telegram dated the 16th September 1897 to Her Majesty's Secretary of State for India, and of His Lordship's reply, dated th e 6th October 1897, regarding the despatch, to Messrs. Bolchow, Vaughan and Company of Middlesborough-on-Tees, of a sample of Salem iron ore and Indian coal, for the purpose of determining by experimental manufacture the value and cost of production of pig iron made from Indian ore with Indian coke.

2. I am to request that, with the permission of His Excellency the Governor in Council, arrangements may be made at once for the despatch direct to Messrs. Bolchow, Vaughan and Company of a 3 ton sample of Salem ore and 5 tons of Sanctoria Coal. The latter may be obtained from either the Bengal Coal Company, the Bengal Nagpur Company or the Equitable Coal Company, and I am to suggest that the Madras Government should communicate direct with the Calcutta Office of one of these Companies. I am also to request that, in

advising

advising despatch of the samples, Messrs. Bolchow, Vaughan and Company may be informed that the detailed statement of information required will be separately forwarded, if it cannot be forwarded before advice of the despatch.

:	Vide telegram dated 6th October 1897 from the Secretary of State

An intimation of the despatch of the samples should ~~also~~ also be sent to the Government of India.

3. I am to say that arrangements are being made for the preparation of the detailed statement of information referred to above, which will be forwarded to Messrs. Bolchow, Vaughan and Company through the India Office by the Government of India, copy being sent to the Government of Madras.

I have &c.

(Signed) M. F. Mackenzie,

Under Secretary to Govt. of India.

(True Copy)

Asst. Under Secretary to Govt. 3-12-97

F
16 2,000—13-10-97.

REVENUE DEPARTMENT.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Read again G. O. No. 331 Revenue, dated 30th March 1897.

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Read again G. O. No. 846 Revenue dated 6th October 1897.

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Read also Proceedings of the Board of Revenue(Land Revenue) dated 2nd October 1897, No. 3730 Mis.

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Read also letter from the Government of India, Public Works Department(Civil Works) dated 5th November 1897, No. 52 C. & I.

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Copy attached.

Order thereon No. 1007 dated 3rd December 1897.

The papers last read above will be communicated to the Board of Revenue. It is observed that only five tons of Sanctoria coal and two tons of Salem ore are at present required for the purpose of a preliminary experiment. His Excellency the Governor in Council gladly accepts the offer of the Bengal Coal Company to supply the coal at cost price. The Board of Revenue is requested to communicate with the Company and to procure the despatch of five tons of Sanctoria coal to Messrs. Bolchow Vaughan and Co: direct at the earliest possible date. Intimation of the despatch should be given to the Government.

2. The Director of the Geological Survey will be requested to deputa Mr. Middlemiss without delay for the purpose of assisting the Collector of Salem in selecting the two tons of iron ore required.

Order

3. Orders will issue in the Public Works Department for the deputation of a Public Works Department subordinate for conducting the blasting operations that will be necessary.

(True Extract)

[illegible]
Secretary to Government.

To the Board of Revenue (Land Revenue)
To the Public Works Department.