

NUGGER DIVISION.

The earliest intimation extant of the existence of ores of iron in this part of the Mysore territory is given by Dr. Buchanan (*Journey* vol. 2 p. 138 et sequent) who mentions that, in all the rivulets of this part of the country, Satimangalum, iron ore in the form of black sand was common; and at a place seven Malabar hours' journey north-east from Satimangalum it was smelted. He likewise mentions that, on the north side of Chica Deva Betta are three low hills, which produce iron ore. Mota Betta is situated about three miles E. S. E. from Humpapura, immediately below the junction of the river Nuga with the Kapini, and to the right of both. Culia Betta is the most considerable mine, and is situated between the two rivers being distant from Mota Betta one coss and a half. West from thence about half a coss, is Hitea Betta, which is on the left of the Kapini. He was told that the ore in all the three places is nearly the same; and this is confirmed by the hills lying nearly in the direction of the strata at Mota Betta.

Description of Mota Betta and its mines.—Mota Betta is a hill of no considerable height, about a mile in length, and extending from north to south. It was then wrought at the south end only, but no trial had been made to ascertain how far the mine extends. The strata that are in view run from about northwest to southeast, or rather more toward the east and west; pointing directly towards the high peak called Bettadapura; while those on the opposite of the Kapini run nearly north and south. The strata dip toward the north at an angle of about 30 degrees. They consist of schistose lamina and, owing to their being penetrated by fissures at right angles to the strata, they break with a smooth surface into angular fragments. The internal structure of the plates is foliated, and these leaves are of different appearances, sometimes straight, sometimes undulated, would seem to show that they have been deposited from water at different times. The strata are from one to three feet in thickness, and consist of granular quartz more or less impregnated with iron ore, of the same nature as the common iron sand of the country. In most of the strata the quartz predominates; and by the natives these are considered as useless. In others although having nearly the same external appearance the iron is more abundant, and these are worked for the ore. In these last, ochres of various colours occur, by which they are readily distinguished from the barren strata. In the rainy season, the workmen content themselves with collecting the fragments of ore which the water brings down from the hill. These resemble the black sand in colour but are larger and more angular. They are separated from the earth with which they are mixed by being washed in long wooden troughs, made of hollow trees. In the dry season, the workmen are forced to have recourse to the strata; but never penetrate deeper than

the surface. Before they begin to work upon any spot, they cover it with a coat of earth for a year; which seems to accelerate the decay, and to render the ore brittle. After it has been dug up with pick-axes, the ore is broken into small pieces, and the iron is separated from the stony matter by washing.

About a coss north from Chandra-guppi (*Buchanan's Journey* vol. 3 p. 251) is a hill producing iron ore, which is wrought to some extent. It is found in veins intermixed with laterite, like the ore of Angada-puram in Malabar. The ore is of the same nature with what is usually smelted in the peninsula; that is to say, it is a black sand ore, which here is conglutinated by clay into a mass, and contains less extraneous matter than common. It is broken into small pieces, and the little masses of iron are picked out of the clay.

The workmen said that in Billighy and Sudha, there is abundance of ore; but in these districts there were no people who understood the process.

At Chica-bayli-caray was a furnace (*Buchanan's Journey* Vol. 3 p. 361) for smelting iron ore brought from a mine called Cudera Canavay and which was supplied with charcoal from the hills to the westward. The ore was brought upon buffaloes and asses. It was in the form of small slaty fragments, that had been broken to pieces with a stone, and thus separated from much sand and earth. These small pieces, when fit for the furnace, were about the size of a hazel-nut. Dr. Buchanan remarks that the operation ought to have been performed at the mine to lessen the expense of carriage; but the danger from tigers prevented the people from staying there longer than was absolutely necessary. The number of these ferocious animals having increased had forced the people to relinquish a mine, named Buca Sagurada Canavay, which is distant from the other one coss towards the N. W. Even Cudera Canavay had then become very dangerous, and in the course of the year preceding Dr. Buchanan's visit three people had been destroyed.

The manner of smelting and forging the iron is exactly similar to that used at Doray-guda, which has been described.

Nail Makers.—There was here in Dr. Buchanan's time a small manufacture of horse-shoes and hob-nails. It contained three anvils, at each of which were employed five men; one who manages the iron, and who furnishes all the tools; one who manages the fire; one to work the bellows; one to hammer the iron, as it is held by the forspan; and one who finishes the nail by giving it a head. The utmost that five men at one anvil could make in a day was 1,200 nails.

Mine at Cudera Canavay.—Cudera Canavay or the horse-hill (*Buchanan's Journey* vol. 3 p. 364) is a hummock about a hundred and fifty feet in perpendicular height. The north end is steepest, the slope toward the south

2d. *Compact magnetic iron ore.*—Tavoy, No. 4.

External and magnetic characters as above.

Specific gravity... 3.462.

It yields in analysis:

Peroxide of iron.....equal to 60.2 metal, 86.0

Silica with a trace of phosphate of lime.....0.9

Water.....13.1

100.0

It contains neither manganese nor titanium.

3d. *Tavoy ore, No. 2.*—external characters as above.

Specific gravity.....4.369.

4th. *Tavoy ore, No. 3,* characters as above, as to aspect and magnetism.

Specific gravity.....4.100

The two latter samples are even richer than the former, as is evinced by the specific gravity, but they are all quite rich enough and pure enough for making the best quality of bar iron and steel.

TINNEVELLY.

is the most southern of the Collectorate of the Madras Presidency. It is situated on the south eastern extremity of the peninsula, with Madura on its north, Travancore on the west, and separated from Ceylon on the south east, by the gulf of Manar. In length it is estimated at 135 miles, by 80 the average breadth, having an area of 5,700 square miles and a population of 10,65,423. For revenue purposes the district is arranged into 15 talooks.

Bramadastum.	Punjamaul.	Streevygoontum.
Hoozoor.	Santoor.	Tencausey.
Naugoonairy.	Sherkerninar Govil.	Tatacoreen.
Nellamballum.	Sherimadavy.	Vedooogramum.
Oottapadarum.	Streevelypootoor.	Vulleyoor.

There is a ridge of mountains towards the west, but the country generally is open. It has few hills and no rivers of magnitude but is watered by many small streams flowing from the western mountains. In my report on the marbles of Southern India I gave some information regarding the crystalline limestones it contains. Since that was published I have printed a geological diagram and remarks on the eastern part of the district, which the Reverend Mr. Caldwell prepared*. These two papers, and the following report on its

*Last year when issuing from the Museum the report by the Reverend Mr. Caldwell of Edyengoody, on the eastern portion of the Tinnevely district, I promised a list of the specimens of rocks and minerals, collected in Tinnevely, by Mr. Bird. This I have not hitherto had leisure to prepare and it was with regret that I subsequently found

iron ores are all that is as yet known of this great province's mineral resources which an investigation of, will, I think, do much for.

I have been favored with the information regarding the iron ores of Tinnevely from Captain Horsley and Mr. Bird, who report that this metallic mineral occurs in various localities of the district. It is met with in the talooks of Vulleyoor and Naugoonairy bordering on Travancore. It is sometimes quarried and used for building purposes, like the laterite of the western coast, which it resembles; though, in general, it is darker in color and contains more metal, but in neither district is this ever smelted, the native furnaces not being equal to the operation. In the vicinity of the hills, in both districts, magnetic iron ore, associated with quartz, is very frequently met with, and some of the pieces have polarity. It is often however free from all quartz and thus consists of oxygen and iron. The natives, however, are as unable to smelt this as the lateritious ore above mentioned and indeed never attempt it in this form though the sand which they smelt, and which is produced in abundance from the hill streams, can only be the magnetic ore in a finely disintegrated state. There are a number of villages all along the foot of the ghauts where iron is made from this sand particularly in the Tencausey and Bramadasum talooks. Steel is made at Vanga-colum in Tinnevely but the process of making it is kept a profound secret, being handed down from father to son as an heir-loom. The price of iron in the Tencausey talook is 1 anna per pound, or rupee 1-0-6 per tolam of 13½ lb. and in the town of Tinnevely itself, 86 miles from Tencausey, iron sells for 1 anna 2 pie per pound. At Vangey-colum where it is made, steel sells at 2 annas per pound.

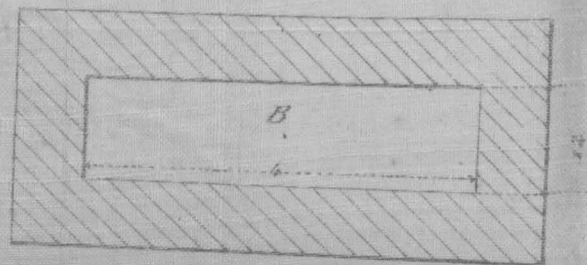
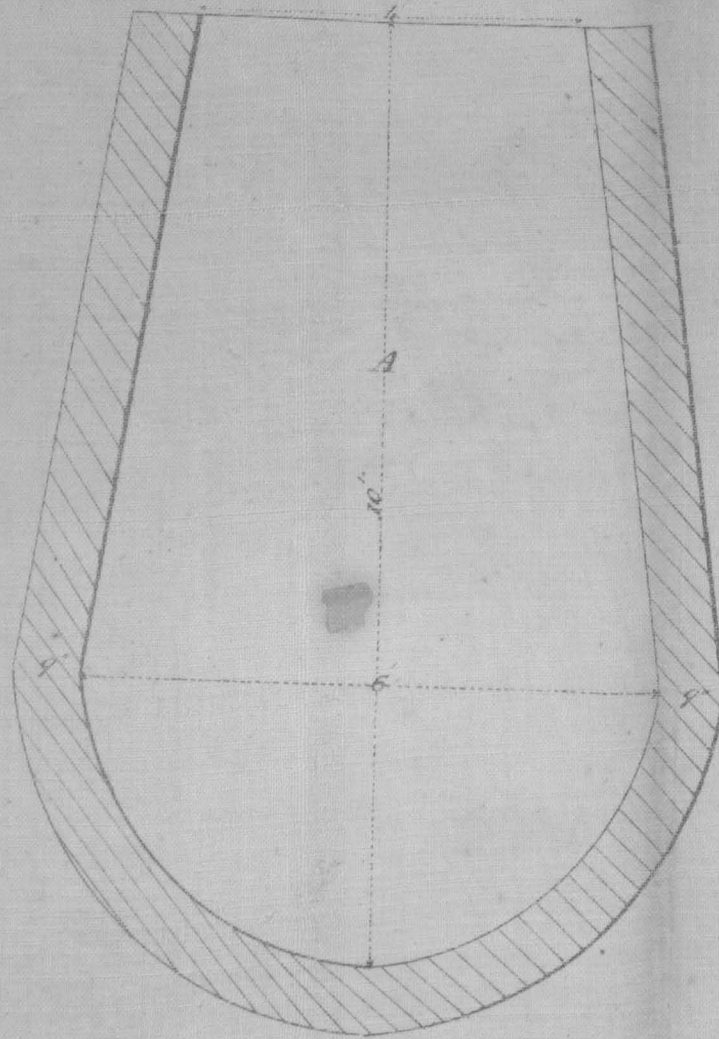
the Reverend Mr. Caldwell's specimens so mixed up, from the breaking of the package, that I have been unable to distinguish from each other the specimens that he had numbered and described.

The Collector of Sea Customs has the honor to forward to the Officer in Charge of the Government Central Museum 2 cases to his address and to state that another package is now lying in the Custom House in a broken condition, the contents requiring to be repacked, which will be delivered to any party authorized to receive the same.

Sea Custom House, } (Sgd.) W. UNDERWOOD,
Madras 11th March 54. } Collector Sea Customs.

In the diagram and in the remarks, Mr. Caldwell described the prevalence of sandstones, compact, coarse grained, fossiliferous, and silicious; but none of these specimens have reached the museum: with the exception of a few specimens of small portions of a lithomargic earth, all that have come to hand consist of limestones, and those mostly fossiliferous. I mention this because it is of the utmost importance to guard against the promulgation of an error as to the structure of this country, and particularly of a part of it such as Tinnevely which from its position in the southern part of this peninsula is so little likely to be travelled over. This precaution is the more necessary also, because the specimens received from Mr. Bird consist of limestones; calc spar; dolomite crystalline and compact; and so far as I have yet been able to understand, these limestones are upraised, traversed and altered by granites and trap rocks.

I trust to have an opportunity of examining the district which forms the subject of Mr. Caldwell's remarks and have the matter set at rest.



A. A Vertical Section through a native Blast Furnace.

B. A Horizontal Section of the Furnace at the charging Mouth.

Scale - 2 feet to an Inch.

It may be useful after the above general remarks to enumerate the sites in the Tinnevely District where iron ore exists in abundance.

(1 & 2.) The streams on the slope of the Koloonthoonamaly hill in the limits of (1) Sherimadavy, and (2) Naugoonairy talooks.

(3.) The river Varanuddy and its several tributary streams near Noon-nymalay hill of Alwarcoorely, and Poolyenthavoo, jungle streams at the foot of the hills in the Perumputh limits of Kadien village in Bramadasum talook.

(4.) Mavoothoo jungle stream in the Saptoor Zemindary, Animah Chuth-rum stream in Sundyoor Zemindary, Thalamaly river of Elundycolum, Cullame river and Varathavoo river of Vatrayeroopoo; Chockumma Colum jungle stream of Cottyoor; and Pauseyputh stream of Paryoor, all in Streevellypoottoor talook.

(5.) The foot of the hills situated in the limits of Pooliengoody, Vasoothavanulloor and Cottyoor in the Shevagherry Zemindary, in the Shenkerninar Covil talook.

(6.) The river and the hill and jungle streams lying within a distance of 20 miles from the following 5 villages in the Tencausey talook in each of which furnaces exist viz: Vullum, Chockempetty, Meenachipuram, Muttalambarei and Vauvanasarem attached to Vadacarei.

The quantity of ore that can be collected by one man in a day is from 1 to 6 mercials or 2 to 12 maunds. In collecting it they remove the first coat of white sand by a mamotty or other similar implement and then gather the black sand in small heaps for the purpose of separating all the white sand by washing, after which, the black sand is taken on pack bullocks to the nearest furnace to be smelted.

The sites where furnaces exist and their number are as under,

Talook.	Village.	No of furnaces.
1. Sherimadavy	Oolaguncolum	7
2. Bramadasum	Veeramoodrum	17
	Vatrayeroopoo Canosapoorum	3
	Coomaputty	2
	Maharajapoorum	10
3. Streevellypoottoor	Thambypetty	4
	Kistnapoorum	9
	Thommanaickenputty attached to Paryoor	4
4. Naugoonairy	Ediencolum	7
	Pooliengoody	4
	Vasoodavanulloor	4
5. Shenkerninar Covil	Coattyoor in Shevagherry Zemindary	2
	Vullein	
	Chockempetty	
6. Tencausey	Menatchepoorum	
	Mattalambarei	
	Vavanagarum attached to Vadacarei	

Mr. Bird has favored me with six plans of furnaces three of which also contain drawings of the implements, and two others plans of the tools, &c. employed in smelting the ore and working the iron. The expense of erecting a furnace is estimated at rupees 2-9-4 to 2-12 exclusive of the charges required for putting a roof over it which is estimated from rupees 5½ to 7 rupees or, both together, rupees 7-13-4 to 9-12. The cost of working a furnace is 1½ to 1½ rupee per diem or 7½ to 31½ rupees for from 6 to 20 days in a month which latter is the longest period during which it can be worked in the month: each furnace is reported to hold 5 to 10½ mercials of ore, = 10 to 21 maunds.

There are no other than the above named places where iron ore is procured to any extent. The total quantity of iron produced in the whole district throughout the year is supposed to be about 35,702½ tolams equal to 20,401½ maunds. There is only one kind of iron made, the price per tolam of which is from annas 4 to 6 and piece 8, 989½ maunds of iron were exported from this district to Travancore in 1853.

It is only crude iron ore, Irotimbookute இரத்திமபூகூடு, that is manufactured. Steel is manufactured only in one village called Vagycolum attached to Bramadasum talook in this Zillah and there is only one description of it. The black ferruginous ore is converted into metallic iron by smelting it with charcoal: one measure, equal to 6½ lbs, of black sand mixed with 3 to 8 measures, or 1½ to 4 lbs, of charcoal is put into a large crucible erected in the midst of the furnace and a brisk fire kept up by means of bellows from morning to evening: as the black sand begins to melt more ore and charcoal are thrown in till the ore amounts to from 5 to 10½ mercials or 10 to 21 maunds and the charcoal from 40 to 84 mercials or 6½ to 13½ maunds. This produces an ingot or iron pig weighing 2½ to 4 tolams or 35½ to 57½ lbs., which the blacksmiths purchase at the various rates of 3½ to 6 pice per lb. and breaks into pieces with a large hammer after heating them in the forge. These pieces are then forged into implements of ploughing and commodities as per list accompanying and sent to the market. Specimens of the iron received from each talook as taken from the furnace and samples of the same from 2 talooks as taken from forges were sent, together with that of steel from the forge at Vagycolum in the Bramadasum talook.

In the year 1853, iron aggregating to 41,411½ maunds, was imported into this Collectorate from the following places, in the proportions set down. Of this amount only the import from Port Novo consisted of pig iron, whilst that from all other places was received in a manufactured state or commodities such as tyre, bar, &c.

	maunds.		maunds.
Port Novo	28,134½	Madura	180
Bombay	6,912½	Tanjore	40
Madras	5,230½	Malabar	24
Columbo	9,113½		41,411½

being gentle. The east and west sides also are pretty steep. The natives said that Doray-guda is about ten cosses to the S. E. and that there is a continued ridge of low hills extending the whole way between the two mines; but none of them contain ore. The surface of Cudera Canavay is smooth and, is not interrupted by rocks. The soil is a poor red earth, Dr. Buchanan saws only one lump of hematite; and that, when compared with the fine mmasse lying on the surface of Doray-guda, was very poor, and ill-formed. The whole extent of the hill is not great, and the miners had contented themselves with digging the ore from the surface of the hill near its summit. No shaft nor pit having been made, he could not form any estimate of the quantity of ore remaining. The mine appeared to be much richer than that of Doray; for the quantity of barren stone intermixed with the ore was very small. This barren stone resembles the ore very much; and, no doubt, could the natives extract it, contains much iron. The specimen which he brought away, had concentric layers somewhat like a log of wood. The superficial earth in most places was not above a foot thick. On digging into it, the miner comes to a mixture of ochres, earth, and ore, in a tabular form. This mixture sometimes extends in depth so far as has been wrought, which nowhere, that he saw, exceeded five or six feet. In other places the miner meets with large masses of ore consisting of a number of plates united together like schist. This by the miners was called black iron-stone. These masses have a tendency to divide into rhomboidal fragments. In other places, the ore occurred in flat pieces, divided by fissures into parallelograms, perhaps three inches long, two broad, and one thick. These fragments are placed in layers contiguous to one another; but they are separated by the slightest force, the fissures being filled up with reddish ochre. By the workmen this was called red-ore; and because it could be taken out of the mine with the least trouble, it was most esteemed. All the kinds, when broken to small pieces, and rendered proper for the furnace, are quite the same. The manner of working was very simple. The miner formed a cut with a perpendicular surface, and threw all the rubbish down the declivity. He then continued cutting down from the hill, with his perpendicular surface, two or three feet in height. He worked with a pick-axe, and cut promiscuously through earth, stones, and ore. Having brought down a sufficient quantity, he rubbed the fragments; and having picked out the smaller pieces of ore, he threw down the hill all the earth, ochres, barren stone, and larger masses of ore; for the trouble of breaking any of these into lumps the size of the first, is greater than that of cutting down more from the hill. Dr. Buchanan states that he observed nothing like strata in the mine, and he looked upon the form the ore had assumed as of very recent date.

Mines on Doda Rashy Guda.—Dr. Buchanan (Journey vol: 3 p. 376)

examined the mine of ore called Kemodu and another of iron, on Doda Rashy Guda. The ore is smelted here in the same manner as at Chica-bayli-caray. When the process failed a brittle porous mass was obtained, which had a greater resemblance to our cast iron than any thing that he had seen produced in India. This mass was fused in a furnace of lower power, and gave an iron softer than the common kind; and from this soft iron were usually formed the hoes, and other digging instruments of the natives. Doda Rashy Guda or great heap hill which contains the mines, is a peak about three hundred feet in height, and a mile in length, that forms part of a ridge running nearly north and south, and lying east from Caducaray. Between the mine and this village is another ridge, on the northern extremity of which is a temple dedicated to Ranga, and named Mavana Canavay, from which the rivulet so called has its source.

As he ascended this nearest ridge, the first rock which he met was an earthy quartz, or hornstone, divided by fissures in all directions, and having some of these fissures filled with veins of white quartz. This rock is not vertical, but dips much toward the east. Further on, the common rock consists of alternate parallel layers, firmly united, of white and quartz, and of brown iron shot quartz, or horn-stone. These layers are sometimes plain, and at others disposed in swirls; and as the stone in decay, by the attrition of its longitudinal angles, has a great tendency to assume a cylindrical form, and always breaks in masses truncated at right angles to the layers, it is often found in pieces which have a strong resemblance to petrified wood. The stone does not break regularly in the direction of the layers, which are disposed in the same line with the strata. These are vertical, and run nearly north and south—but he was by no means sure of the nature of the brown part of this stone, he thought it may very possibly be hornblende overcharged with iron; and the sienite found nearly in the direction of its strata, strongly confirms this opinion.

Kemodu.—Between the two ridges he came to the channel of a rivulet, named Aladi-holay; which at that time was quite dry and here he found the place whence the glass makers procure the ore called Kemodu. For about three quarters of a mile the bed of the rivulet is filled with stones of a steel-grey colour. Many of these are the ore called Kemodu. It is in water-worn masses, from the size of a man's head downwards, and possesses the external characters of the grey ore of Manganese. When powdered it is attracted by the magnet. Intermixed with the Kemodu are other masses of a similar appearance but which are useless. On breaking these they are found to be all different, from the common rock before described to almost perfect ore.

Source of the Kemodu.—On ascending the eastern bank of the rivulet

The iron commodities sell at rupee 1-2-2, per maund. The Porto Novo pig iron alone is applied to all the purposes for which iron is useful.

The names of all the tools and implements manufactured in this district from the iron of this country, with the selling price of each are given in the accompanying list. Four papers of drawings of the instruments marked A, B, C & D were also sent.

The charcoal employed in smelting the ore is brought from hills. The charcoal sells at the furnace for 7 annas per cottah equal to 84 lbs. The quantity expended for one smelting is from 40 to 84 mercials or 160 to 336 lbs.

There are no forests in the immediate neighbourhood of the furnaces which are generally erected in the vicinity of habitations not far from the hills. For preparing charcoal a man proceeds to the hill in the morning, fells those trees which are not useful for timber, chops them into pieces puts them into a pit dug for the purpose and setting fire to them covers the pits first with boughs &c. and then with mud, and afterwards returns home in the evening. He proceeds the next day to the same hill excavates another pit fills it with pieces of wood as he did the first day and covers it, then removes the old covering and takes the charcoal home and sells it for 2 or 2½ annas.

They prefer Indian iron to English. The reasons given by them for that preference is that the Indian iron is softer than the other.

From 2 to 5 annas is the wage of a smith.

No improvement can be suggested on the methods now adopted by the native manufactures that would tend to cheapen the cost of production.

The iron produced from one smelting is from 2½ to 4 tolams or 35½ to 57½ lbs. From this and the answer to the last part of the question No. 3 it will be seen that 14 to 16½ lbs. of metallic iron is produced from 100 lb weight of the ore.

Half of the metallic iron is lost in converting it into bar iron.

A LIST OF NAMES OF TOOLS &c. MANUFACTURED FROM THE IRON OF THE DISTRICT OF TINNEVELLY, WITH THEIR SELLING PRICES.

No. in the papers of drawings and B accompanying.	Tamil Names of Tools and implements &c. marked A manufactured from the iron of the Tinnevely District.	The same in English.	Selling price as per list received from the Tabulars of				Definition of the terms.
			Brenna-dusem.		Shornna-day.		
			R.	A. P.	R.	A. P.	
1	விச்சரிவான்	Veecharwal	0	12	0	0	0 A kind of heavy bill hook.
2	கோடரி	Kodaree	0	6	0	0	8 Axe.
3	கந்தாலம்	Koondalum	0	10	0	0	12 6 A kind of pick axe with a sharp point at one end.
4	பிக்காகல்	Pickaxe	0	14	0	1	8 0 Pickaxe.
5	குமிழுணி	Koomubani	0	1	0	0	3 4 Nail with a head or stud.
6	கம்பையாணி	Kambeiani	0	2	0	0	0 { A kind of nail used in joining the cross piece of wood holding the door plank together to the door.
7	கதவுக்குப்பி	Kadavocoppu	0	2	0	0	3 4 { Air iron ferrule at the point at one end of a hot tom part of the door upon which it turns.
8	பூடுகு அல்லது பிடுகு	Poodogu	0	0	6	0	11 8 Clamps.
9	கொண்டமுனை	Kondemoolie	0	0	6	0	3 4 A kind of iron peg.
10	பாளையரிவான்	Paleiarival	0	2	6	0	5 0 A kind of light billhook.
11	கீல்	Keal	0	8	0	0	6 8 The same as attakeal—See No. 14.
12	கொண்டிக்குரை	Kondicooloo	0	2	0	0	3 4 Plough share.
13	கரைக்குரை	Sorricooloo	0	2	0	0	3 4 A kind of ditto.
14	அட்டைக்கலை	Attakeal	0	3	0	0	1 0 Hinge of the cover of chest, &c.
15	காசாணி	Kasani	0	8	0	0	0 A kind of nail with the head like a cash.
16	சட்டையாணி	Sadeiani	0	4	0	0	0 Do. with the head protruding a little at both ends.

periority of the Gwalior iron over that principally worked in the Himalayahs, depended on the former being a magnetic ore, like that of Sweden; but the first accurate information on the subject was communicated by Dr. Royle to Mr. De La Beche, who states,* on the authority of that gentleman, that magnetic iron ore is extensively diffused in hornblende slate in the central range of mountains in India, and that it also occurs in the Himalayahs. This geological position corresponds with that of the Nirmul ore: but the latter does not bear any resemblance, except in its peculiar lustre, to the Menaccanite of Cornwall, to which it is compared by De La Beche; nor could Dr. Malcolmson detect any titanium in it. With regard to the geological relations of the magnetic iron ore, it is also necessary to observe that in India it is not confined to the hornblende schist, but is found extensively distributed in the granite and gneiss of the Carnatic and Mysore, in quartz rock near the iron works of Porto Novo; and as has already been observed, associated with galena in the diamond sandstone of Cuddapah. The discovery of a mineral, so generally confined to the primary rocks, in the great sandstone formation, affords an additional argument in favour of the opinion of those, who consider this rock and the subjacent schists, as equivalents to the older European sedimentary formations, rather than to those of the supermedial order."

Of the other districts of the Hyderabad dominions, less exact information is on record, and all my efforts to obtain specimens of the ores have failed. There has no iron ore been found in the northern or southern divisions of the Berar district and all the iron and steel used in the latter is imported from Bombay, Jubbulpore and Nirmul. Neither is there any iron ore in the western division of that district, the rocks in which consist wholly of the trappean formations, and though some small hills of coarse laterite occur in the Nelingha and Owsa Talooks these do not contain any ore of iron. Captain Bullock, however, considers it likely that iron ore will be found in the Gangriah range, on the bank of the Taptee.

The tract to the south and south west of Burra Ekailce and part of the Tandoor and Chincholee Purgunnahs are considered by Captain Taylor to be the nearest iron ore district. But at present the iron imported into the western division of Berar is said to be brought from Bellary and Cuddapah, and a small portion of British red iron via Ahmednuggur and Sholapoor. Nor has iron been discovered in the district of the eastern division of the Raichore Doab, the iron required being imported from Bellary.

Iron ore is found however in some places in the hill country about Tavengere and in large quantities in Moloor. Some years ago an attempt was made to smelt iron at Tavengere, but was abandoned, probably owing

* Manual of Geology, 3d Edit. page 435.

to the exactions of zemindars, and the only iron now manufactured in the district is at Seevapoor to which the ore is brought from Soondoor. Dr. Voysey in his private Journal speaks of the iron mines and iron and steel of Sinsellah, and in the Madras Central Committee's proceedings (p. 155 and 124) mention is made of the existence of Hematite, yellow and brown clay iron ores; sand iron ore for the manufacture of steel iron; glance and iron pyrites; and of the existence of oxidulous iron ore in the Warungul and Cummumet District. In his report on the northern and eastern districts of Hyderabad the late Dr. Walker also mentions (Madras Journal of Literature and Science vol. 16 p. 182) the first of its products in importance to be the ores of iron which are very widely and commonly diffused, occurring as they do, not only in the granite, and gneiss; but in the sandstone on the bank of the Godavery and in the limestone which bounds the Kistnah.

The oxygenated iron ore besides being found throughout the Warungul Circar is met with in Cummumet particularly in the Purgunnah of Kulloor and Anantagherry, where it is extensively smelted, and the ore sent to the Purgunnahs of the Circar, and also to the neighbouring Circar of Dewarcondah to be there manufactured into metal. In the Godavery sandstone, the brown clay iron ore is found existing on the surface in the shape of rolled pieces of various sizes, and in such abundance that no mining is required to supply the few furnaces, the ore being picked up from the sides and foot of the low hills. In the Elgundel and Maiduck Circars yellow clay ore is found wherever laterite rests on a trap hill; it is mined with facility and ease, the chief labour in furnishing the supply being the toil endured in ascending and descending the steep hills where it is found. There are furnaces at Lingumpilly, in the Maiduck and Tatapilly, Nizamabad, in the Elgundel Circar. The iron procured from this species of ore is used in the manufacture of steel, and a kind of monopoly of it is attempted by a Mogul who farms the famous steel manufacture of Konasamoondrum near Neermul, from whence steel is sent to Persia and Arabia. The common mode of smelting is well known to be rude and imperfect, great labour is bestowed in the process and much less incurred, about 8 or 10 per cent. of metal is procured from the richer ores, but the poorer, which possess however the advantage of being more easily smelted, scarcely yield half that produce. Hematite and Pisiform iron ore are found in many parts where the formation is granitic, but they are never manufactured into iron. Lumps too of titaniferous iron ore are frequently found in sinking wells, and sometimes superficially in the same formation; they are never smelted. A dark brown cubical iron ore is found in the tabulated limestone of the Kistnah but it is considered useless; it is not found in very large quantities. He had also seen specimens of glance iron ore found in the granite, and sometimes used for antimony to sprinkle the eyelashes.

A LIST OF NAMES OF TOOLS &c. continued.

No. in the papers of drawings and marked A and B accompanying.	Tamil Names of Tools and implements &c. manufactured in the districts.	The same in English.	Selling price as per list received from the Tabulars of			Definition of the terms.
			Brenn- dansen.	Sherma- davy.		
17	வெட்டிவான்	Vettarival	R. 0	A. P. 0	Billhook	
18	குழைச்சுமன் வெட்டி	Koolochai Muna-vetty	0	6 0	0	8 Mammatry or spade with an eye to admit the handle.
19	தாங்குமன் வெட்டி	Tharanga Mun-vetty	0	5 0	0	Do. with a point at head to be driven into the handle.
20	காப்பான்	Tappaul	0	4 0	0	{ Bolt.
21	கொண்டி	Kondy	0	0	6 {	Hinge upon which a gate or door turns.
22	நாங்கிலிக்குடி	Mauranghi or Nattanghi	0	4 0	0	{ A kind of joint or hinge fastened to the door or its side post to admit of the chain used for holding it—a clincher.
23	மூன்று கண் சங்கிலி	Moookan Sanghily	0	6 0	0	118 A chain of 3 links.
24	ஒத்தைகண் சங்கிலி	Ottakan Sanghily	0	4 0	0	10 Do. of one long link.
25	பூட்டு	Poottoo	0	9 0	0	4 { Lock.
26	சதாக்கைச்சால்	Doseikal	0	2 0	0	{ A frying pan to fry pancakes upon.
27	டேலியம்	Sattooyam	0	4 0	0	{ A kind of ladle used in making pancakes.
28	கொஞ்சுநாப்பான்	Sorugu tappaul	0	3 0	0	4 A kind of bar bolting perpendicularly.
29	தொழிந்த நாப்பான்	Thoretti tappaul	0	0	0	0 Do. bolting horizontally.
30	சுமன்டகம்	Karanduan	0	2 0	0	{ A chunam box to contain fine chunam to be rubbed on betel leaf before chewed.

31	பாக்குவெட்டி	Paukoovetty	0	1 0	1	2	0 A kind of scissors for cutting area nuts.
32	கொனியூசி	Koneloose	0	0 2	0	0	4 A kind of large needle used in sewing gunny.
33	வாச்சி	Vauchi	0	10 0	1	8	0 Adze.
34	(பெரிய சுத்தியல் அல்லது கூடம்)	Paria Soottrial or Coodem	0	7 0	2	8	0 Sledge hammer.
35	சுத்தியல்	Soottrial	0	4 0	1	8	0 Hammer.
36	பத்தக்குறு	Pattacoradoo	0	6 0	0	3	4 A pair of tongs.
37	ஆட்டி	Aupoo	0	4 0	0	2	0 An iron wedge.
38	மலைக்கடம்	Maleicoodem	1	4 0	4	0	0 A kind of smith's hammer, heavier than the sledge one.
39	கொட்டலாம்	Kottalam	0	10 0	1	4	0 Mason's hammer.
40	மடக்கால்	Maracal	1	0 0	1	0	0 A measure of capacity containing 8 puddies.
41	நாழி	Nazhi	0	6 0	0	6	0 A measure equal to one-eighth of a meral.
42	ஊக்கு	Olluck	0	2 0	0	4	0 One fourth of a puddee.
43	(தவளைக்கொத்து விநிவதான்)	Thavaleikottoo	0	4 0	0	0	0 A kind of iron hook.
44	நாந்து	Virivoothaul	0	1 0	0	0	0 A hook.
45	வண்டிப்படை	Thoorandi	*3	8 0	+5	3	4 Tyre.
46	குடப்பூண்	Vandy puttei	0	2 0	0	2	6 Washer of the nave.
47	அச்சு	Coodapeon	0	4 0	5	3	4 Axle.
48	சாவி	Achul	0	3 0	0	3	0 Linch pin.
49	பெட்டிசாவி	Petti Savi	0	2 0	0	0	0 Key of box.
50	பெருந்தாணி	Yazhuttani	0	0 6	0	2	0 { A style or iron pen.
51	சூரி	Soori	0	0 4	0	0	0 { A knife.
52	சுண்ணாம்புத்தி	Soomambookutti	0	8 0	0	0	0 A cruet or cruse to keep in fine chunam.
53	குடைபாணி	Koodeani	0	0 0	0	1	8 A nail of a larger size than the Kausani No. 15.
54	கையாணி	Kyani	0	0 0	0	0	10 The nails used in joining the spars of a roof.
55	பட்டையாணி - 10	Pattayamies 10 in No.	0	0 0	0	0	4 A nail for reapers.
56	கடப்பாணி	Cadapanel	0	0 0	1	0	0 Crowbars.
57	தொடப்பூட்டி	Thottipoottoo	0	0 0	2	0	0 A kind of lock.

* Weights unknown.

+ Of 5 tolas.

beyond the mine of Kemodu, he came to a conical peak on the eastern ridge : and observed that all the stones on its side were stained with the steel grey of that ore. He saw none perfect on it ; but on breaking the stones, he found them in all stages, from the rude rock, to a state approaching to maturity. Indeed, many grains of pure Kemodu were very discernible, imbedded thickly in the substance of these stones.

Common Iron ore.—Immediately south from this spot (Vol. III. p. 378) is the peak called Doda Rashy Guda, whence the iron ore which supplied the forges was procured. This ore is quite the same with the black kind at Cudera Canavay, but it is disposed in a different manner. It is imbedded in large irregular cavities of the barren stone, or matrix. This consists of plates that are separable without much difficulty, and which he had no doubt, are the brown layers of the common stone of the hill separated by the white ones having been corroded by iron. Its strata may be traced running in the direction of the meridian, and in general vertically. The ore is similarly composed of plates ; owing to the nature of the mine, the manner of working it was somewhat different from that used at Cudera Canavay, and the workmen were forced to dig the ore from under the caverns of the matrix. He nowhere saw that they had ventured in farther than ten or twelve feet ; so that he could not say whether or not the internal parts of the hill contain any veins, or rather beds, of ore. Openings have been made in various places for about a quarter of a mile in length, which seemed to be the extent of the mine.

In a recent communication which Dr. Kirkpatrick has favoured me with, he mentions the occurrence of a black ore (Iron or Tantalum ore) from Shemoogah talook ; magnetic iron ore and laterite or vesicular Hematite from the Bababooden hills and Shemoogah talook ; and iron ore from Oeddoor talook, and native sulphate of iron from the Bababooden hills.*

Dr. Clarke (Geology of Bangalore p. 107) mentions that he had been favoured with specimens from the Bababooden hills and that flinty slate and quartz rock much impregnated with iron seemed common. One specimen of flinty slate, or perhaps what Buchanan would call hornstone, affected the magnet, and another was full of particles of iron sand, granular magnetic iron ore. He possessed two kinds of the magnetic iron—one an amorphous mass, of a reddish blue colour, magnetic and possessing polarity in a very great degree—in fact the natural magnet or loadstone, apparently the same as found in Siberia and the Hartz. The other specimen or specimens are slaty, tabular slaty masses externally of a brownish yellow tinge and internally of a dark purple colour. This slaty kind is also highly magnetic, and exhibits polarity in a

* None of these specimens have reached me.

very high degree. Besides these, there is hematitic iron ore and its passage into a rock which somewhat resembles laterite.

Dr. Clarke thus continues, "I am not aware that this rock enters into the formation of the Bababoodens, but it is found in the neighbourhood.

The rock, then, forming these hills are flinty slate, and quartz rock, both much impregnated with iron, the granular magnetic iron ore. Hematitic iron ore, slaty magnetic iron ore, the same in amorphous masses, and argillaceous potstone. Dr. Clarke adds that the whole of the Nuggur or Bednore district of Mysore abounds with iron which he was told fetches a very high price in the Bombay market. At Hurryhur, distant from Bangalore 185 miles, and according to Heyne 1831 feet above the level of Madras, and probably the lowest point in the whole of Mysore, Buchanan tells us the basis of the country is somewhat between an argillite and schistose hornblende and between the strata of this argillaceous hornblende slate are masses of an earthy quartz or hornstone impregnated with hornblende.

A list of the specimens of iron ore from the district of Mysore now in the Museum will shortly be printed.

NAGPORE.

Although the Nagpore country has only in the past year fallen into the possession of the East India Company, by the demise, without heirs, of its Rajah, it has long been occupied by the Madras Army, and, thus, in a military point of view, belonged to the Madras Presidency. The general situation of these territories is between $18^{\circ} 40'$ and 20° N. L. and $78^{\circ} 20'$ and 83° E. Longitude. Their extreme length is about 450 miles from north to south and their breadth from east to west about 300 miles. The total area of the country is 76,432 square miles with a population of 4,650,000. Nagpore is bounded on the north by the Saugor and Nerbudda territories ; on the south by the Hyderabad country ; on the west by the Wurda and Waen Gunga which separates it from Berar and the east and south east by hilly tracts and uncivilized tribes.

There are plains immediately in the vicinity of Nagpore ;—between the Wurdah river and the Waen Gunga, and at Chutteesgurrh which are extensive and reach from the foot of the Langhee range of hills to the banks of the Mahanuddee : all of these plains may be about 1,100 feet above the sea ; but with these exceptions, the general aspect of the country is mountainous and woody and the Puchmurree hills attain an altitude of 4,200 feet above the level of the sea.

The country is traversed by many rivers, the Wardah, Waen Gunga, falling into the Godavery ; the Mahanuddee, &c. &c. which are navigable for several months of the year to boats of considerable burthen.

TRAVANCORE

is not British Territory but a native state with which we have a subsidiary alliance. It forms the most southern portion, on the west, of the peninsula of India, and has an area of 4,722 square miles with a population of 1,011,824.

In the Madras Almanac for 1838 is a long article which gives the following sub-divisions of this territory.

Agusteshwer,	Kunutumaad.	Puraur.	Trevandrum.
Amballapullay.	Kurnagapullay.	Peeravum.	Tirwalla.
Aulungaad.	Kunatoor.	Pundalum.	Thoduwalla.
Changanashairy.	Manvillaykurray.	Quilon.	Vellavancode.
Kotium.	Meenachel.	Shencotta.	Yeddapullay.
Kartigapullay.	Mautapully.	Sharetulla.	Yedanunga.
Kottakurayya.	Neyattencurray.	Sharankeel.	Yathumanur.
Kukkolum.	Neddoovencaud.	Tooallah.	Yekum.

The most recent information extant regarding the iron ores of this territory will be found in the Catalogue of the Madras Exhibition, from which the following extract is taken :—

"The principal ores obtainable in any large quantities are iron and Plumbago. The former is found mixed with sand, stone, laterite and clay in nine places of the Districts, viz. Shencottah, Agasteeswarom, Neyattencurray, Neddoovengaud, Quilon, Coonatoor, Moottoopolay. After collecting a quantity of the ore sufficient for one furnace, it is removed to the furnace into which it is placed with alternate layers of charcoal. The furnace is then lit up and a blast kept up with a pair of bellows till the ore be smelted, the fire is then extinguished and the metallic mass is found in a rough bloom which is converted into malleable iron by repeated beatings and heatings :—or by being again smelted is converted into steel. The District of Shencottah is the only one in Travancore where any extensive smelting of iron ore is now conducted; a quantity of about 600 candies of iron bloom is annually manufactured, which at an average rough calculation is equal to 300 and odd candies of malleable iron. From all the other Districts together, the annual manufacture does not exceed 200 candies of bloom or about 100 candies of malleable iron.

<i>Names of District.</i>	<i>Annual Production of Crude Iron. Candies 500lb. English.</i>	<i>Malleable Iron. Candies 500lb. English.</i>
Shencottah.....	558	313
Agasteeswarom.....	104	78
Neyattencurray.....	2	1½
Neddoovengaud.....	3	2
Quilon.....	3	2
Coonatoor.....	16	8½
Moottoopolay.....	1	½

This manufacture if scientifically conducted and properly encouraged, could

be improved so as to meet the wants of the country, which is not the case at present. For a better and cheaper article is imported.

The quantity of that article, annually imported into this Country, is as follows :—

Years.	lb.	Years.	lb.
1850.....	728	1853.....	1068
1851.....	1182	1854.....	847
1852.....	1118		

"Plumbago" occurs in many places near Trevandrum as well as in the Districts of Neddoovengaud, Neyattencurray, Velavancode, &c., it is found in large masses and of good quality in some places, while in other localities it is mixed with laterite and other rocks. No use is made of this article here except by the Potters who rub the outside of their pottery with it to impart a temporary shining colour, for when washed in water it goes off. Any quantity of it may be collected without much trouble. The specimens sent to the Exhibition are all from places within 14 miles of Trevandrum, and from 4 to 5 feet from the surface. The 3 specimens separately packed in a lump, were obtained 5 miles S. E. of Trevandrum from a clay soil and the rest out of a laterite bed 5 feet below the ground. These two are the only minerals, of this class, as yet discovered in Travancore."

It would appear from the information sent to me, that there are a number of villages all along the foot of the ghats, on the eastern side where iron sand is smelted, particularly in the Shencottah talook. It is also manufactured in the southern talook of Travancore, and the following memorandum shewing the quantity and cost of iron made from the ferruginous sand at Myladdy in the Agasteeswarom talook will be found interesting.

One bullock load of sand when properly smelted produces one or more lumps of impure metal (termed by the natives cutties) which are valued at from two to three rupees. These cutties are then given over to the smith who reduces them to pure metal by means of repeated heatings and hammerings, and the iron thus obtained is valued at a half more than what it fetched in its impure state. The time employed in bringing the sand from the hills, washing, cleaning and preparing it for the smelting process, until it is finally reduced to the cuttie state, is generally from five to six days, and one day more must be allowed for the operation of heating and hammering by the smith. The weight of the good iron thus produced is usually from four to six tolams, the tolam being 16½ avoirdupois. Thus, after seven days labour, one bullock load of sand reduced to iron, may be valued at an average of rupees 3½, but this calculation supposes that the sand is of the first quality; for if mixed with earth or other foreign matter the cutty obtained from it will be less both in quantity and quality. From the foregoing data, it will be found that one ton of iron will cost about rupees 100, and that the time required to make that quantity will be about 190 days.

Mr. Beaumont the active and scientific Superintendent of the Porto Novo Company sent me two boxes of specimens, in order to show the materials used and the products of the different processes in the manufacture of iron, all arranged in order. Also specimens of the Malabar Jungle woods, interesting because so numerous, and varied in quality and appearance. He desired me to note, as it may not be known, the very much larger scale of furnace and native iron manufacture, in Malabar, than in the districts East of the Ghauts. The Moplahs, in iron making, as in other things going ahead. He sent me a sketch of the Malabar native furnace which differs in shape from that employed in Salem &c.—but all practice precisely a similar process. He also promised a case of tools, knives, &c. &c. all made by his own workmen out of his own iron.

MADURA.

The provinces which now form the Collectorate of Madura in the Southern Carnatic came into our possession on two separate occasions, in 1792 and 1801. This Collectorate lies between the and degrees of north latitude and the and of east longitude, is bounded on the north by Coimbatore, on the south by Tinnevely, on the west by a range of mountains which separates it from Malabar, and on the east by the sea. It is 199 miles long and 166 broad.

It has an area of 10,700 square miles and 570,340 inhabitants, and for revenue purposes is divided into the following twelve talooks.

Dindigul	Mailoor	Shevagungah
Hoozoor	Nellacottay	Teroomungalum
Iyempully	Rangaree	Tandicomboo
Madacolum	Ramnad	Thencurray.

In its physical features, the country is flat to the south and east and hilly and mountainous on the north and west, and has forests and fertile valleys.

The geological features of the country have been well reported on by the Rev. Mr. Muzzy who has kindly given the Government Museum the benefit of those few leisure moments which he could spare from his devoted Christian labours, and as these have just appeared, in a separate form, it will suffice here, to mention that the rocks of Madura consist of granite, sienite, and gneiss, with mica and clay slates; that the most important of the minerals are quartz, opal, marble, beryl, garnets, steatite, gold and iron, and that there is a prospect of more important minerals being discovered. Regarding the iron ores, however, which forms the subject of this report, the Rev. Mr. Muzzy mentions

In 1839, Captain Horsley informs me that he superintended an experiment with the iron ore of the south of Travancore, a rich oxide of iron procured in the vicinity of Oodagherry. A blast furnace on the English model was erected and a tolerably efficient blast maintained by means of a double actioned bellows worked by manual labour: but owing to the want of good fire bricks the result was not so satisfactory as it otherwise would have been. Out of 680lbs. of ore, about 45 per cent of good iron was obtained. Limestone in the proportion of lbs. $1\frac{1}{2}$ to lbs. 10 of the ore was used as a flux and charcoal as fuel: of the latter 1,700lbs. were consumed in smelting the above quantity of iron.

In addition to the above information to which I am indebted to Captain Horsley, General Cullen has sent a packet of the iron sand collected in the beds of hill streams in the extreme south of Travancore in the vicinity of the Arabooty lines; also specimens of iron of the 1st melting and also of the more perfect iron as used on the 2d melting also 3 smaller specimens of gneiss to show the rocks forming the large hill near which, in the laterite, are found numerous specimens of iron ore, all from a place called Thonikul a little S. E. of Allinghal (or Theranghul) near Azengo.

The ore is mined for in the laterite, circular holes about $2\frac{1}{2}$ or 3 feet diameter being sunk through the laterite to a depth of about 30 feet. The stratum of iron ore is met with, it is not above 6 or 8 inches thick but forms a nearly uniform stratum at that depth from the surface.

Very little iron is now manufactured though there are traces of great workings formerly.

The ore is found in ? and ? and it is also dug for in the laterite plateau near Trivandrum.

A list of the specimens of iron ore from the district of Travancore now in the Museum will shortly be published.

LOCALITIES WHERE IRON ORE IS SMELTED IN TRAVANCORE AND THE QUANTITIES OF IRON PRODUCED.

Talook	Localities.	Estimated quantity of crude iron manufactured annually.		Estimated quantity of malleable iron from the foregoing quantity of crude iron.	Nature of the ore.	Candy price per Candy.		
		Candy of 500lbs.	Price per Candy.	Candy of 500lbs.		Candy of 500lbs.	Price per Candy.	Candy of 500lbs.
Shencottah.	{ Shencottah. Shevelanulloor.	558	9 9 6	813 17 6	9 Blacksand.			
		104	25 8 0	78 35 3	Ditto.			
Agasteesheram.	Maroongoor.	3 $\frac{1}{2}$	18 2 0	2 24 4	0 Clay iron stone.			
Nedoovengaud.	{ Thonikul and Bombay Coono.	3 $\frac{1}{2}$	12 4 0	2 $\frac{1}{2}$ 17 8 0	Ditto.			
Quilon.	Pernand.	16 $\frac{1}{2}$	12 0 0	8 $\frac{1}{2}$ 25 0 0	Ditto.			
Coonatoo.	Coonatoo.							

A very rich ore and in remote times extensively worked, but not of late.

(Signed) W. CULLEN.
Resident.

There was a good general description of the products of these territories given about 12 years ago, in the Bengal and Agra Gazetteer, in which it was mentioned that *iron is found in profusion, and smelted from the ore in considerable quantities*; that gold in small grains, but not to any extent, had been found in the sands of the Jook Nuddee, Maha Nuddee, Sen Nuddee, Deo Nuddee and Marree Nuddee: that the once famous diamond mines of Wyraghur had ceased to be worked; that marble, capable of receiving a fine polish, had been found in different parts of the country, that talc, red and yellow ochres, and limestones abound, but good clay for bricks is scarcely to be met with: and that scientific research and experiment would probably bring to light many valuable minerals and fossil remains, hitherto unknown.

The first information which reached me in answer to my recent enquiries regarding the abundance of iron ores in the Nagpore country was given by the Rev. Mr. Hislop who mentioned that on the banks of the Wein Gunga are stores of iron ore which all the railroads in all the world would not exhaust: and since then Mr. Hislop has sent me a report on this mineral product, from which the following information is derived.

Much of the information which he has communicated was obtained by his colleague the Rev. R. Hunter and himself on a mission tour undertaken in January 1853 in entire ignorance of there being any ore in the district they proposed to visit, and performed so as to have little leisure for statistical investigations of a merely secular kind. The remainder of the facts Mr. Hislop learned during a second Mission tour in 1853, in a different district but under circumstances the same as before.

The Nagpore territory is divided into five provinces, one of which usually known as the Collectory may be called the Metropolitan division, and is on the west. The other four are Chind Wada in the north, Chanda in the south, Bandara in the east, and Rayepur to the east of Bandara. It is in the subhas of Chanda and Bandara that the chief iron districts are situated. They are most accessible, lying on both banks of the Wein Gunga, a noble stream, the importance of which to the well-being of Nagpore it would be difficult to over-estimate. In comparing the currency and weights of this with other parts of India, it is to be borne in mind that Company's rupees 100 are generally equal to Nagpore rupees 115 and that the maund in common use here contains 15 sirs of 2 lbs. each.

Answer to Query I. The sites where iron ore is found are,

1. Khandeshwar Hill 2 miles W. S. W. of Injwadi 3 miles in the same direction from Weiragad, and 2 miles in a straight line east of the Wein Gunga.

2. Lohara 17 miles, west of the same river, and about 11' N. E. of Sindawahi.

3. Bhanapur Menda 7 miles, and 4 Gunjawahi 10 miles west from the Wein Gunga, but about 6 miles further down the river than Khandeshwar.

5. Pipalgaum and 6 Metapar 22 miles S. W. from Pawani, which is on the west bank of the Wein Gunga above Khandeshwar.

At all these places, which are within the subha of Chanda, iron ore not only exists abundantly, but is mined. There is another locality in the same province, where it occurs, but is not extracted, viz.

7. Bhanishkhindi 6 miles E. of Segaum, and about 50 from Pawani on the Wein Gunga.

At all the above localities the ore is either magnetic or specular. From Khandeshwar continues Mr. Hislop I had the pleasure to forward to your Museum last year a specimen of ore, which I believe was magnetic. At all events ore of that description is plentiful there. Yesterday I transmitted to you by Banghy specimens of both magnetic and specular ore from Pipalgaum. Both species are found in the same mine, but the one is strongly attracted by the magnet, and the other not. The magnetic ore displays polarity, but its powder is not of so deep a black as is generally the case. The gangue is a hard quartz rock for the most part compact, but at Pipalgaum coarsely granular and apt to decompose on the surface. At Khandeshwar the metamorphic strata are tilted up at an angle of 60° or 70° to a height of about 250 feet above the plain, of which the upper 100 feet are a wall of naked metalliferous rock, appearing at a distance like a huge town rising towards heaven. The country around this mine is flat, though jungly, and a well frequented road parallel to the course of the Wein Gunga passes the foot of the hill. The other sites which I have examined in the Chanda subha for accessibility are very similar to Khandeshwar. None of them however possess the advantage of having a river, that can be made navigable, so near as it. Even without any improvement this tributary of the Godavery could afford a convenient outlet for the produce of Khandeshwar mine for the rainy months of the year.

Laterite or the hydrous oxide of iron is common throughout the subha of Chanda, but from the abundance of the magnetic and specular ores in that province it is not used for any purpose but building.

In the subha of Bandara however the lateritic is the ore commonly smelted. With this view it is quarried in

8. Ambajiri and one or two villages in its vicinity forming the north-west corner of the province, and situated in the parganna of Chandpur. These

TRICHINOPOLY

is a Collectorate in the southern portion of the Madras Presidency with no seaboard but bounded by Collectorates on every side: on the north by Salem and South Arcot, on the south by Madras, on the east by Tanjore and on the west by Coimbatore. It has an area of 3,169 square miles and contains 634,400 inhabitants and for revenue purposes is arranged into 8 talooks.

Arealore,	Moosery,	Volieondapoorum
Conaud,	Torriote,	and
Laulgoody,	Vittoocutty,	Woodiarpolliem.

The country lying north of the Coleroon is chiefly undulating plains intersected by several mountain streams rising in the Putehai Mullay and Collay Mullay range of hills (the highest points of which are 2,500 feet above the plain) which cross the north eastern extremity of the province. The southern portion of the district is mostly flat, comprising a tract of richly cultivated alluvial land along the banks of the Caverry and Coleroon.

Trichinopoly is one of the Collectorates to which the Iron Company's monopoly extends to them, the right of cutting fuel. Mr. Bird mentions that all the iron used by the artificers of the city and generally of the villages, is either from Salem or of British manufacture and imported: that there is only one village in this district where the ore is attempted to be smelted, and this is Coopputty in the talook of Torriote under the Collay Malay range of hills, in the Salem Collectorate, where the ore is dug.

In this village the ore is smelted in the usual method; an earthen clay furnace of about 3 feet high and 1 foot 6 inches breadth is constructed, charcoal is laid thickly on the floor, the ore is placed thereon, and then charcoal piled on the ore. Fire applied, and two blast bellows kept going until smelting takes place, and the lumps of metallic iron formed. A furnace of the dimensions quoted above is capable of smelting at one time about 15 Madras measures of ore, and the daily yield of iron is valued at 9 annas and 8 pice. The monthly cost to work this furnace would be rupees 5-10.

No steel is manufactured in the district.

Charcoal is abundant and cheap and the brush wood jungles extensive and dense, throughout the Arealore and Woodiarpolliam talooks.

A list of the specimens of iron ore from the district of Trichinopoly now in the Museum will shortly be forwarded.

VIZAGAPATAM

is a non-regulation district or Collectorate on the Coromandel Coast lying between latitude $17^{\circ} 10'$ and $80^{\circ} 50' N$, and longitude $82^{\circ} 30'$ and 84° east. It is bounded on the north by Ganjam, on the south by Rajahmundry, on the west by the chain of mountains called the eastern ghauts, which separate it from the Nizam's dominions, and on the east by the Bay of Bengal. It has an area of 15,300 square miles and contains a population of 1,047,414 inhabitants. Its sub-divisions into talooks are ten in number, viz.

Cassimcotta,	Paleondah,
Chodavarum,	Sooloor,
Coopilly,	Survasiddy,
Golgondah,	Vizagapatam town and
Huzzoor Cutcherry,	Vizianagrum.

The country is irregularly mountainous and hilly, and the coast generally bold. Amongst its minerals are found manganese, plumbago, antimony, porcelain earths, felspars, rock crystal, garnets, mica, tale and iron. It has not however, been at all examined and little is known of any portion except the Vizianagrum Zemindary, which the Zemindar and Mr. Crozier, have done much for.

The only other information has been received from Mr. A. Robertson, and from Captain Hamilton through the Military Board. Mr. Robertson mentions that the iron ore of this district are chiefly in tracts seldom visited on account of their extreme unhealthiness, and it has only been by references that he has obtained the following information, regarding the sites of the iron ore, and the existence of eighteen or twenty smelting places in his district. Mr. Elliot mentioned some years ago that, of the iron and steel manufactured, rudely in many places, and particularly in the hills, the steel is reckoned of very fine quality, but differing in no wise perhaps from the wootz, which is already well known in England. He sent a small piece of iron, and a pair of cock-spurs manufactured in the hills, the natives of the hill tracts being much addicted to cock-fighting. These spurs are curious from their great size. They are tied along the middle and hind-claw of the cock, and from the weight and keenness of the weapon, one blow generally decides the combat, serious wounds are often inflicted on the owners from attempting to handle the birds after the fight has begun.

Plumbago also is said to abound in the hills skirting the western boundary of this district. The deposits have never been worked, and that which is brought to the coast is coarse and impure: in an appendix to this report there will be found valuable information regarding an ore which requires further analysis.

knowledge of its arts should have disappeared, but it would seem that even in Mysore and Malabar the enquiries of Dr. Buchanan only 54 years ago have been already greatly forgotten.

Pieces of oxidulous iron are found strewed over the surface of Palaveram Hill, on the sides and at the base of which much black iron sand is to be had when it rains. More of the oxidulous iron was found on a small hill, south of the cantonment, and more abundantly near the village of Coveum.

There are also small hillocks at the bottom of a mountain near the village of Coveum three miles from Palaveram, these small hillocks resemble walls built of red earth in breaking which specimens of magnetic iron ore in quartz are found. And there is also iron dust. The people at that place say that there were, in ancient times, bloomeries there and one of the specimens is a half smelted iron slag containing portions of semi-carbonised wood. On enquiring of Dr. Ratton also he forwarded to me specimens of oxidulous iron and iron sand, met with in abundance in the neighbourhood of Chingleput, although the Tashildar was not acquainted with any locality in the Chingleput talook in which iron ore was to be met with. The servant of the Museum searched all over the surface at the foot of the hills near Chingleput, but found no iron ores except at the foot of a hill called (Venpaukum) three miles south of Chingleput. Mr. Shubrick very kindly detailed a party of convicts with whom he examined the place, and he found iron ores to be abundant. The specimens sent consisted of magnetic iron ore in a matrix of quartz.

The laterite of the Chingleput Collectorate, is a ferruginous clay embedding small rolled pebbles, and with all the characters of a sedimentary rock of the tertiary formation, and I mention this because Sir Charles Lyell classes it among the volcanic formations. The amount of iron in this clay varies in different localities, but it has been mentioned to me that the average does not exceed eleven per cent. It is abundantly quarried at the Little Mount, near Saint Thomas' Mount and at the Red Hills, but in the three localities the appearance of the rock differs. The only ore that seems to have been smelted however is that mentioned by Voysey as near Nyour.

On the borders of a tank north of the Red Hills he obtained a very considerable quantity of the pisiform brown iron stone which he found also at intervals all the way to Nyour Choultry, in the neighbourhood of which it occurs in large quantity. The iron clay was frequently seen between the Red Hills and Nyour, sometimes containing both large and small pieces and blocks of quartz. On approach to the choultry he observed a number of smiths at work. The forge and bellows of the usual rude construction: the iron ore was brought from the neighbouring hills which are continuous with those of Naggery Nose, Worrumallepett, and appear to be of the same composition

granite at bottom and sandstone at top. The ore was the slaty red iron ore, of mineralogists, and produced tolerable iron. In the neighbouring jungle several large blocks of granite were visible peeping through the iron clay: in one place containing large specks of black mica, the stratification not real, since it was not continuous. The iron ore exactly resembles that of Midnapoor containing brown red hematite and quartz.

A list of the specimens of iron ore from the district of Chingleput now in the Museum will shortly be forwarded.

COIMBATORE.

This Collectorate has not received much attention from the statistician since Dr. Buchanan's* journey in 1801, part of which was directed to the iron mines in the Coimbatore Collectorate—the late Captain Newbold having only alluded to the Beryl mines of Peddioor and Captain Campbell's remarks only, also, had reference to the process of manufacture. Coimbatore has a population of 821,986 inhabitants and an area of 8,280 square miles. On the north it is bounded by the Mysore, on the south by Madura and Travancore; on the east by Salem, and on the west by the ranges of hills which separate it from the western coast of India. It has 13 Talooks, viz.

Auditor	Dharapooram
Caroor	Kanghiem
Cheyoor	Purmdoray
Chuckragherry	Pulachy
Coimbatore	Pulludum
Collegal	and
Dencikencottah	Sattimungalum.

Coimbatore is a flat open table laid averaging about 800 feet above the level of the sea, but it has on its borders and included in itself parts of the eastern ghauts 4,000 feet, the Neilgherry range 8,000 feet and the Velingherry and Paulhaut ranges, the heights of which are from 1,500 to 2,000 feet and the lofty Annamally mountains. Specimens of beryl and of rock crystal have been received from there and the iron ores, as before mentioned received the attention of Dr. Buchanan and, since his time, of Captain Campbell. The Salem Local Committee for the Exhibition of 1851, reported that there were two varieties of iron produced from the Coimbatore ores, one remarkable for its softness and malleability, the other for its steel-like hardness, which adapt it for the formation of edge-tools, cold chissels, &c. Bloom iron from Paulhaut is readily malleable and furnished the hard steel-like iron. A

* I have felt some doubts regarding the localities indicated by Dr. Buchanan, but have endeavoured to be as accurate as possible; but it is proper to add that since the above was written, Mr. Thomas has kindly sent more information to me, which from its form, I regret I have not been able to get ready in time.

Iron ore it is known is to be found in different parts of the Jeypore Zemindary within this district. This part of the country is now being opened up, but at present we are not acquainted with further facts than that a few poor people go from one place to another and work the iron ore which in different localities is to be found on the surface of the ground.

It does not appear to Mr. Robertson that iron ore is to be found in this district in any great quantity unless it may be in some of those parts which from their extreme unhealthiness have not been explored: if to be found there, it could scarcely be worked with advantage, for those who inhabit such tracts are very ignorant and disinclined to labour.

The quantity of iron imported for consumption in the district is 169½ tons in 1854-55, and is of itself presumptive evidence that the ore is not abundant in localities easily accessible.

There are several places where daggers and other weapons are manufactured with some degree of skill, but the steel used in the manufacture is always imported, not worked up in the district and a report from *Maringhy* gives the following details regarding the Jeypore iron.

An iron mine exists at the hill called Boregay ghaut, belonging to the Jeypore Zemindary, at a distance of 5½ coss from Paravateepoor and a specimen of the ore, marked *A* is herewith sent.

The ore is beaten into small particles, put in the sun for one day, and being mixed up with charcoal made of a wood called "Wodesa currah" in the proportion of 6 viss of the former and of the latter 1 candy, it is smelted in a furnace; one lump of iron of the first produce is herewith forwarded marked *B*.

The above iron is heated in the fire and refined, a sample of which is herewith sent marked *C*. The iron is never manufactured into steel.

From the appearance of the abovementioned mine which is a kind of cave, it seems that upwards of 1,000 bandy loads of iron ore can be obtained: one man can bring 2 cavady loads a day from the above cave to the village called Vudallah, a distance of half a coss.

The ore is manufactured into iron in a furnace at the village Vulladah in the Jeypore Zemindary. The ore is first beaten into small particles on a stone with iron hammer, and put into a furnace and smelted, which is again heated.

The cost of making a furnace and building a shed over it amounts to about 4 rupees; there is no other expense besides buying charcoal. The people who make iron, make the charcoal and get the ore, whereby there is no other cost beyond the wages of labour.

About 6 viss of ore can be put at a time in the furnace and it produces one viss of iron.

In the furnace at Vulladah about 150 maunds of iron of the sample marked

B is manufactured in a year which only is sold by them. Iron of the sample marked *C* is only manufactured when specially ordered. The above iron is sold at 4½ rupees a cantium of 8 maunds and is carried to Chicacole, Vizianagram, Guzpatenagram and other places by traders.

About 1,275 bullock loads of iron are annually brought into the Collectorate by traders from Nagpore and sold at the following rates.

Sowlapoor bars, each bullock load	Rs.	6	8	0
Chendragery do		6	0	0
Lumps do		4	12	0
Dondahs do		5	0	0
Bars do		9	0	0

This iron is used for all purposes for which this metal is required. The difference of price is owing to the various degrees of wastage in each sort of the above iron.

The iron manufactured in this country is used in making plough-shares, axes, mamoties, spades, crowbars, bill-hooks, wheel-tyres and other implements used in this country. Charcoal is made from jungle which is near the furnace and sold at 2 dubs a candy; and one candy of charcoal suffices for working the furnace one time. There are extensive jungles in the neighbourhood of Vulladah which are extending; one man can make 2 cavady loads or 4 candies of charcoal a day. The smiths state that the iron manufactured as above and that brought from Nagpore answers for making implements very well, better than European iron, the mode of managing which they are not acquainted with and consequently cannot work up. The smiths receive as hire from 2 to 4 annas a day according to their merits. The following are the suggestions by which the present cost may be brought to a lower scale.

If the mines were excavated by blasting the rocks with which they are covered, ore could then be the more easily taken out.

If a road were made between the mine and the furnace, and bandies brought into use, they would convey more than coolies. Only half a coss of road is required to be made to admit of bandies bringing charcoal to the furnace. The road above recommended can be made at a small cost.*

If charcoal be made in large quantities at a time there will not be much wastage.

By making a large stock of bellows and iron tools at once there will be a saving.

Any process for producing more metallic iron than what is now being produced with a certain quantity of ore is not known.

If 100 pounds of ore are smelted, 16 pounds of iron are produced.

If the iron manufacturers in the hills make the above iron into bars, one-

* Orders have been given to clear this road.

mines along with the neighbouring ones in the southern extremity of the Saugur and Nerbudda territories are situated about 30 miles from the west bank of the Wein Ganga, but considerably further up that river than any previously mentioned.

9. The districts of Hatta, Kamta, Lanji and Bandara or Beihala. In each of them there are opened from 5 to 12 laterite quarries at as many villages. At Mundipar Ghat on the Rayepur road there is a quarry from which along with other specimens *yesterday I had the pleasure of sending you a fragment such as is selected for smelting.*

There are no localities in the province of Nagpore, so far as I know, where either the magnetic or specular ore is met with; but laterite suitable for the furnace exists at Pandara Talaw on the W. S. W. of Umred, and at Karandala on the east of the same town not to mention several other villages.

In the Chindwada subha also it occurs at Saugor 8 miles north of Kamharpani and at Chawarye midway between the town of Chindwada and the British station of Seoni.

I can scarcely say at which of all the sites I have mentioned iron ore is most abundant, except that the ore of the metamorphic strata is richer in metal than that of the lateritic formation. Any mine, which is wrought, whether it yield the magnetic, specular, or hydrous oxide ore, seems to me to be sufficient to supply the wants of all India. The single hill of Khandeshwar with the rocks around its base for example appears to contain an inexhaustible store of this, the most useful of all metals.

II. In laterite quarries, which require to be excavated to a depth of from 3 to six feet before ore of any value is obtained, it is obvious that comparatively little can be collected; but at Khandeshwar where the ore is lying on the very surface in enormous masses, any quantity may be gathered, for which human strength is competent. The only obstacles, which the natives have to contend with in collecting it, are the extreme hardness of the gangue, and the utter inadequacy of the implements they employ for breaking it. To avoid the labour of surmounting these difficulties they are in the habit of collecting all the crumbling pieces, and all the small fragments, that have been broken off the strata in the convulsions of nature; while from the blocks though richer in metal they studiously turn away. The ore is seldom smelted at the spot, where it is collected, but men from the neighbouring villages repair to the mine and having spent some hours in choosing their favorite kind of fragments and breaking them into smaller pieces of about 1

inch square, carry them on bullocks but more frequently in Kawadi baskets to their homes, where their furnaces are erected.

III. The sites of the furnaces are so numerous, that I cannot hope to recount them all.

Around Khandeshwar there are Injwadi with 23 furnaces; Dewalgaum 3; Ketadi 2; Nawargaum 4; Shirshi 3; Koshvi 4; Surodongari 3; Armori 5; Manjawada 2; Salmada 3; Wanki 4; Shiwalkheda 5; Deroda 2; Warda 2; Harda 2; Awargaum 2; Total 69.

In the neighbourhood of Gunjawahi, Bhanapur, Menda and Lohara mines, are Sindawahi 10; Methegaum 10; Kini Murmadi 3; Saradpal 3; Jankapur 4; Bhanapur 3; Pendri 2; Gunjawahi 2; Lohara 2; Mendaki 10; Balapur 6; Total 55.

Supplied from the mines of Pipalgaum and Metapar, are Dhoma 10; Nawatale 10; Belara 3; Jambulghat 1; Total 24, which, with the previous numbers, make an aggregate of 148 furnaces in the subha of Chanda.

In the pergunna of Chandpur and subha of Bandara there are furnaces at Ambajiri, Patarapet and Goreghat, which must amount to nearly 40; or if we include those at the neighbouring villages of Jatama Pipalwani, and Pulpul, which though politically under the Assistant Commissioner of Seoni in the Saugor and Nerbudda territories are physically part of the same district, the whole will be at least 70.

The Abur ore for smelting; magnetic and specular ores. In the reduction of laterite into the metallic state, there are in the pergunna of Chandpur, subha of Bandara, and in the neighbouring part of the Seoni district of the Saugor and Nerbudda territories, furnaces at Ambajiri 42; 3; Agri 3; Kotari 5; Bopali 3; Jamt Agri 9 and Jatama 19, in all; the same subha at Mundepar on the Rayepur road the furnaces are 3; at Kohola and Putalitola, which are near it, 20 and 5 respectively. North of the Rayepur road in the districts of Hatta, Kamta, Lanji and Bandara, these must be at least 30 villages with an average of 3 furnaces each, giving a total of 90 furnaces. These added to the 42 near Ambajiri and the 28 near Mundipar amount to 160 furnaces in the subha of Bandara smelting the inferior kind of ore, combining this aggregate with that formerly found, we arrive at the conclusion that there are at the very lowest estimate.

I. Furnaces in Chanda for magnetic and specular ore.....	148
II. Furnaces in Bandara subha for laterite.....	160

Total number of furnaces..... 308

fourth of it is wasted, but if it is done by the smiths of the plains, only one-third will be the wastage.

Captain Hamilton mentions that the iron stone is smelted on the hills by the rangers and brought down into the surrounding villages in pigs weighing about 4 lbs. each, and there sold to Bunjaries and others who go from Vizagapatam to that place. The Bunjaries from the Mahratta territories bring a large quantity at a certain time of the year, especially in the months of January, February and March, and sell them at a village called Paravathepoorum about 60 miles from Vizagapatam and situated in the direction of Jeypoor. The ore is disposed of by pigs or by weight according to the demand at the time; the quantity obtainable at the above place is from 3 to 4000 candies during the dry season of the year and when brought into the Vizagapatam market it is found to be so badly smelted that it has to be put through a process of fusion to render it fit for being wrought up,—by which process there is a wastage of 50 per cent, as found by practical experience now going on in this arsenal, owing to which it becomes as dear, if not more so, than the Europe iron procurable on the spot.

With the exception of country mamoties, the country iron in its crude state, as brought into the bazar, cannot be made into good intrenching tools, without much extra labour and expenditure of fire and also great wastage, as stated above, and as brought to the market, the price of it is $1\frac{1}{2}$ rupees a maund equal to 25 lbs. English weight.

There are but few iron tools made up in this district except those of the most ordinary description such as the mamoty, a small half pick, smith's implements of the rudest kinds, and a kind of bill-hook stuck into a long handle, which however if well made is much better adopted for clearing away brush-wood or the thorny underwood of a jungle, than the English bill-hook.

A small thick headed tilting axe is also made in the district and if but made well and a little improved upon, would be more effective in the hands of a native than the English tilting axe, which is much too heavy for him.

The few tools in individual use by carpenters and sawyers are also made in the district, and in rude simplicity do not differ from those used by the same class throughout India.

The native sawyer will never use the large Europe timber saw in preference to his own narrow bladed frame saw which like all native saws is made to cut reversed to that of the Europe one.

The report received from the Chodavarum talook mentions that there is a hill called Ganiranyee, two coss from the village of Muttum in the Pandaroo talook; and another hill one coss from Chentalapaudoo in the Madgole Zemindary having on each an iron mine supposed to contain the one nearly 20, and the other 15 candies of iron ore the specimens of which are sent.

The iron is excavated with crowbars and pickaxes, and one man can collect two maunds of ore in one day. The ore is not smelted near the mines. That from the hill Ganiranyee being carried to the village of Muttum, and that from the hill of Chintalapandoo, a distance of two coss, to a village called Vuddapunookoo, where it is smelted.

There are furnaces in the villages of Muttum, and Vuddapunookoo. The cost for constructing a furnace is four annas, and that for making a bellows of cow-hides, is half a rupee. One maund of ore can be smelted at a time, a furnace can be worked twice in one day. As the workmen themselves extract ore from the mines and bring the same to the furnace, the monthly cost cannot be ascertained. It is however estimated as follows, viz.

Cooly hire to one man for extracting ore from the mines at 4 dubs per day.....	Rs. 2 8 0
do. to one woman for bringing the ore to the furnace at 3 dubs per day.....	1 14 0
Value of 120 candies of charcoal at 2 dubs per candy.....	5 0 0
Wages to two bellows men at $2\frac{1}{2}$ rupees each.....	5 0 0
do. to one man for other work.....	2 8 0
	16 14 0

This can be reduced if the work be carried on to a greater extent and with proper care and discipline.

It is understood that besides the two sites named above there are others at Cummarigoodah, Talaberada, Bundighat and other villages in Soojanacotah talook of Madgole Zemindary where iron ore exists. The people of those places not having as yet come in, the particulars of those sites could not be stated. No exports of iron are ever made: but sundry implements suitable to different classes of workmen are manufactured from the iron of this country: the selling prices thereof cannot be ascertained.

Bunjary merchants bring iron into this talook from time to time, and sell it at about $1\frac{1}{2}$ maunds per rupee. In 1853 one hundred and fourteen and odd maunds of iron were brought into this talook; mamoties, plough-blades, bill-hooks, axes and other implements can be manufactured from the country iron.

It is ascertained that iron was never manufactured in this talook to a greater extent than at present.

The people who smelt ore are themselves accustomed to cut down fuel and make charcoal. One cavity load of charcoal is worth two dubs. Two candies of charcoal are required for smelting.

There are in this talook large mountains and forests which are neither increasing nor diminishing in their extent, one man can make two candies of char-

that the iron ore of this district is widely diffused. It is found in the clefts of the mountains and in the sands and rocks of the vallies and plains; it is everywhere diffused through the soil, and held in solution by the waters, and deposited in some of the springs and pools; it forms a principal compound of many important minerals and is sometimes found in its native pure state. The different ores of this mineral found in Madura are,

1st. THE OXIDES.—These are the most abundant, the richest and the most easily wrought. They comprise the granular, the earthy, the hematitic, the specular, the hydrous and anhydrous, the magnetic and ochrey.

The granular Oxide is found in the iron sand of the soil and is gathered in the rivers, creeks, torrents, and on the sea shore; it is also found in granular masses in the mountains and hills, and in some cases is highly magnetic; and as its specific gravity is from 5 and 5; 5 to 6.5 the ore must be very pure. As would be expected of ore so pure and easily obtained it has been wrought more than any other. Considerable space in many places is covered with the slag of former furnaces where this ore has been smelted. Owing however, to the inadequate means used to separate the metal this slag is still rich. The specific gravity of some specimens cannot be less than 4.5 to 5. Ore of considerably less specific gravity has been wrought in Europe with profit.

The earthy, or magnesian oxide is found in earthy masses and rolled crusts mingled with magnesite and dispersed through the soil on the Palney and other mountains, sometimes it is associated with decayed felspar and stentite. This ore, though similar to the Bog variety which is wrought in Europe and America, is of too low a specific gravity to repay the labour of smelting.

The Hematitic Iron is not abundant; it occurs in reniform and botryoidal shapes and highly polished surface; it is found at Conoor on the Neilgherry Hills, and at Passumallie near Madura and in a few other places associated with laterite, some of its positions are with difficulty accounted for unless we suppose it deposited, in some way from the atmosphere; in other places its efflorescence from the ground is apparent.

Specular Iron, the bright lamular variety is found in small quantities at Manaporia, 25 miles from Trichinopoly, on the road to Dindigul, associated with quartz rock; rock crystal; crystallized and granular chlorite and calc spar. In this location are found the octahedral crystals of iron in considerable numbers and perfection.

The Hydrous and Anhydrous oxide are frequently met with, the former in most of the locations where iron is found and the latter on the Palney

where it occurs of red and reddish brown colours and a granular texture and associated with the iron magnesite.

The magnetic iron is also of frequent occurrence throughout the district. It is sometimes met with in the octahedral and other forms of crystals and sometimes in lamular and granular masses and sometimes in the form of sand.

The ochres are of more rare occurrence. They are the yellow earthy and hard red concreted varieties. They occur in nodular masses in a quartz and iron gravel with laterite and jasper at Sevagunga.

2d. THE CLAYEY LATERITE ORES are of frequent occurrence. In some places they are found in nodular and concreted masses, made up of different layers of a tolerably pure oxide, or oxo-carbonate, a little resembling hematite; in other places it occurs in extensive beds, either upon, or just below the surface composed of these nodules so small and firmly cemented that the mass is of considerable hardness and solidity, and is quarried and used for building. The Fort at Tirupatoor was faced almost entirely with this stone. In other places it appears as a red or brown granular and compact cement, somewhat resembling anhydrous oxide, and forming a glomerate with quartz pebbles or any stone that comes in its way. In some places it unites with clay. In its composition it appears to be similar to the siderite or clay iron stone of Nicol, which belongs to the sparry iron ores and is composed of iron peroxide, Carbonic acid, Manganese, Magnesia and Lime.

This ore is too full of impurities to be wrought much as an ore, but possesses interest as indicating the mineralogical changes which are constantly going on around us; this ore is evidently forming from the iron in solution in the soil.

3d. SULPHURET OF IRON is another ore that occurs sparingly in the district. The uncrystallized varieties are met with in the loose sand and sienite of the Palney Hills and in the granular limestone at Ammaperttee near Manaporia.

4th. SILICATE OF IRON.—Still another kind of ore is the Silicate in its varieties. These are the beautifully crystallized Yenite, Anthosiderite, Welo-bite, Hisingerite. Although the localities of this ore are not numerous in the district there is one of peculiar interest. It is near the village of Kothamperttee 32 miles from Madura on the road to Trichinopoly. The ore crops out about one mile east of the Travellers' Bungalow in a hill of quartz, the whole of which it colours although it lies only on one side. It is seen again in a tank $\frac{1}{4}$ of a mile west of the bungalow, and again 4 miles still farther west, it forms a hill of ironstone some 50 feet high and nearly half a mile long when it disappears and, in about a mile still farther west, it rises again into a ridge

coal in one day. The blacksmiths of this talook prefer Indian iron to English iron because they do not know how to temper the latter. The daily wages of a blacksmith in these parts varies from two to three annas.

The writer makes the following remarks in conclusion.

A.—There does not appear any other mode of extracting ore from the mines than by excavating it with crowbars and pickaxes.

B.—Although roads be constructed to the sites of mines yet carts or barrows could not be employed for bringing the ore to the furnaces, but it can be conveniently carried by men and bullocks.

C.—If the work be carried on to a greater extent, a reduction can be effected in the quantity of charcoal now used. Besides this, charcoal can be prepared with less waste.

D.—If charcoal be prepared in the neighbourhood of the furnace the cost on this account will be reduced.

E.—The cost of making bellows cannot be reduced, but it would be convenient to receive hammers and other implements from other countries.

F.—The workmen do not know any process which would be productive of a larger quantity of iron from a given quantity of ore than at present, but think this may be done by making choice of good ore.

G.—As the mines of ore are on and near the hills, the construction of roads even if practicable will be attended with great cost.

If 100 lbs. of ore are smelted, it produces 25 lbs. of metallic iron.

In converting the metallic iron into bar iron, the wastage amounts to one half of the former article.

The report from Bonunghy mentions a hill called Borracondah in the Pachipenta Zemindary running east and west, with a stream of water on the eastern side and that all round the hill foot of this there is much iron ore in small pieces, in pits, intermixed with clods of earth. Besides this, large quantities of similar ore can be had by the side of a hill, Sobicondah, near the village of Soby, in the Vizianagrum Zemindary.

Iron ore is dug out on the eastern sides of Borracondah and Sobicondah respectively. The pits are excavated with crowbars, and one man can collect two maunds of ore in one day. The clods of earth which contain the ore are beaten down with hammers, and the ore picked up therefrom. Iron ore is smelted near their dwelling houses by a class of pariahs called "Ozoola" residing in the villages of Condah Sadah, Ranjivulsah, Toocoor and Soby, in the Bonunghy talook in the Vizianagrum Zemindary.

There are furnaces at Condah Sadah, Ranjivulsah, Toocoor and Soby, a drawing of which and of the apparatus employed in smelting the ore and working the iron was annexed. A furnace can be erected in two days by one

man at the cost of four annas, and the cost per mensem of working it is rupees 30 or one rupee per day, viz :

Hire to 4 coolies for digging and collecting the ore at 2 annas each day.....	0	8	0
do do smelting it during one night do do.....	0	8	0
One rupee.....	1	0	0

One maund of ore can be smelted at a time.

Metallic iron is produced in small quantities at Coondah Sadah, Ranjivulsah, Toocoor and Soby, and sold to the hill people of Anuntagherry Mootah of the Vizianagrum Zemindary at 10 rupees per candy; but it was never exported any where. No other kind of iron is produced in this talook.

If one maund of ore is mixed with double that quantity of charcoal and the whole put into a furnace, and fire blown with bellows, the ore melts and produces one quarter maund of metallic iron. Metallic iron is produced in these places but it is not refined here for the market, specimens of the iron ore herewith sent. Steel is not manufactured in this talook.

About 100 candies of iron are brought to Durmavanum and Sroongavarapocotta by Brinjary merchants from Jeypoor, Nagpore and other places by way of Cassuputtum, in lumps and bars: the former is sold at rupees 12 and the latter at rupees 14 per candy. From these two sorts of iron, plough-shares, axes, mamoties, bill-hooks, tires for wheels, hinges for doors, tips of arrows and the like things are manufactured.

Bill-hooks, axes, plough blades, and other implements are manufactured by the Ozoola people who smelt the ore and sell them in hill countries as follows :—

One bill-hook.....	0	1	0
One sickle.....	0	0	4
One axe.....	0	1	0
One tip of an arrow.....	0	0	4
One plough share.....	0	2	0

Samples of these are herewith sent.

In former days, iron ore used to be got in great quantities from the above mentioned and many other places and converted into iron, but in consequence of the Ozoola people who work at the pits being now reduced to a small number, the manufacture has fallen off.

There being forests in the neighbourhood of the villages where this work is carried on the workmen themselves cut down wood and make charcoal. Two candies of charcoal are required for one smelting i. e. for smelting one maund of ore: one candy of charcoal is sold for half an anna.

There were extensive forests in the neighbourhood of these places for-

Below I give a sketch of one of these furnaces taken at Armori one of the villages supplied with ore from Khandeshwar.

The erection is of clay with a framework, as you will perceive, of wood. Its front is built up considerably above the fire to protect from heat the face of the workman, who plies alternately his two pairs of bellows on a platform, resting upon three supports, two of which are the arms of a cleft branch. The whole cost of constructing it would not exceed Rs. 1. Attached to each furnace there are generally 3 men, 2 to relieve each other in working the bellows, and one from time to time to supply ore and charcoal. The daily expense may be for ore $\frac{1}{2}$ Anna, charcoal 2 Annas, labour 3 Annas, in all $5\frac{1}{2}$ Annas.

IV. Around Khandeshwar in the subha of Chanda, the greatest quantity of iron is produced and certainly there, also, are the greatest capabilities for increasing the manufacture. The furnaces cannot be wrought in the rains as they are all under trees in the open air. Taking 8 months of 25 days each or 200 days throughout the year as the season of labour we would have for the 148 furnaces smelting superior ore 29,600 days, and for the 160 smelting inferior ore 32,000 days. But each day there are produced $1\frac{1}{2}$ maunds at each of the former furnaces of iron in its impure state, which by the process of refining into bar iron will become 1 maund. This when made into bar iron will become 1 maund, and at each of the latter $1\frac{1}{2}$ maunds, which by the same process will be reduced to about $\frac{2}{3}$ of a maund. We have thus, in regard to the superior ore.

$29,600 \text{ days} \times 1\frac{1}{2} \text{ maunds} = 51,800 \text{ maunds of impure, or } 29,600 \text{ maunds of bar iron and in regard to the inferior ore.}$

$32,000 \text{ days} \times 1\frac{1}{2} \text{ maunds} = 42,666 \text{ maunds of impure, or } 24,000 \text{ maunds of bar iron.}$

Total 94,466 maunds of impure or 53,600 maunds of bar iron. The bars are called *Kandhas* and *Mehhs** according to their form. In these shapes the iron is generally sold, some of it however is subjected to still further purification, by which it becomes good malleable iron, and is said to lose about half of its weight. It is then usually sold in the form of the tire of a large wheel. Most of the iron produced in this territory is used here chiefly for agricultural purposes, but a part is also sent to Umarawati in Berar, whence it finds its way to Puna and other towns in Western India. The price of bar iron per maund at the furnace is 12 Annas, in Nagpore $1\frac{1}{2}$ Rs.; of malleable iron at the furnace Rs. $1\frac{1}{2}$, in Nagpore Rs. 3. The profit which falls to the share of the merchant is evidently exorbitant, as the distance between Ambajiri, one of the places of produce, and Nagpore the place of sale, is only 50 miles and the risk is trifling in the extreme.

V. In this part of India no steel is manufactured. In the making of iron, the ore is previously roasted to render it more frangible, then after it has been reduced to smaller pieces it is put along with charcoal into the furnace without any flux. There is a passage through the front wall of the furnace under the bellows, by which the scoriae from time to time are allowed to escape. In about 7 hours the ore is properly smelted and is taken out a red hot mass, when it is partly cut in two, and allowed to cool. In this state it is known by the name of *Chul*. The *Chul* is then committed to blacksmiths to be heated and hammered into a *Kandka*, or if halved into a *Mekh*. The furnace is twice filled and emptied, that is, two *Chuls* are made at each in the course of a day.

VI. There is no iron imported into this territory, though we depend upon others for our supply of steel.

IX. The charcoal at all the smelting villages, which I have visited, is quite at hand, and therefore may be had at a low rate. The cost of charcoal for one smelting may be about one anna.

X. The forests in the neighbourhood of the iron districts are very extensive, and in the subha of Chanda were rapidly increasing up to the period of the country's annexation.

XI. There are three kinds of steel used in this part of India, (1.) that brought from Nirmul in round cakes commonly called wootz here known exclusively *polad*. (2.) English steel named by Hindustanis *ispat* and by Mahrattas

* The specimens forwarded to you by banghy along with the ores are a larger and a smaller *Mekh*, both being smaller than *Kandka*, which is moreover of a different shape.

merly, but as they were cut down for timber and fire wood they are diminishing in extent: one man can cut wood and make three caudies of charcoal in a day.

The blacksmiths in these parts prefer Indian iron to English iron, because they do not know how to temper the latter.

The daily wage of a blacksmith is two annas.

If roads are constructed to the pits, carts can be employed, with advantage, for bringing ore to the furnaces. Also if roads are constructed to the forests where charcoal is made, carts can be used with advantage in bringing the same to the furnaces. Roads can be constructed to the mines, and the forests where charcoal is made.

If fuel is burnt in a pit while it is little green, and the fire is extinguished by covering the pit with green leaves and earth, the charcoal will be produced with less waste.

If 100 lbs. of ore are smelted they produce about 25 lbs. metallic iron. In 3½ lbs. of metallic iron, 1½ lbs. will be lost in the process of making bar iron from it.

The report from the *Saloor talook* mentions that iron is manufactured from ore found in mines in the following villages appertaining to the Pachipentah Zemindary viz.

- | | |
|----------------------------|---------------------|
| 1. Chindaleah, | 10. Samalah, |
| 2. Sepoyputty near Murlah, | 11. Madagadah, |
| 3. Doosarah, | 12. Gunmalah, |
| 4. Soyaroo, | 13. Lotaroo, |
| 5. Ally, | 14. Arakoo, |
| 6. Doodary, | 15. Suttavah, |
| 7. Peddacumbarah, | 16. Chinchoomundah, |
| 8. Rogah, | 17. Guntesseemah, |
| 9. Bejapoorum, | |

Blacksmiths who reside in the above villages conduct the process. Ore is found in Pachipentah and some more villages, but it is not so useful as that found in the above villages.

There is plenty of ore in the above villages and the smiths get whatever quantity they occasionally require. These smiths make metallic iron with the above ore and sell it to the cultivators and others in their range at 2 or 3 dubs for 1 or 2 viss, which the people get made into such implements as they require by a class of people called "Oodolavatta," giving them as remuneration a small quantity of grain or a few dubs.

The iron manufactured as above in Pachipentah Zemindary is never sent to other countries, but used in it as above stated.

Iron is manufactured in the Jeypore country in abundance, and Brinjary merchants import it into the plains through Parvettipoor and Saloor. The Banians purchase it and sell it to other traders at the rate of from 5½ to 6½ rupees a cantlum weighing 8 maunds each, according to its quality.

Iron ore is dug up from the mines in the plains and near the foot of the hills, the latter places contain the most. When the pit is sunk nine or ten feet deep, it is abandoned and a fresh pit opened. The pits are dug with pickaxes and crowbars; one man can dig up from 2 to 5 cavady loads a day depending on the nature of the soil whether hard or loose. Whatever ore is dug in the village is manufactured there and never carried to other villages.

Plans of the furnace and the apparatus are herewith submitted. There is no established scale of expenses for making a furnace or for using it, or of the ore that can be put in the furnace at a time, but from an experiment now made 22½ cutcha seers of ore produces 8 seers of metallic iron in three hours' time.

The practise of making iron into steel does not exist in the Pachipentah Zemindary.

The following particulars are found from an experiment made. 45 cutcha seers of ore was heated with 27 cooneums of charcoal, the ore so heated weighed 22½ seers which, after pounding into small particles, was placed at the entrance of the furnace together with 11½ cooneums of charcoal, and a small quantity of the particles together with five or six times the amount of charcoal was put into the furnace at intervals, at the same time using the bellows. The result was 8 seers of metallic iron which on being again smelted with 8 cooneums of charcoal, produced 4 seers of good iron.

The iron manufactured in the Jeypore country is brought by the Brinjary traders into the Saloor division in quantities proportionate to the demands: the iron so brought is of 2 or 3 sorts as per samples herewith sent. The best of it when manufactured into ladles, crowbars, spades, &c., by smiths in these parts sustains a loss of 4 or 5 seers in every 10, the middling sort loses 6 seers in every 10, and the worst sort loses 7 seers in every 10. Crowbars were formerly made with the country iron, but as round rods are now brought from the coasts they are converted into crowbars with little labor: with country iron, other implements such as mamoties, spades, plough-shares, ladles, knives and the like things are made.

The prices of the materials made with the country iron varies according to their size, viz.

1. Mamoties are made of from 12 to 20 annas.
2. Pickaxes at 6 annas, 5 annas, 4 annas, respectively.
3. Spades for 2 annas, annas 1-6, annas 1-3, respectively.
4. Plough blades, at 6 annas, 5 annas, 4 annas, 3 annas, respectively.
5. Ladles according to their sizes.
6. Knives do do

This iron is besides applied for making hinges, nails, &c.

The manufacture of iron was never carried on in these parts to a greater extent than at present. Charcoal is made and stored by the parties at the places where there are funaces, the jungle being at hand, charcoal is however

The latest information received regarding the iron ores in the *Warungul Talook* is from Captain Hare who mentions that in the Warungul talook (so far as he can discover) there is only one place where the iron ore is found, viz. at a hill lying about 20 miles west of the Cantonment. This he was prevented by circumstances from visiting personally, but he sent several men on whose report he could place the utmost reliance, and both they and the villagers around declare the ore exists in the greatest abundance. At the foot of the hill are the excavations opened by the natives, and about 125 men and women are daily employed there. The specimen marked No. 1 was picked up in the mines, there are also large masses of the ore on the hill, but the miners shrink from the labour required to break them up. The specimen marked No. 2 was obtained from one of them.

The mines are worked by men of the lowest caste, and the profit arising from their labour is very small; they sell the ore on the spot at the rate of 240 lbs. for $\frac{1}{2}$ an anna. There are no furnaces very near the mine, the nearest being 3 miles off at the villages of Moolkamoor and Kotapilly; the ore is sent to about 26 villages all within 70 miles.

There are 26 villages to which the ore is conveyed from the hill and in each there are on an average two furnaces. Men of the Wanjawar caste purchase the ore from the miners and carry it on bullocks to the different furnaces, the price they get for it depends very much upon the distance they have to carry it; at the villages of Moolkamoor and Kotapilly they get a Hyderabad Rupee for 96 maunds (or 2,304 lbs.) He visited these furnaces and said they are of earth and 252 lbs. of the ore is smelted in each one daily.

In the Cummam Talook at a village called Joojoolphar about half way between Cummam and Budrachellum there are iron miners and several furnaces.

Their method of smelting the ore is very simple. A pit about 2 feet deep is dug and over it a chimney is built; this in the first place is filled with charcoal and lighted, as soon as flame issues from it, the ore and more charcoal are put in alternately but in small quantities at a time, and this is continued for 12 hours during which period two men are incessantly working a pair of bellows the drop runs off through small apertures prepared for the purpose, and as soon as sufficient metallic iron has become formed to fill the pit, the chimney is broken down and the red hot mass dragged out and allowed to cool all night; the next morning, it is taken to the forge and worked into bar iron which operation takes 10 hours. No steel is manufactured there.

The charcoal is brought from the neighbouring jungle and is sold at the furnace at 900 lbs. of the best kind per Rupee. An inferior description which answers well enough for the forge is to be got at 1,080 lbs. per Rupee, 210

lbs. of the best charcoal is required for one smelting, and 120 lbs. or more of the 2d sort for one forge, the forests are inexhaustible.

10 Men make 4,300 lbs. in 3 days.

The blacksmiths decidedly prefer iron of this country which they say is much more malleable than English iron.

In cantonment a blacksmith gets 6 annas, but in the villages 3 or 4 annas not more.

132 lbs. of metallic iron is the produce of one smelting or in other words is produced from 252 lbs. of the ore, consequently 100 lbs. of ore will yield 52 lbs. of metallic iron.

132 lbs. of metallic iron (which is the produce of one smelting) when worked in the forge yields 3 maunds of the specimen No. 1, or $2\frac{1}{2}$ of that marked No. 2, so that about half is lost.

The following calculation will shew what is expended at each furnace and forge.

Expended on	{	1 Bricklayer to build up the chimney.....	0	2	0
one furnace		6 Coolies to work the furnace.....	0	9	6
		252 lbs. of iron ore.....	0	1	9
		210 lbs. of best charcoal.....	0	4	9
Expended on	{	5 Coolies to work the forge.....	0	8	0
the forge		120 lbs. of 2d. sort of charcoal.....	0	1	9
Total Hyderabad Rupees...			1	11	9

This is the sum spent in manufacturing 3 maunds of bar iron No. 1 from 252 lbs. of the ore. The blacksmiths always sell their iron to the village Sahoocar from whom they take money in advance, and to whom they are almost invariably in debt; they do not get more than 1-8-0 for a maund of specimen No. 2 and 1-4-0 for a similar quantity of No. 1 specimen.

1 Rupee 4 annas $\times$ by 3 maunds = 3 Rupees 12 annas, deduct the price of labour 1-11-9 and there remains 2-0-3 profit.

Before concluding this report on the ores of iron of Hyderabad, I may mention that the discovery which the late Dr. Walker made of coal on the banks of its river, renders all connected with these ores, and with the iron ores of the Nagpore country, of importance to the best interests of Southern India. To those conversant with the subject it is not necessary to mention that the great demand for this country's superior charcoal iron, will always secure for it a price beyond what can ever be afforded for railways and other common purposes, and the great hope for Southern India is that the coals of the Godavary

brought for sale from the hills into the plains such as Saloor, at the rate of about 4 dubs per cavady of 2 candies.

The jungles very near the villages in the Pachipentah Zemindary are somewhat scanty, but in places which people do not much frequent, jungles are abundant, and the trees being first cut down and dried, each man makes upwards of 10 or 20 candies of charcoal in a day.

Iron brought from the coasts is used for crowbars, wheel hoops, &c. it being so conveniently formed, and for the other things country iron is considered preferable.

It is not usual to hire smiths for wages: they make and sell the materials themselves, but when occasionally hired, they take 4, 5 or 6 dubs a day in proportion to the work.

The ore dug in all places does not produce the same quantity, but varies: people say that the ore which is of a black color and heavy produces more than that of a yellow colour and light.

No. 17. VIZIANAGRAM ZEMINDARY.

Mr. F. H. Crozier, in 1850, wrote to me as follows:—

Sir,—I do myself the honor to acknowledge the receipt of your letter dated November 6th requesting further information respecting certain products of Vizianagram Zemindary and at the same time conveying the very kind and complimentary acknowledgments of the Central Committee to the Rajah which I have had the pleasure to communicate.

2. On the receipt of your communication I despatched a qualified person to the locality whence was obtained the pieces of black ore, formerly submitted to the Committee, under the designation of Antimony ore, and I beg herewith to transmit a rough plan and description of the ground, its extent, depth, supposed quantity of ore, &c. &c.

3. Its position is within a few miles to the southward of Cheepooroopully a large village about 20 miles due north of Vizianagram, we came upon it accidentally when on tour of Circuit in December last, and having been subsequently informed that it was a species of Antimony ore, it was so designated in the list submitted by the Rajah in the following month of May.

4. I beg now to transmit by banghy about 1 lb weight of the ore, in a pounded state after having gone through the process of burning, a few small pieces in its crude state shall also now again be sent, and any further supply for experiments that may be called for shall be shipped by the first opportunity by sea. At present it is to be had, merely for the hire of excavation and bringing it to this place, viz. 3 annas per cooly load, bandy hire is also to be obtained; during the dry season in any quantity at one rupee and four annas per bandy, a good road I am happy to say is now in rapid progress between this and Bimlipatam the

nearest seaport when the present rate of bandy hire of one rupee between Vizagapatam and Bimlipatam will probably be reduced, and the traffic open throughout the year, instead of, as at present, being confined to the dry season only.

5. I do not myself profess to have any personal knowledge whatever of the nature and properties of the ore, but from one or two incidents very recently occurring I have reason to think the substance of value, and which I will state, for the information of the Committee.

6. When at Bimlipatam some months since I met an encampment of Mundoolawanloo or itinerant sellers of medicines on route from the northward to Madras. On examining the articles they had for sale in the prepared and original state, I found some of the ore correspond in appearance, with that we had obtained from Cheepooroopully, and they confessed that they always made a detour from the direct road to that place for the express purpose of procuring it, the slight difference perceptible between my specimens and theirs they accounted for by saying that they dug it from beneath, whilst that I had was from the surface of the ground: and it was so, for the pieces with me I had merely picked up in passing. The best or brightest of pieces, I now beg to send, have very recently been obtained at the depth of a yard and two yards under ground. How deep it goes beyond that I am unable to state, but there are about fifty bandy loads of this, I am informed, now procurable.

7. The other circumstance it may be useful to mention, is that on the receipt of your letter under acknowledgment I sent for one of the soorma merchants in the bazar, and on my shewing him several pieces of that by me, he at once said it was soorma of inferior description and worth about 2 annas a lb in the crude state: he further said that he had been in the habit of purchasing the same ore from the Mundoolawanloo caste I have above referred to. That contained in paper No. 1 and No. 2 was obtained from a specimen I gave him at the time and weighing a little more than $\frac{1}{2}$ a lb. each. Nos. 3 and 4* are from pieces of the ore obtained subsequent to the receipt of your letter under acknowledgment, and obtained at a depth of between three and four feet below the surface of the ground.

8. The two specimens of Plumbago sent to the Committee were obtained from near the Villages of Rampilly and Ransipatam† the former situated about 10 miles due west of Cheepooroopully and the latter due west of this, and distant about 15 miles. It is found in the beds of two small streams or ravines, is used to a great extent in polishing chatties, and is obtained to any quantity hitherto required, for the cost of cooly hire (about 1 rupee) in excavating and transporting it.

* No. 4 not ready: pieces however in the crude state are forwarded.

† Ransipatam on the map.

Angrej, and a third kind manufactured at Tendukheda on the north bank of the Nerbudda, which goes by the name of Khedi or village steel. The Nirmul steel is decidedly preferred to any other, and is used for swords, knives, &c. The English is employed for carriage springs, and the Khedi for pointing the coarser sort of tool e. g. crowbars, pickaxes, &c. The reason assigned for the non-manufacture of steel in a country, where iron ore, and that magnetic iron ore, is so abundant, is the ignorance of the people. The classes of workmen engaged at the furnaces are chiefly oilmen, fishermen and ghonds.

XII. A few skilled artificers in Nagpore get 6 annas per diem, common blacksmiths 4 annas. In the jungly districts the average rate is not more than 2 annas. A hammerman in Nagpore is paid 2 annas, and a bellowsman 1 anna; but in the several districts, where rice is remarkably cheap, the half of these sums would be reckoned ample. In these parts of subha of Bandara, where iron is made extensively from laterite, the relation between the agriculturist and the blacksmith is very primitive. The farmer buys the iron necessary for his field operations and furnishes it along with charcoal to the lohar, who for his labour receives 5 *Kudans* or 40 pails of undressed rice per annum for every plough kept on the farm.

XIII. As improvements on the present system I would suggest that the people employed in collecting and smelting the ore should be taught the benefits arising from a distribution of labour, whereby one set of labourers should be engaged constantly in the former department and furnishing supplies to those who were equally devoted to the latter; that there should be introduced among the miners more powerful implements for prosecuting their work more especially for pounding the ore; that the furnaces should be in the immediate neighbourhood of the mine, which in the case of Khandeshwar Hill and several other localities is quite practicable, and that a flux, where procurable, should be employed. I have to thank you for the information you kindly procured for me to the effect that dolomite would not be suitable as a flux. In the beds of Kunker, however, and in a tertiary argillo-calcareous freshwater deposit, from which there has recently been obtained a series of interesting fossils, there might be found a sufficient quantity of carbonate of lime for this purpose. I say nothing here of hot blasts and machinery and works on a large scale, as these imply European capital and superintendence; were these bestowed however I have no doubt they would not be spent in vain, but that ample returns for all outlay of time and money would be obtained in the extensive and profitable trade thus created, and I trust that under the enlightened administration of the present Commissioner an undertaking worthy of British enterprise, commensurate with the mineral resources of the country, and bearing some proportion to the existing demand for iron throughout India, may be encouraged.

The banks of the Wein Gunga might afford more than one site for the erection of extensive works, but if it were deemed expedient to fix upon only one, then I think it should be Kandeswar, situated as it is within such a short distance as two or three miles from the river, in a comparatively level country abounding in timber, and capable of drawing its materials for a flux from the stores of kunker and earthy limestone up the stream and of transmitting the produce of its furnaces even without any improvements in the river navigation during the freshes of the monsoon by way of the Godavery to the Bay of Bengal.

In connection with these remarks it may be interesting to add the following which appeared in one of the Bengal papers, regarding the iron of Nagpore.

The great territory which has just lapsed to the British Government, and adds to the Empire a state of which even an American might be proud, is as rich in minerals as in cotton. Both resources were neglected by the Native Government, and both require European capital and energy for their full development. About 80 miles to the south east of the capital is a place called Wyragurh, and about 11 miles from this, almost on the bank of the Wyen Gunga, stretches an iron district. In its centre, for some 250 feet, rises a low hill, called by the natives Khandeshwar, the upper half of which is a perpendicular mass of rock. The entire "mass with a basis of quartz, is richly laden with iron," while at the bottom of the ascent huge masses of iron ore are lying about, untouched, unworked, and apparently unnoticed. Upon the slope of this hill, amidst the jungle which covers a gradual ascent, are the mines opened by the natives. They are rather "diggings" than mines; mere surface excavations, like those in which the earliest settlers in California found their gold. Never deeper than five feet, they are entirely without system, and commenced wherever the workmen fancy that the metalliferous rock appears most easily friable. Large pieces are rejected. However rich or accessible they may be, they are carefully avoided, for the wretched native tools employed would be ruined in the effort to divide them. Even these diggings are not regularly worked. Men visit the hill as they please, quarry a few fragments of the small size preferred, break them into still smaller pieces, and carry them to their villages. Of these, the most important is Trijwarree, where there are twenty-three furnaces, the neighbouring villages supporting forty-seven more. In all, the same process is pursued. The furnaces are of hearth, charcoal is the only fuel employed, no "flux" is heard of, and cold and hot blasts have never entered into the imaginations of the cultivators, oilmen, and fishers who betake themselves to the trade. The profit is as wretched as the process. Each furnace produces on an average every day a lump of cast iron called a "kotie," and weighing about a maund.

9. I hope to be enabled personally to visit, in the course of our present tour of the Zemindary, both these spots, and in the meantime can only state as reported to me, that it is excavated with crowbars in lumps of considerable size, and then exposed to the sun to enable the procurers to pound and so render it more easy for conveyance to their various villages for use. That obtained from Rampilly is preferred by the potmakers, but I can see little difference myself between the two sorts, and think the preference may be given in consequence of the situation of that village, being nearer and more accessible, and in a more habitable part of the country. Rampilly I should mention is not situated within the Vizianagram, but in the small independant Zemindary of Salloor, at present under management of the Governor's Agent.

10. I may have mentioned, as perhaps a subject of interest in geology, that the great place of resort by the potmakers for obtaining the black mica or albaeum, also greatly used in their trade, is from Coodoo a village situated due west, half way between Cheepooroopully the position of the black ore and Rampilly whence the best plumbago is obtained.

11. I beg again to send about 1 lb of each variety of plumbago and shall be happy to send any further quantity by sea if required. I should however mention that the time for procuring the plumbago from the veins or pits is chiefly confined to two or three months during the dry season of the year from March till about the end of May before and after that time the water in the channel where it is formed I am informed prevents the excavation."

I may here remark, that the ore, first mentioned by Mr. Crozier, which the people consider an inferior description of the sulphuret of antimony, *soormah*, so largely used in medicine and for the toilet in this country, has been carefully analysed by Dr. A. Scott, who has reported it to contain 53 and 54 per cent of metallic manganese, and oxygen about 22.558.

CONCLUSION.

In the foregoing pages, I have endeavoured to give the information which the contributors, in furnishing the Museum with specimens of the iron ores in the Madras Presidency, have communicated to me regarding them: and in most cases, have only so far altered the authors own words as to change their epistolary or tabular into a narrative form. I hope that the information now submitted will prove of benefit to the country, and as this seems to have been the chief motive that induced those, whose names are recorded in the body of this report, to collect the details it contains, in returning them my best thanks for their willing assistance, I trust that their benevolent aspirations may be realised.

I have the honor to be

Sir,

Your most obedient Servant,

EDWARD BALFOUR, *Surgeon.*

In charge of the Government Central Museum.

I HAVE BEEN INDEBTED TO THE FOLLOWING GENTLEMEN, FOR THE INFORMATION CONTAINED IN THIS REPORT.

A. Ramanjooloo, Arnee.
Balmain, Captain James, Commissioner, Raichore Deab.
Beaumont, Esq., J., Superintendent Iron Company.
Benson, Captain Robson, Sub Assistant Commissary General.
Bird, Esq., C. J., Collector of Tinnevely.
Bird, Esq., J., Collector of Trichinopoly.
Bombay, The Government of,
Bourdillon, Esq., J. D., Secretary to Government.
Brooke, Captain A. E., Commanding Arnee.
Bullock, Captain, Deputy Commissioner Berar.
Ballard, Esq., E. A., Special Agent, Masulipatam.
Bushby,* Esq., G. A., Resident, Hyderabad.
Caddell, Captain, Commissary of Ordinance, Masulipatam.
Campbell, Brevet Major J., Assistant Commissary General.
Connolly, Esq., H. V., Collector of Malabar.
Cotton, Colonel Arthur, Chief Engineer, Madras.
Cunningham, Captain F., Mysore Commission.
Dalyell, Esq., R. A., Assistant Collector, Salem.
Davidson, Major Cathbert, Assistant Resident, Hyderabad.

* At page 100 for Mr. Boothby, read Mr. Bushby.

in a small mountain, and after forming some prominent peaks of this mountain and covering the ground for some distance and the foot of it with iron stone it disappears, and again rises in about one mile still west into long ridges and forms the highest peak on a mountain of some 600, or 800 feet high. From this point to the place where it first appears is a distance of 8 miles, within which distance it forms an important part of 7 considerable hills and mountains besides strewing a part of the plain where it had been excavated with its ore.

This ore is strictly silicious, and the composition is in various proportions, from a slightly coloured &c. ferruginous quartz to a black ore of considerable richness. The crystals also are of different forms and sizes from rectangular or rhombic prisms at about 4 or 5 inches long and half an inch thick to those of the size of a needle and fine silky fibres; and from the twelfth of an inch in diameter to fine rounded and angular grains not larger than the head of a pin. The abundance of these and their red colour give to the masses they pervade a curiously spotted appearance. The granular and massive varieties are the most abundant. The specific gravity of this ore is from 4 to 5 which is much heavier than many ores that are wrought in Europe with much profit. The ore out of which the Scyrian steel is wrought is of nearly the same gravity and this is the case with much of the ore out of which English iron is made. Although its union with quartz might render the smelting more difficult, yet there is, in the immediate vicinity of this mountain of iron, a considerable quantity of granular limestone which might be used as a flux.

5th. THE CARBONATE OF IRON occurs in small quantities in greenstone near Dindigul.

These are a few facts relative to the iron of the district, but our knowledge of this as well as of other minerals is increasing every year, and it is confidently expected that facts much more important and encouraging to those anxious for the development of the natural resources of the country will soon be known, and it is only necessary further to remark that near Tovarencoorchy, the common iron smelted in the Madura and neighbouring district is made into steel. Iron ore is met with in various localities of this district, it is found in the neighbourhood of Cottamputty on the high road from Trichinopoly to Madura and throughout the Shevaganza Zemindary—which lies to the eastward of the above road and between it and the coast. There are a number of villages all along the foot of the Ghauts where iron sand is smelted particularly in the talook of Thencurray. Steel is made at Tovarencoorchy in the Madura district; but the process of making it is kept a profound secret, being handed down from father to son.

Statement shewing the sites where Iron sand is found and Furnaces erected.

Talooks.	Places where Iron sand is found.	Places where Furnaces are erected.
Madacolum	{ Iyoor..... 1 Pauraputty 2 Yermaraputty 1 Oodapanaiknoor ... 2	{ Iyoor 1 Pauraputty 2 Valiapully 1 Voosalumputty, a hamlet belonging to Coonoovarum Cotay 2 Caloothooputty, a hamlet attached to Senthory village..... 1 Carootha Naikenputty ... 2 Pareyoorputty 3 Bodukamputty 4 Teroonoothooputty ... 5 Pillya Natham..... 6 Serlingaudooputty 7 Punnoovarputty 8
Maylore	{ Moody Maly River .. Teroomany do. ... Palaur do. ... Moolyoor Qdy, or stream.....	
Tandicomboo.....	{ Sengoorchy Banganatham..... Sathoor..... Vadamadura..... Singaracottay..... Canavoyputty..... Poothoor..... Moosooavanoothoo ...	{ Same Villages.
Nellacottay.....	{ Jagaputty..... Codulvaury Neelamalacottay	{ Same Villages.
Ramgherry	{ Caroopoor..... Combay Veeramalay..... Cadavoor.....	{ Caroopoor. 1 Poothanathom..... 2 Panugaputty ... 3 Toppunputty. . . 4 Nullam Paly. 5 Moollepaudy. 6 Caradyputty ... 7 Valacoorchy..... 8 Serkaputty 9 Cunja Naikenputty.10 Seegumputty11 Malumputty12 Umma Samookum13 Yendapooly14 Maully kuttiputty15 Uckyemputty ... 16 Venguttia Naikenputty.17

CONTRIBUTORS, *continued.*

Elliot, Esq., William, Civil and Session Judge, Cuddapah.
 Eveyard, Assistant Surgeon Edward D'Arcy, Civil Surgeon Mergui.
 Fischer, Esq., G. A., Mootadar, Salem.
 Fulljames, Major G., Political Agent, Rewa Caunta.
 Hamilton, Captain J., Asst. Commissary of Ordnance.
 Hamilton, Sir R. N. C., Indore.
 Hall, Esq., A., Collector of South Arcot.
 Hare, Captain, Hyderabad Contingent.
 His Highness The Nabob of the Carnatic.
 Hialop, The Reverend H., Nagpore.
 Horsley, Captain W. H., Civil Engineer.
 Jenkins, Major W. G. P., Asst. Qr. Master General Saugor Division.
 Keatings, Captain, Nimar.
 Kirkpatrick, M. D., Assistant Surgeon J., Mysore Commission.
 Knox, Esq., W. Acting Collector of Ganjam.
 Leslie, Dr. W. A., Honore.
 Lushington, Esq., T., Collector of Masulipatam.
 Malby, Esq., E., Member of the Board of Revenue.
 Malby, Esq., F. N., Member of the Board of Revenue.
 Military Board, Madras.
 Morland, Major.
 Murray, Esq., M., Collector of Cuddapah.
 Muzzy, The Reverend Mr., Madura.
 Ogilvie, Captain Robert, Assistant Commissary General.
 Parker, Esq., J. D., Collector of Madura.
 Pearse, Captain J. L., Mysore Commission.
 Pelly, Esq., C., Collector of Bellary.
 Prendergast, Esq., T., Collector of Ganjam.
 Robertson, Esq., Andrew, Collector of Vizagapatam.
 Rohde, Esq., J., Inspector of Prisons.
 Russell, Captain J. G., Assistant Commissioner, Kurnool.
 Scott, Dr. A., Deputy Assay Master, Madras Mint.
 Scott, Major F., Deputy Qr. Mr. General, Madras Army.
 Shubrick, Esq., Charles, Collector of Chingleput.
 Sullivan, Esq., A. W., Collector of Vellore.
 Taylor, Captain Meadows, Depy. Commissioner, Naldroog.
 Taylor, Esq., G. N., Sub. Collector of Rajahmundry.
 Thomas, Esq., E. M., Collector of Coimbatore.
 Thomas, Esq., E. C. G., Asst. do. do.
 Thomson, Esq., James, Chairman, Madras Chamber of Commerce.
 Tulloch, C. B., Major General A., Commissary General.
 Wedderburn, Esq., A., Sub. Collector of Cuddapah.
 West, Dr., Civil Surgeon, Tellicherry.
 Winsom, Lieutenant G. V., Executive Engineer, Jubbulpore.
 Yaldwyn, Major General J. W., Commanding Bellary.

This is cut in two, while red hot, with hatchets, and the halves are thrown into a smaller furnace to be refined. They are then divided once more, still with the hatchets, and handed over to the blacksmith to be hammered into bars. From two maunds of the unwrought iron as it issues from the first furnace, one maund of malleable iron is ultimately produced, which sells at Trijwarce for 1½ Nagpore rupees, or a little more than one Company's rupee. Eight annas, therefore, is the amount daily produced by each furnace, the cost of charcoal and some other expenses is about 3 annas, and the remaining 5 annas forms the wages of the two or three workmen attendant on the furnace. Be it remembered, these are the statements of the miners themselves, who have every inducement to diminish their income, and exaggerate their outlay. It may be observed also, that with these wretched tools, without capital, without machinery, without a flux, without the means of erecting a good furnace, and with their utter neglect of the best ores, the wretched miners of Khandeshwar can still turn out seventy tons of iron a month. The extent of the supply we cannot ascertain, but it appeared to our informants almost inexhaustible. Nor is this all. At Meytapore, twenty miles nearer Nagpore, 25 furnaces are supplied with iron dug from a great plain covered with red earth. The ore is scarcely so perfect as that of Khandeshwar, but it is found only two feet from the surface. At Lohara, and in the subah of Bandara, 125 more furnaces are known to be in work, and the whole, though ruder in construction than those which Tubal-Cain must have employed, more than supply the necessities of Nagpore. Neither fuel or flux are wanting. Round Khandeshwar for hundreds of miles, the jungle is inexhaustible, while food is so cheap that labour can be obtained at rates, to which even those current in Bengal appear excessive. No flux can be found near the mine, but within three miles runs a broad river, and along the banks of some of its feeders the common kunker, or lime stone, an excellent material for the purpose, is distributed in abundance. The Wyn Gunga is navigable for several months in the year, and if the improvements suggested by Colonel Cotton were introduced, the water communication down the Wyn Gunga and Godavery would be perfect. Of all the iron districts of which we have as yet received an account, Khandeshwar appears to be by far the most promising.

It has been pointed out to us that Mr. Oldham, the Company's geologist, in his remarks upon the iron districts of Beerbhoom, has adduced facts which prove that the profitable manufacture of iron in India is almost impossible. We think that far too wide an interpretation has been placed upon the views, which that gentleman considered it necessary to adduce. His arguments were published at a period when English iron was much cheaper than it is at present, and scarcely half the price it will reach in Calcutta during an European war—secondly, we question if he desires to extend the application of

his calculation, beyond the districts he had personally surveyed. He calculates, if we understand him correctly, that while the production of a ton of pig iron in England would cost 52s. 10½d., in Beerbhoom it would cost only 41s. 10½d. In order however to erect furnaces capable of supplying the Indian demand, it would be necessary to expend £36,000, and when waste and charges for repair are taken into the account, there would remain from the proceeds about £1,687 or less than five per cent. Therefore says Mr. Oldham :

"It appears, most obviously and clearly to result from these considerations that, under existing conditions, the manufacture of iron, on any efficient scale, and on the European system, cannot be undertaken in this district, with certain prospect of such a return as would justify the great outlay required."

The calculation, however, is based upon the supposition that the iron is to sell for £5 a ton, and that the average profit on that quantity shall be exactly one shilling. The Railway Company would now be too happy to pay seven pounds, and the difference upsets all Mr. Oldham's calculations at a stroke. Moreover, many of the sources of expense existing in Beerbhoom would not exist in Khandeshwar. In the latter territory, there is fuel, and cheap fuel. There is labour, and cheap labour. The "flux" which is to cost in Beerbhoom twenty-seven shillings a ton, could not cost a tithe of that sum in Khandeshwar. There is a great river upon which to convey the iron produced, and the ore is confined to two subahs never fifty miles from the stream. Should the Government of India be true at once to its own interests, and its own responsibilities, and erase the native tyranny, Nagpore may yet become what nature intended it to be, the South Wales of the Indian Empire.

A list of the specimens of iron ore from the district of Nagpore now in the Museum will be shortly published, but before concluding this report, it may not be deemed superfluous to add from letters of Captain Jenkins and Lieutenant Crump the following history of the discovery of coal, on the northern frontier of this presidency which I shall describe as the

COAL OF AMEERKUNTUCK.

Amongst the coals early discovered in India was the deposit in that extensive area on the banks of the Bahmance river, which Captain Kittoe, describing it as Talcheer coal, gave the details of in the Bengal Asiatic Society's Journal. A few years afterwards, the late Dr. Walker discovered coal cropping out at Kotah on the banks of the Godavery and it is generally understood that there is an extensive coal basin there where the mineral may in time be profitably worked. Further to the north and west, on the banks of the Nerbuddah, coal was discovered and several boat loads were lately sent to Bombay by Sir R. N. C. Hamilton, which were tried and found to be more useful in

Memo. of Expenses and profits of Furnaces in the Bellary District.

Talooks.	Furnaces.	Villages.	Expenses of a Year.										Rent payable.										Profits.												
			Expense of each Smelting.				Expense of a year.		Value of articles destroyed in a year.	Total amount of expense.	Rent payable to the contractors of Forests for being allowed to cut wood for charcoal.				Grand Total of expenses.	Particulars.		Iron produced.		Profit remaining after defraying expenses.	Amount of permanent stock that would be required to set up a new Furnace.	Number of Maunds of Ore smelted each time.	Pounds of Iron produced from 100 Pounds of ore.												
			Furnace.	Wages.	Hire for bringing stones.	Value of articles destroyed.	Total.	Number of times.			Amount of expense.	To other dominions.		To the contractors of this Talook.		Total.	Rent payable to the Sundoor authorities for the ore taken from their country.	Gravel.						Months in which work was performed.	Average expense of a month.	Number of Maunds.	Price of each Maund.	Amount.	Impurities of iron, the refuse after purchases by Ironsmiths.	Ore dust purchased by Ironsmiths.	Total.				
												Sundoor.	Mysore.		Price.			Hire for bringing it to the Furnace.	Amount payable to Government.	Total amount of rent.															
Koodlighee.	Furnaces where Iron Stone is smelted.	Iron Stone.	Nookanabell.....	1	144	28	9 2	181 2	3	543 6	49 8	592 14		6	4			18	28	620 14	9	68 15	9	41	8	697 8	12		698 4	77 6	105 11	2 1/2 Maunds and 8 Seers.	19 Pounds.		
			Woolavakuntahully.....	1	144	21	9 2	174 2	3	522 6	49 8	571 14		2	2	4			18	24	595 14	9	65 3	4	41	8	697 8	12		698 4	102 6			105 11	
			Kukkoopy.....	1	144	14	9 2	167 2	3	501 6	49 8	550 14		1	1	4			36	41	591 14	9	65 13	2	46	8	697 8	12		698 4	106 6			105 11	
			Chellapanahully.....	1	144	7	9 2	160 2	3	480 6	49 8	529 14		2	2	4			60	66	595 14	9	66 7	4	46	8	697 8	12	2	700 4	104 6			105 11	
			Thummerbundy.....	1	144		9 2	153 2	3	459 6	49 8	508 14	4		4	4			60	68	575 14	9	64 1	4	46	8	697 8	12		698 4	121 6			105 11	
		Gravel.	Maramanahully.....	1	138		5 0	143 10	2			321 12		6	6		10	56	13	90	411 12	9	45 12	3	5	1 8	457 8			45 8	45 12	66 5	54 Maunds.	9	
Madugserah.		Furnaces where sand is smelted.	Large furnaces.	Sindhigherry.....	1						215 2	33 8	250 10 8		8	8				11	19	269 10 8	8	33 41	4	5	50	14	315		315	45 5 4	40	3 Maunds.	25
				Small furnaces.	Goondamalah.....	1							107 9	19 12	127 5 4		4	4				5	10	137 5 4	8	17 2	8	11	0	14	137 8		137 8	20 2 8	20

(Signed) C. PELLY.

Collector.

raising steam than bituminous coal from England. There were thus three points on the northern frontier of the Madras territories, one in Cuttack on the Bahmanee river, one in the Hyderabad dominions at Kotah on the Godavery, and one on the Nerbuddah territories about Jubbulpore where coal has been known to exist, but from the following extracts an extensive deposit of the mineral would seem to exist near the Tirreah Hill, a site somewhat intermediate between the Cuttack, Kotah and Nerbuddah coal basins. With so little really known of the general features of that part of the country, it is with pleasure that we are able to give this interesting account of a so slightly known tract, and we would be glad to receive any further information regarding its mineral productions.

"Your desire to learn something more touching the Coal fields beyond Umcer Kuntuk has suggested to me the idea of sending off to you this day, by banghy, a small box of specimens sufficient for analysis—but the Mahanuddy, Sumbulpoor, and Cuttack, are the outlets for the mineral wealth of those "diggings" rather than the Nerbuddah which lies too far West, besides which it has plenty of Coal of its own.

Nos. 1 and 2—are specimens of two different seams of Coal, lying below the great Mekul hill Eastward, about twenty miles apart:—and, be it observed, they are from the top of the seams—stuff such as in England would be thrown aside at the mouth of the pit till they had worked down the second bed—therefore, the presumption is that much better is to be found below. Clay shale overlies the Coal;—Coarse grit sandstone is above the shale.

No. 3—is the common iron stone of the country, so common that you may pick it up on the surface as much as you please,—as this pebble. It contains a large percentage of iron, but the people cannot work it; it is too hard to smelt without a flux and fluxes they know not.

No. 4—is a clay iron stone, or, I suppose, clay oxide is the correct term—which they do work, for it smelts easily without flux, and first rate, tough, soft, iron it makes too: this ore they dig out (the specimen in question came from a "kadau" surface mine below Umcer Kuntuk in the side of the Mekul hill.

No. 5—is the first running of the iron from the ore; to make it good they run it twice again, the last time with hard wood charcoal.—Major Scott the Quarter Master General will have a trace of the route we took from the sources of the Nerbudda, for Captain Jenkins sent him one down lately."

"During the trip lately undertaken by Lieut. Crump and myself, to the country beyond Ammerkuntuk, quitting the source of the Nerbudda and descending the steep and rough Pukerah Ghat, we passed through Paindra,

a place of some importance, being the residence of the Thakoor of the district. It contains some three hundred houses, and two or three Boomeahs. From the foot of the Ghat to Deavee the country is tolerably level, open, and partially cultivated, rice being the chief produce; then, through undulating land with Surrye copse, and, after crossing the Bahmanee, some 80 yards wide, deep bed, but shallow water, we are in the Surrye timber forest on the Tirreah hill.

Tirreah hill is of considerable extent and appears to be a step or berm of the great Mykul range, as we did not observe any *ascent* between the Mykul range and the Bahmanee. To the S. E., the Tirreah hill is joined by the *Lingha* a heavy range of hills, but too far off for me to enter them in this sketch, and in fact there are many hills which we passed near but which I had not time to sketch in.

The general character of the country is undulating, often like a rolling *Prairie*, with occasionally heavy ranges of hills "cropping out."

On crossing over Bijlee Dhar from our hut on the Buckseye River we picked up coal in the bed of the Poolsah river; it had evidently been carried down by the stream,—and again when crossing the Bunneah hill, we found it in great abundance in a deep ravine. At the Sirmuddee water fall, on the Bisvaah, I found an extensive seam of coal under a stratum of grey sand stone; and riding up the Dujjai Nullah found that *the bed of it was formed of coal*; and, on the right bank, the coal was not two feet below the surface.

In the Hustoe river, between Hutney Day and Nowgotta, we found lots of coal which had been brought down by the stream, and from this it appears probable that extensive coal beds exist to the north of Hutney Day.

In the Choornai, near Kaanta Kource, we found coal which had been brought down by the stream; and I was informed that in a hill at Arreeturah there was lots of iron stone (we found it in other places during our trip;) and that in a nullah near Nuckkeah there was a "black stone which caught fire when the jungle was being burnt and continued burning for a long time." I wished to visit those places but our time being limited, I could not go so far.

The coal we found is, probably from exposure, of inferior quality; it gives out a great deal of smoke when burning, and trying some of it in a clay pipe, I found it thrown out a very brilliant jet of gas.

It is probable that this valuable article may exist in many other spots, but though we were exceedingly desirous to pick up as much knowledge of the resources of the country as possible, yet from the way in which we were obliged to hurry through, our observations were necessarily very limited.

The next thing to be considered is whether this coal &c., could be made

Talooks.	Places where Iron sand is found.	Places where Furnaces are erected.
Iyempully.....	{ Not specified in Tahsildar's report.....	Iyempalliern 1
		Sittooravoo 2
		Canavoyputty 3
		Aundypetty 4
		Poodoor..... 5
		Pooleamarathoo Cottay..... 6
		Pandyady 7
		Calloopetty 8
		Jogypetty 9
		Uttu koamby.....10
		Apil Naikunputty ... 11
		Veeroopautchy12
		Arasapillyputty13
		Dasaryputty14
Shevagunga Zemin-dary.....	{ Iron Ore is found at Kelavadypullum..... Shevagungah.....	Site of Furnaces.
		Kelavadypullum. Palcolum.

Mr. Parker considers that Madura cannot be called an iron producing district. According to the Tahsildar's reports ore is found in 2 villages only, Shevagungah and Kelavadypullum situated in the Shevagungah Zemindary; and in them the quantity found is insignificant. The district exports no iron and the greater part of that which is used within itself is derived from Salem and England.

The quantity produced within the district is chiefly obtained from sand found in mountains and jungle streams. A specimen of this reached by Banghy; the Talook which extracts most iron is Iyempully lying partly under the Pulney Hills; but the total annual value is estimated by the Tahsildar at only 630 Rupees. Ramnad is returned as producing no iron whatever. If 630 Rupees, therefore, be multiplied by 9 for the 8 Government Talooks and the Shevagungah Zemindary, the total will exhibit the highest estimate that can be formed of the quantity extracted in the district within a year. This amount Rupees 5,670 is far above the reality. Crude iron is the only description made. Very little steel is made and that in one Talook only* from Salem iron. The

* Rangherry.
tools manufactured in the district from indigenous iron are mamotics, kohitahs, small pickaxes, scales and a few other implements of a coarse description.

Better tools are made from English and Salem iron, but on the whole the iron smith's work in the district is rough though better in Dindigul

than elsewhere. The European residents of Madura send to Palamcottah, Salem and Trichinopoly for anything they require moderately good. The Madura blacksmiths consider that in number the tools made at Parnagoody in the Ramnad district are greatest.

The furnace used is made of burnt clay. Its height is $2\frac{1}{2}$ feet diameter, at bottom 16 inches at top 9 inches. Its shape is conical and costs 1 rupee. This is placed in a space about $3\frac{1}{2}$ feet square, enclosed by a very low wall, through an aperture under which a clay tube is introduced and two pair of native bellows applied to the outside end. In the furnace is first of all placed a layer of the ashes of cholum stalk; above this a layer of charcoal; on this is placed the iron sand and then another layer of charcoal. In smelting the lump of iron remains in the furnace and the dross is carried off by an aperture in the furnace. The iron is taken out by a pair of pinchers. A small iron rod is used to clear the tube in which the bellows are inserted and a rough kind of hoe cleans the bottom of the furnace.

The cost of the above is as follows.

	Rs.	Rs.	As.
The furnace.....	from 1	to 1	8
2 Bellows.....	2	4	
1 Pincer.....	2	0	
1 Iron rod	1	0	
1 Hoe.....	0	12	
	7	0	

The furnace is worked in partnership by all the persons engaged, 14 in number, who divide the profit between them as compensation for their labours.

- 4 Bellows blowers.
- 5 Charcoal Carriers.
- 4 Carriers of iron sand.
- 1 Superintendent.

The iron makers refuse to divulge the amount of their profits but they must be moderate.

Charcoal is abundant in this district and procurable nearly everywhere.

The blacksmiths consider Madura iron to be very hard and to answer well for tools.

The monthly importation of iron into Madura town they estimate at

Salem iron.....	60	Tolams.
English do.....	90	do.

available; and though it would be difficult to give a definite opinion without having visited the whole of the ground, yet I am of opinion that the coal from the neighbourhood of the Tirreah hill could be made available for the Jubbulpoor and Mirzapore railroad.

In 1852 I examined the life between Dimow and Sohagpoor, and, as I reported at the time to your Office, I am confident that if necessary a road could easily be run between those points.

The country between Sohagpoor and the Tirreah hill I have not visited, but I estimate the distance to be not more than 50 or 60 miles, and from the general run of the country I should say that there are no heavy hills between Sohagpoor and the coal fields. Some light might perhaps be thrown on this subject by examining the Field books of the guide who surveyed the road between Sohagpoor and Pandra in 1852; I regret that I have no copies of those Field books.

The Loam is a very lofty hill; and the Gudguddah flows at the foot of another very lofty and extensive range of hills. The hills running from the Gudguddah to the south of Udjghurbarah are singularly picturesque, lofty and exceedingly precipitous—they are of sandstone formation, as are most of the hills in those parts. The Pulmah range gradually increases in height until we arrive at Laafah which is a very lofty and steep sided mountain looking down on the rest of the chain. It is a natural fort of great strength, and is well supplied with water; there are no works excepting at the gateway. The approach to the Fort is on the Northern face of the hill. The Thakoors of Laafah villages have for many ages been the Killaders of Laafah fort. From Laafah an easy ghat leads down to a narrow, long and (for these wilds) rather thickly populated valley; on the right is the heavy Koomoo or Boondra hills, and on the left a range which sweeping round the head of the valley near Koongsarraha joins the Mykul somewhere about Mooswah Ghat.

The whole of the country we hunted over is well watered with rivers, rivulets or springs; the Hustoe is the largest river we met with and though many are fine wide streams, yet all are shallow, with generally sandy beds and low banks, so I do not think that they would be of use for conveying the produce of the country.

The whole of this interesting country is covered with a forest of the magnificent ever green Surrye, and even in the hottest weather the grass in the low lands and vallies is green; and if you will but imagine a few herds of Elephants, Bison, Buffalo, innumerable Deer, and very few inhabitants (Bipeds) scattered over the lands, you will have a very good idea of our late hunting ground.

The Surrye is a noble tree being often upwards of 50 feet to its lowest branch or rather fork, and from 7 to 11 feet in circumference; the wood is heavy, red, hard, resinous, and the natives say all but indestructible. I should imagine that it would make first rate sleepers for railways. The inhabitants are few and consist of Rajpoots, Gonds, Aheers and Booneahs.

The Tuhkoors of the different districts and their followers are all Rajpoots, who, when Delhi was seized by the Mahomedans fled to Nagpore and placed themselves under the protection of the Rajah. The Rajah gave them certain portions of his jungle territory to cultivate and keep in order, and there these people have been settled ever since.

The Gonds are the same as all the inhabitants of the hills in Central India. The Aheers are chiefly professionals who come up from the lowlands with immense herds of cattle, to graze during the dry season on the rich grass of these vallies. Cattle are sent from great distances for this purpose. I saw some fine herds of Buffalo from Mirzapoor. The Thakoor gets 5 Rupees per hundred for the grazing of Buffaloes.

The Booneahs are, I think, the most interesting race we met with; they are regular savages, living chiefly on what they can kill with their bows and arrows. They live in family groups, 4 or 5 huts forming a village. The huts are neatly made of bamboo basket work plastered inside with clay, the roofs being thatched with reeds, and a wall of bamboo basket work is thrown round the hamlet. These Booneah hamlets are generally situated in wild spots in the jungle, and besides, these villages on the plains they always have certain hiding places built in out of the way places high up in the hills; in these places they always keep the greater portion of their supplies, and fly to the hills on the slightest alarm. They occasionally cultivate a field or two of grain, and a patch of tobacco; they also collect wild fruit, honey, lac, and the Tussair silk cocoon. The poison they use on their arrows is so virulent that it kills a Bison in three hours; they say it has no effect on an Elephant. It does not injure the flesh as food. We, after infinite trouble, added this famous poison to our stock of jungle curiosities. When these savages condescend to cultivate they fell all the timber on the place they have chosen, burn the wood, spread the ashes, and when the rains commence sow the seed. For ages these unfortunates have been bullied by Tuhkoor, Gond and Aheer, and to this I attribute a great deal of their timidity, and all their poverty; for were they kindly treated, and a pair of bullocks or so given occasionally in times of difficulty, I am confident that they would be easily reclaimed. I saw a village of civilized and tamed Booneahs near Kamnugger; they had been located on the same spot 20 years, had their ploughs, &c. &c., whereas a jungle Booneah is continually shifting his residence. All this country belonged to the Nagpore

and its branches, or the coals on the Brahmoney river in Cuttack will be found as in Britain associated with or not far removed from bands of iron ore, which may be convertible into iron at a price that that country will be able to purchase at. The Rev. M. Hislop expresses the benevolent wish that something may be done to open a road to the treasures of iron ore on the banks of the Weyn Gunga, and Mr. Boothby will, I trust, early order a special enquiry to be made to ascertain the area occupied by the coal beds on the Godavery, and make this information at once public, and this I mention as the earnest wish of benevolent men as well as of those connected with trade, and I join with them in this wish, for the sake of science.

A list of the specimens of iron ore from the district of Hyderabad now in the Museum will shortly be published.

INDORE

is not a British, but a native state with which the Honorable Company have a subsidiary alliance, and within eight miles of the capital of which, at Mbow, soldiers from the Madras army are stationed, and a notice of its ores of iron is therefore desirable. The present Maharajah Holkar is preparing to have the mineral products of the country examined, and it is anticipated that copper will be discovered. I am indebted to Sir R. N. C. Hamilton for several specimens of the ore and iron, and the charcoal and its wood employed in smelting the ore.

The illustrated catalogue of the great Exhibition of 1851 (vol. 2 page 861) gives the following as Sir R. Hamilton's account of the process of smelting: with a section of the furnace.

"The furnace in which iron-stone is melted is excavated out of the ground, about 12 by 10 feet, and 10 feet deep; the furnace is made of clay, plastered with cow-dung (heaped). Double bellows are fitted, air-tight at the bottom, worked by a man sitting between them; at the bottom of the furnace is an earthen sieve through which the dirt and refuse drop. The holes are filled with earth at first but this gives way as the iron melts and comes down: when choked the holes are opened by an iron poker the drops and dirt fall. The fire is formed of caked cow-dung broken small, charcoal broken the size of marbles is placed about one inch in thickness, then a layer of cow-dung and charcoal, and so up to the surface, when the ironstone is piled about 18 inches, and covered in with the wood cut into the small billets. After four hours' incessant plying of the bellows, the furnace has attained a heat which makes the first layer of stone rock and the dross fall through; the whole mass has become gradually heated, and as it falls, the stone on the top

which is regularly served keeps falling into the furnace. In this way the furnace is piled and filled for 12 hours, the bellows going the whole time: the furnace is now left to cool, and according to the season, is ready to open in from 12 to 24 hours.

The iron will amount to about 40 lbs. weight (20 seers,) which at the pit, including digging the stone, firewood, and every charge, sells so that the profit averages one rupee per seer: the people consequently work only as their wants require, and not regularly.

Nothing more is done by this class of workmen: the iron is sold as it comes out of the furnace, and worked up by another class.

A list of the specimens of iron ore from the district of Indore, now in the Museum will shortly be published.

KURNOOL.

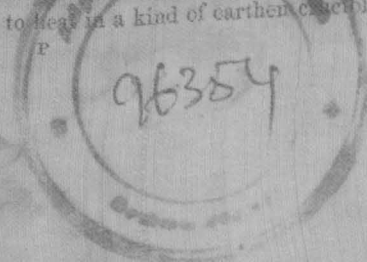
Kurnool is one of the non-regulation districts of the Madras presidency and came into our possession by conquest, in 1839. It is bounded on the north by the river Kistnah which separates it from the Hyderabad country, on the west and south by the Bellary and Cuddapah collectorates, and on the east by the collectorate of Nellore. It has an area of 3,243 square miles and supports a population of 273,190. It is divided into the following talooks:

Atocor,	Kurnool,	Pannim,
Changulmurry,	Nundial,	Ramulcottah in Dhong,
Culloor in Goodoor,	Nundicootor,	Servell.

In its general features this small district is flat with solitary hills rising from its surface, a few of which cluster towards the south, approximating to each other and it has on the east the Nulla Mulla mountains, a range covered with dense forests with a few passes through them. The rocks consist of Hypogene lime stone and sandstone and mica schists, and of mineral products of use in the arts marble, copper? lead, antimony? and iron have been discovered in them.

Ores of iron are in extreme abundance throughout the district and can be had in any quantity, are even smelted by the inhabitants to a considerable extent and the iron used for home consumption. There have only a few specimens (vide appendix,) been sent to the Museum of the ores of Kurnool, probably because of their similarity: amongst others is one from Ramulcottah.

All the hills in the neighbourhood of Kurnool abound in iron ore of various kinds for the most part *hydrated oxide of iron* and a species of *Red Hematite*: at certain times of the year the natives smelt it in a simple way by mixing the powdered ore with charcoal and exposing it to heat in a kind of earthen crucible.



Rajah; whether the people will benefit by the change of rulers remains to be proved. They could not be worse off than they were. The Booneahs and Gonds have a curious way of counting distance. Their "Distance Table" is as follows:

One haank is as far as a yell can be heard from a hill top.

Two Haanks = one Daab.

Two daabs. = one Coss = $2\frac{1}{2}$ miles.

Twelve coss. = one Munzil or the distance a man can walk in one day.

The Booneah like the Gond speaks a kind of Hindustani, but many of their words were strange to us and our people, and I think that there is a good deal of Sanscrit in their bolee.

Extract from letter of Reverend S. Hislop, dated Nagpore 24th March 1855.

"When out on our Mission tour, I had an opportunity of seeing the coal, which lies on the North of this, and which is connected with that on the Nerbudda, I found that it immediately underlies what used to be called the Diamond Sandstone, a sandstone which is characterised in the Nizam's country as well as in this Territory by being traversed by iron bands. The carbonaceous beds are just the same as those in Bengal and from the vegetable remains are evidently not older than the lowest strata of the oolite or the highest of the Lias."

(A true extract.)

ALEXANDER HUNTER.

I subjoin an analysis by Mr. Mayer of the 2 specimens of coal received with the letters of Lieutenant Crump and Captain Jenkins the analysis is incomplete as the several gaseous constituents were not collected for want of the necessary apparatus, which however has been ordered.

Composition of the coal.

	No. 1	No. 2
Combustible matter, being organic constituents.....	87.30	84.50
Ash, incombustible residue.....	12.70	15.50
	100.00	100.00

The ash examined gave the presence of

Bases.	Acids.
Lime.	Sulphuric.
Alumina.	Chlorine trace.
Iron and	Silicates.

Incombustible residue soluble in dilute Hydrochloric acid.	0.80	0.80
Specific gravity of the coal.....	1.35	1.81

J. MAYER,

Professor of Chemistry.

NEILGHERRIES.

The Neilgherries comprise two distinct tracts of mountainous country the one called the Neilgherries proper and the other the Koondahs, of which latter however the surveys remain uncompleted.

The area of the plateau of the Neilgherries, as defined on the north-west, north, east and south by the crest of the mass of mountains, and on the south-west by the outline of the Koondahs, comprises 268,494 square acres, in its geographical extent, though a far greater amount of land is actually available for cultivation, on the countless undulations of the whole surface.

The geological formation of the Neilgherries is composed of Hypogene plutonic rocks, the mass of the mountains being granite frequently passing into sienite, intersected by innumerable dykes or veins of basaltic rock, hornblende, quartz, and other minerals. In the Koondahs, trap is more extensively developed, being often found there capping the hills and overlaying. Hornblende rock passing into hornblende slate and hornblende porphyry, and imbedding garnets also occurs in some abundance and this rock is highly ferruginous and decomposes into a stiff red clay which forms extensive beds in many parts of the Neilgherries covered only by the soil. Beds of gneiss which occur greatly torn and distorted and dipping to the east at an angle of 36° and 60° at the N. E. angle of the plateau, are the only stratified rocks. Near its junctions with the granite, the gneiss is much altered and perforated in all directions by veins of igneous rock. It is from Captain Ouchterlony's very valuable report (Memoir &c. 1847) that the above is drawn, and a longer than usual description of the geological features of these mountains has been given, because of the hopes that exist of discovering in them metalliferous deposits in sufficient abundance to be profitable in working them. Copper, lead, tin, manganese and iron, are all said to occur.

Metalliferous deposits, ores of copper and lead.—Metalliferous deposits writes Captain Ouchterlony (Madras Journal of Literature and Science, vol. 15, page 3,) do unquestionably exist in the Neilgherries. Ores of copper, (pyrites) and lead (galena) have been found embedded in quartz, but unfortunately not in situ being merely portions of blocks of stone found in the walls of some "cairns" or ancient places of sepulture, in the neighbourhood of Nunje-naad, not far from the foot of the Koondahs. The circumstance was brought to the notice of Government some time since (I believe by Dr. Burrell and Captain Congreve) when I was directed to co-operate with the latter officer in instituting an inquiry as to the origin of these ore blocks. Captain Congreve however shortly after left the Hills, and though I have taken advantage of every opportunity which offered to pursue the desired object, I am sorry to

English iron is preferred by the blacksmiths for the axles and tyre of wheels of bandies (which are very abundant in the district) owing to the comparative ease with which it is worked; but they state that the Madura iron is harder than that procured either from Salem or England. A vast quantity of English tyre for wheels is sold in the bazar.

MALACCA.

See Tenasserim Provinces and Eastern Settlements.

MASULIPATAM.

is a Collectorate formed out of part of the Northern Circars and has on its north, the Collectorate of Rajahmundry; on the South Guntoor and the sea; on the west the Hyderabad Dominions and on the east the Bay of Bengal. Its area is 5,000 square miles and its population 544,672.

Its aspect on the sea border is low, but it is mountainous towards the west. Of its rocks or mineral productions, little is known—but the following information has reached me regarding its ores of iron.

Captain Ogilvie, in reporting on the products of Masulipatam (p. 120 Proceedings of the Madras Central Committee) mentions that in the village of Nullacherlah in this district, iron ore is procurable in large quantities. At the village of Donacherla, it is excavated, and iron made after the native system, with a blast, obtained from a common pair of hand bellows; some idea may be formed of the value of the ore, when it is sold at a rupee a maund, after having been three times passed through the forge; iron ore of a different description not so valuable, is found in the Juggiahpett Talook.

In addition to the above information, I have been favored with the following interesting report from Mr. Lushington.

From the enquiries instituted, it appears that out of the 15 Talooks composing the Masulipatam District, iron ore is found in four only. These are Juggiahpettah, Tirwoor, Gollapully and Pentapaud which extend as the frontier Talooks from the Kistna to the Rajahmundry District.

Juggiahpettah.

- 1 Shairmohammedpettah.
- 1 Gandraye.
- 1 Tukkelapadu.
- 1 Ramachendroonepettah.
- 1 Boceharum.
- 1 Veerabundroonepollen.
- 1 Duchoopaulm.

Iron stone is found to a great extent in the Talook, and the villages noted marginally which lie in the hilly country near the Kistna to the west of the Moonyair river and are particularly celebrated for it. Stones containing a certain quantity of ore, are found extensively scattered over the surface in many parts; but are not nearly so productive as those dug from beneath it: rich

layers varying in extent are found at a span's depth, and extend to the depth of about a cubit: under these layers is common earth. The stones are almost invariably red.

Furnaces were worked in several villages, but the last has lately been discontinued: one cause of this is said to be the difficulty in procuring Chundra wood "Mimosa Catechu" the fuel best adapted for smelting purposes. It is much more abundant in the adjacent parts of the Nizam's country, where iron ore is also found. Ore is occasionally taken from this Talook to be smelted across the border; and iron prepared there is brought to the Juggiahpettah market. A moturfa tax of $1\frac{1}{2}$ Rupee is levied on stones taken from the Company's to the Nizam's country on a quantity differing in amount but fixed by local custom, and apparently more or less what might be considered a supply for one furnace for one year.

It is calculated that 8 maunds of metallic stone well broken up, and smelted with 8 baskets of charcoal (each basket containing 10 maunikas) gives 2 maunds of crude iron. This is again purified, and after the second process sells in the bazar at about 20 or 21 Rupees per candy. The cost of production is reckoned at 16 or 17 Rupees a candy. The iron was held in estimation.

Tirwoor.

- 1 Chundroopetta.
- 1 Telladavarapully.
- 1 Pectrala.

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Iron stone is found to a considerable extent both on and beneath the surface in the villages named marginally; one furnace, however, only is worked: it is in Chundrapetta; Chundra wood is the fuel used. The cost of production is said to be about 14 annas or 1 Rupee per maund, and the market price about $1\frac{1}{10}$ Rupee per maund or an average of $18\frac{1}{2}$ Rupees per candy as cost of production, and $21\frac{1}{2}$ Rupees as the market price.

Gollapully.

- 1. Somavarum.
- 1. Ramanakapett.
- 1. Chettapoorum and others.

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3
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Iron stones and ore are found to a great extent in the villages noted marginally. They are procured principally at a short distance below the surface in conjunction with other stones of various descriptions in proportions of $\frac{3}{4}$ or $\frac{1}{2}$ of iron stone to $\frac{1}{4}$ or $\frac{1}{2}$ of other sorts. The manufacture is carried to a much greater extent in this Talook than in any other, there being 14 furnaces in Somavarum, 5 in Ramanakapett, 5 in Chettapurum and 1 in Lopoody, or 25 in the Talook. Chundra wood is the fuel used, the cost of production is from 15 to 17 Rupees 3 annas, and the market price about 18 or 20 Rupees: the iron manufactured at Somavarum and Lopoody is said to be the best. In the former village especially the manufacture is of a very ancient date—and

say my efforts have not been crowned with success, for although many large channels of quartz occur in the neighbourhood of the spot where the blocks were found, and all running in a true metalliferous direction, east and west, I have not been able, though I have traced them a long distance, and crossed their backs in various parts, to detect in any of them a trace of ore, or any of those peculiar indications on the surface, which would elsewhere characterise a vein or lode bearing ores of either copper or lead.

The Todars dwelling near the spot declare their belief that the blocks were brought from the Koondahs "and although this can be little better than surmise, I should certainly say from the aspect of that range of mountains, that deposits of ore are more likely to be found in it than in the Neilgherries. It bears much more the look of a mining country; and the violent igneous action which has evidently prevailed amongst its rocks after their formation, favours the expectation that metalliferous deposits will be found there, if they exist in quantity anywhere about this mountainous district.

MANGANESE.—The black oxide of manganese is found about the Hills in many places, existing in small veins and retiform deposits, but I do not think it could be profitably worked, as the continuance of a supply in a particular spot could not be depended upon, and it could not moreover be brought into any home market, at a sufficiently cheap rate to compete with other ores.

LATERITE.—Laterite is also found in various parts of the Neilgherries, generally in an advanced stage of decomposition, forming a lithomargic clay, which underlies the soil of many tracts of land. I observe the existence of laterite most frequently where the sienite contains much hornblende, which favours the belief that it is the result of decomposition of the primitive rock, hastened by the action of the atmosphere upon its excess of ferruginous matter. A bed of this rock occurs near Keitee sufficiently indurated to be fit for quarrying for building purposes but no use is made of it by settlers owing to its being more costly than bricks.

Ores of iron.—Ores of iron are met with in many parts of the Neilgherries occurring in small veins, and disseminated through the mass of the rock enclosing it but nowhere (that I have seen) in sufficient quantity to be worth working. A great many varieties of iron ores exist, more interesting to the mineralogist than to the statistical recorder. These are, hematites, specular iron ore, micaceous iron ore, magnetic iron ore, and iron pyrites, but all found in insignificant specimens.

As it is of the iron ores only that this report should make mention, I may remark that conflicting accounts have reached me of the economic value of those on the Neilgherries. Mr. Beaumont considered that all those which he

saw there, are not worth the working, while Mr. Ross, in whose opinion we must also have great confidence, intimates to me the occurrence of an ore of iron of great commercial value and he is only waiting moderate weather to examine and fully report upon it. In this state of things, I think the best course is to republish here all that Benza wrote on the ferruginous rocks of those mountains.

The next rocks to be described says Dr. Benza (*Madras Journal of Literature and Science* vol. 4, p. 249,) are two metallic ores, in all probability, originally imbedded, as veins, in the rock: which last being now decomposed, they are left imbedded in the lithomargic earth: indeed, one of these ores is still seen as a vein, in the undecomposed rock. The first is the magnetic iron ore, so common in many parts of India, and which, besides the metal, contains variable proportions of quartz (No. 14). The places where I have met with this iron ore," he continues, "are marked in the map: in some of them the ore is imbedded in the lithomargic earth, while in others it is like a vein in the rock. I saw it in this last position in the road descending to Kaitee valley, where the metal is very little in quantity, compared with the granular quartz, which in some parts of the vein predominates to the almost entire exclusion of the metal (No. 15). The two places on the Neilgherries, where I have seen this ore very rich in metal, are, one near the village of Vartsigiri (Kotagherry) and the other close to, and traversing, the Lake of Ootacamund in two places. The specimen from Vartsigiri (No. 16), is very compact and rich in metal. I took it from a large block, probably the outgoings of a thick bed at the Southern extremity of the Valley, at the other end of which the village stands. Generally speaking, the quartz is lamellar, very rarely granular, and it seems to alternate with the metal in parallel laminae. The appearance, composition, and proportion of the ingredients of this magnetic iron ore are very different in different places, nay, in the same vein. For instance, the vein seen just below the building called Gradation Hall, between the road and the margin of the lake, in its N. E. extremity has a compact, metallic structure, highly magnetic, with hardly any quartz (No. 17). A few yards to the south-west, the vein contains a good deal of quartz; the metal is more oxidated, although maintaining still its magnetic powers (No. 18). Following the vein in the same direction, we see it appear in the opposite side of the lake, in the banks of the road, which goes round and close to the lake. There the ore has lost a good deal of its quartz; the iron is more oxidated, and the rock assumes a kind of columnar structure (No. 19). This is the appearance of the vein in the section for the road. But the out-croppings of the vein at top of the same hillock are compact, scabrous, and of a slight cellular texture (No. 20). Going on always, S. W. we see the same vein continued over the next hill, close to the road going to the Kondah; and so much divest-

bloom from Kenthakudavoo subjected to similar treatment, burned, cracked under the hammer and would not work, and the natives state that it is necessary to subject the bloom to a second fusion and much hammering before they can bring it to the state of the soft malleable iron, in which it is met with as an article of commerce. The Committee remark that this statement seems to correspond with what one might expect from the difference of appearance of the two samples; the one of Paulghaut being highly metallic as shown by its bright metallic lustre, while the black charry look of the other seems to indicate such an excess of oxides as to unfit it for the hammer.

In Dr. Buchanan's time, iron was smelted from black sand at Topum Betta, about five miles north from Coimbatore; and at other two places, at no great distance he likewise (vol. 2 p. 283) examined a forge for smelting iron, at a village named Cotumbally. It was wrought by the people called Siclars; and the plan was nearly the same with that of the forges, above the ghaut; but it was in every respect more miserable. The furnaces being built in the open air; so that in the rainy season they could not be used. The iron sand was found in the channels of little torrents, which wash it down from the hills in the rainy season. Much of it he was told, came from a village called Yirsholavaram, in Canghium district, which is on the south side of the Noyel.

Some people of the Shanar tribe who made iron near China Mali told him that when they take the mass of iron from the furnace, they immediately cut it in two with a strong kudali, or hatchet. In this state it is sold to the blacksmith, who by repeated heating and beatings reduce each portion to a small bar. Four Shanar worked at each furnace, every one performing a part at each stage of the business. In the rainy season they collected the sand. Then they made the charcoal; and, finally, in an interval of about three months between the crop seasons of the palmira and coco-nut palms (*Borassus flabelliformis* and *cocos nucifera*.) they smelted the iron. They paid a thirtieth part of the iron smelted to the Government, besides a duty for permission to cut timber for fuel. He likewise mentions (vol. 2 p. 307) that in the journey to Mullinur he passed an iron forge, of the same structure with that seen in Major Macleod's district, and, like it, calculated to smelt

black sand. Also iron ore (vol. 2. p. 343) that in the channel of a mountain torrent near Main-gaby or Annamallay forest he found iron ore of a nature exactly similar to the black sand, but in lumps about the size of peas. The surrounding strata were all aggregate stones of a foliated texture running east and west, and strangely undulated, so as to resemble marbled paper. From these while they are in a state of decay, the ore is probably derived.

COORG

is a small tract of country lying to the south west of Mysore which came into the Honorable Company's possession, by conquest, in 1832, and is now governed by a Superintendent. It has an area of square miles and a population of . It is bounded on the North and East by Mysore and Coimbatore, and its other sides, are encircled by the province of Malabar. Except towards the north where there are extensive tracts of table land, it is composed almost entirely of high mountains separated by narrow valleys. Towards the east the sides of the mountains are entirely covered with immense forests, the trees of which are often of great size. The whole of the southern and central parts of the country abound also with wood, though in the valleys between the ridges of hills there is a little cultivation. The line of Ghauts which terminate the district towards the west are very lofty and beautiful and also covered with splendid forests. Towards the north however, the wood greatly diminishes. Some of its woods are known and are said to be of great value, but of its rocks or minerals there has not been any information recorded.

CUDDAPAH.

This Collectorate was formed from the eastern portion of the districts which were ceded in 1801, by the Nabob of Hyderabad. It is 262 miles long and 160 broad, has an area of 12,970 square miles and contains 1,228,646 inhabitants, and is arranged into the following 14 Talooks.

Budwail	Doopaud	Poolvendala
Chennoor	Doovoor	Roynachoty
Chitwail	Goorcomecondah	Sidhout
Comalapoor	Koilgoontla	and
Cumbum	Muddenpuly	Zummuilmudogo

It has Kurnool on the north, Nellore on the east, Mysore in the south, and Bellary on the west. The Collectorate is generally level but has high mountains both on its eastern and southern borders; in former years, the products of this Collectorate received attention from Dr. Heyne, Dr. Voysey, General Cullen, Dr. Malcolmson and Captain Newbold, and its rocks are known to consist of hypogene limestones and sandstones while the mineral substances which have been ascertained are natron (Native Soda) gun flints, saltpetre, salt, alum, tin? marbles, antimony, lead, copper, manganese? diamonds, and ores of iron. The lead and copper ores are principally in Sidhout and Budwail. For almost all the information and specimens which my recent enquiries have produced I am indebted to Mr. Murray, Mr. Wedderburn, and Mr. Elliot. Dr. Malcolmson has mentioned that magnetic iron ore is associated with galena in the diamond sandstone of Cuddapah (R. Geol.

ed of iron that it resembles a friable stratified sandstone, the quartz being granular (No. 21). * * * * * Before concluding my observations regarding this magnetic iron ore, I must repeat what I said in the beginning: that it is found in thick beds, evidently imbedded either in the original rock, or, which comes to the same thing, in the lithomargaceous earth, the result of its decomposition.

Iron ores are so common on these hills, independently of the oxides of that metal contained in the minerals forming the rocks that many springs of water are of the chalybeate class.*

The next species of iron ore on the Neilgherries is the hæmatitic, forming immense beds, and sometimes whole hillocks, among the hornblende rocks, and sienitic granite in all the places where it is found, large blocks of this ore are seen projecting through the soil, having a scabrous, cellular, and sometimes cavernous appearance at the surface.

As this rock very much resembles the laterite of this part of India, I shall be more particular in describing its geological position and association, in order that it might be seen whether it ought to be classed with the laterite of the low lands, or among the iron ores found in many other parts, associated and in veins, in primitive districts.

Before entering into the description of this rock, I must remark, once for all, that the position and association of the rocks on the Neilgherries is not so easily ascertained, and clearly seen as in other localities of India on account of the enormously thick stratum of red earth and vegetable soil, which cover uniformly the whole plateau. So that we are often reduced to the necessity of judging of the nature of the rock composing the hills, by the few projecting masses at the top, or on its declivities.

It is for this reason, that I am unable to say positively whether the rock I am going to describe be overlaying or one of those metallic veins which traverse the original rock; although I have more than one reason to surmise that the last is the position of this ferruginous ore on the Neilgherries. All I have been able to ascertain regarding this ore, may be detailed by describing one or two of the localities, where this formation is seen developed in a more marked manner than anywhere else on the Neilgherries. The most extensive formation of this hæmatitic iron ore is seen on both sides of what I shall call Scotland Valley.† It is the valley through which the superfluous waters from the lake discharge themselves into the Moyar river; this valley runs, nearly E. and W. Above two hundred yards below the bund of the lake,

* Baillie's Observations on the Neilgherries, page 14.

† Sir Frederick Adam, Governor of Madras, called it by that name on account of a resemblance he saw in it to some place in Scotland.

close to the left bank of the stream, we see a large block of compact iron ore jutting through the soil (No. 23.) Proceeding westward along the right bank of the torrent, for about a quarter of a mile, we come to a place where the stream is joined by another flowing from the S. W. On both sides of this river (until we come to this junction,) the projecting rocks which in some places make up knolls and hillocks, are of the usual sienitic granite, with a good deal of hornblende and a few garnets.

On fording the river, at the place of junction we see on the opposite bank all the projecting rocks to have totally changed their character; they are now cellular hæmatitic iron ore, rich in metal (No. 24.) That rock is seen protruding through the soil of this and of the next hill (W.) Some of the enclosures for cattle on the declivities of this hill are constructed with large masses of the cellular iron ore, which however in some of them has a very compact structure (No. 25.)

The highest of the two hills appears to be entirely formed of this rock of which huge masses are seen in the intervening ravine. On the summit of the highest hill the rock assumes a pudding-stone-like structure, being a hard conglomerate of numerous rounded pieces of ferruginous clay iron ore, strongly agglutinated together by a clayey cement (No. 26.) A prodigious number of these rounded pebbles are scattered about, covering nearly the whole of the summit of the hill (No. 27,) many of the hard blocks of this conglomerate resemble very much (if they are not identical with) the laterite of the low lands of India.

Descending from the summit, along the western declivity of the hill (facing Pinnacle Hill) and only a few yards from the top, the rock insensibly changes its appearance and structure. It becomes by degrees more compact, and loses its cellular structure; in short, it assumes the compact appearance of common hæmatite iron ore (No. 28,) very rich in iron, and in this state it continues to the foot of the hill on that side, where some of the projecting masses of this iron ore are flanked by others of sienitic granite, or rather hornblende rock.

These two hills, on the N. E. side, and at their foot, close to the stream, are skirted by immense masses of sienitic granite, through which the waters of the river are heard roaring, except at one place, at the foot of the high hill, where the river is forced to go towards the new road from Neddiwattum to Ootacamund. In that place the iron ore bed crosses the stream; forms numerous projecting masses on the slope of the opposite hill having a N. E. direction crosses the road of Neddiwattum, and terminates in the summit of the hillock to the N. E. of the road; beyond the latter place, this rock cannot be traced.

Now this filon of iron ore, after crossing the stream of Scotland valley,

a considerable quantity has been supplied therefrom for the requirements of the Bezoarah anicut.

Iron ore is found to some extent in the villages named marginally at a short distance below the surface. The stones are generally red in colour—some are tinged with yellow, but the red ones are the best. There are 3 furnaces at Jugganathapooram, 8 at Guntavarygoodem, and 2 at Marallamoody 13 in all. Chundra wood is used for fuel. The cost of production is about 15 Rupees and the market value 17½ or 20 Rupees. Labelled specimens of iron ore, crude iron, and purified iron are sent as per list.

The furnaces are very much the same in all the abovementioned villages, and are of the simplest construction; a mud wall about 3½ yards thick is raised to the height of a yard and a half; in this an indentation is made as represented in the annexed diagram—under this indentation a pit of 1½ feet is dug. It is smeared over with pulverised Chundra wood charcoal and a pipe introduced through which the nozzle of the bellows afterwards plays, a fire is lighted, and the pit is filled up with alternate layers of charcoal, and ore, the latter having been previously broken up into small pieces of 1½ oz. or an oz. when the pit is filled to the ground level, a retaining wall of mud lined with burnt earth is raised to nearly the height of the former one (represented by the dotted lines in the diagram) and the space so formed filled up with layers as before; a funnel is inserted at the top, and the whole closed a few interstices merely being left to keep up the current of air, and the ignition. This is generally done in the evening. In the morning of course the layers have sunk very much from the gradual smelting, fresh supplies are therefore put in and the bellows set agoing. They are worked all day, and in the evening this is broken open, and the fused mass taken out. It is broken up, and fused again, when it is considered fit for the market from 1 or 1½ maunds of iron are generally produced at each operation.

The expenses may be very roughly estimated as follows.

	Rs.	As.	P.
Value of charcoal.....	0	4	0
Do. of ore, stone &c.....	0	4	0
Hire of bellows men*.....	0	4	0
Miscellaneous cooly hire.....	0	2 to 6	
Total.....	0	14 to 16	annas, as

* The hire is nominal as far as money payment goes. The furnace owner and his relations are the labourers and the sums of money merely represent their time and trouble.

the cost of production for 1 maund. It has before been mentioned that the market prices run from rupees 15 to rupees 22, so that the trade does not appear a very remunerative one. The average price of country iron in the Masulipatam market is 1 rupee 3 annas, that of Europe bar iron 1 rupee 15 annas per maund.

The manufacture of steel is unknown throughout the district.

List of labelled specimens of iron ores and iron sent from the Masulipatam Collectorate.

Gollapally Talook.

- 1 Parcel of iron ores found between Soorapully and Somavarum.
- 2 Do. crude iron of Ramanakapettah.
- 1 Do. iron ore found in the jungle between Ramanakapetta and Chit-tapoor.

Pentapaud Talook.

- 1 Do. iron ore found in Maurellamoody village.
- 1 Do. of purified iron.
- 1 Do. iron ore found in Doobajerla village.
- 1 Do. do. in Janardanapooram under Nullajerla village.

Tiruvoor Talook.

- 1 Do. of iron ore.
- 1 Do. of bar iron.

Juggiapetta Talook.

- 2 Do. of iron ores.
- 12 Total—twelve.

Captain Cadell has likewise favored me with the following memorandum regarding the iron procurable in the Masulipatam district which deserves record.

In Sheermahomedpett, Goodrai, Ramachendrapett, Dachapollum, Tuk-kallapaud, and several other villages of the Juggiahpett talook, iron stone is found to a great extent. It generally lies about a span from the surface, and

is evidently and clearly seen flanked on both sides by sienitic granite, jutting in large blocks through the soil in the very same way as the masses of the iron ore shoot up; and therefore it is fair to conclude, that the last do not overlay the former.

I must here call the attention of the reader to the almost imperceptible transition of the cavernous tabular kind of ferruginous conglomerate into the uniformly compact hematitic iron ore of this hill: an appearance that I had an opportunity of observing also in the Northern Circars at Pandagarah, near Samulecottah where the compact, slaty hematitic iron ore is seen passing into a conglomerate very much like laterite (Nos. 29 and 30.)

The two hillocks S. E. and close to the lake, and on which Cluny and South Down houses are built are chiefly composed of the same iron ore. The sections in their declivities, on account of the road which goes round the lake, show the ore decomposed into a red clayey earth imbedded in the lithomargic earth, resulting as we have seen, from the decomposition of the original sienitic rock.

Before concluding these details regarding this iron ore, I will point out some particularities, in which (notwithstanding its similarity in appearance) it seems to differ from the laterite of the other parts of India, that I have had an opportunity of examining. The rock of the Neilgherries is by no means so cavernous, and has not so many tubular sinuosities as the laterite of the Carnatic, Northern Circars, &c., it seems also to be richer in metal, and what appears to constitute a marked difference, it is entirely divested of any quartz, or sandy particles which abound so much in the laterite of other places. Besides, we are told by Doctor Hume, that in the laterite of the Red Hills, Nellore, &c., a marl or carbonate of lime is occasionally one of the ingredients, no traces of this carbonate are found in the stone of the Neilgherries.*

That this rock of the Neilgherries is to be classed with hematitic iron ore, rather than with the true India laterite (an overlaying rock,) is very probable, considering that rocks similar in appearance to it are found in Europe, while the last is peculiar to India.† I have specimens in my possession, and have deposited others in the Museum of the Madras Literary Society, which shew in the small thickness of an inch, or little more, the ore changing from compact hematitic into laterite iron ore.

This iron ore disintegrates, the pieces getting rounded, for reasons not easily explained, and are either scattered about the soil, or re-agglutinated by a

* Tracts.

† If my memory serves me right, I think I saw in the Museum of the Asiatic Society of Bengal, a specimen marked "black, brown, solid and perforated iron ore, from Poort in Upper Lusatia," which appears to me similar to the Neilgherries hematitic cavernous iron ore.

clayey paste forming a conglomerate; which either adheres to the lateritic rock or to the ore itself. If these rounded pebbles are of moderate dimensions and of different sizes, a conglomerate is the result perfectly similar to the conglomerate laterite of the Carnatic, but when the pebbles have an uniform size, and are not larger than a pea, then it becomes the common pisiform iron ore, the pisiform clay ironstone of authors. In this state, the rock has different degrees of compactness from crumbly to compact, in which last case it is employed for architectural purposes. This detrital rock sometimes is seen at some distance from the iron ore.

The third species, which abounds all along the intervening land, from the foot of the western ghats to near the sea shore, resembles very much the modified hematitic iron ore (not the pisiform) being cavernous, not tubular, abounding with quartz pieces and sand, having not only the cavities lined with powdery felspar, but, in the compact portion of the rock, having small pieces of the same mineral in the compact state. The late Dr. Christie tells us that it is remarkable that this rock occupies both the foot of the hills, and many of their summits likewise, so hinting at the possibility that the ghats were elevated after the formation of the laterite.*

With regard to the question, whether all these three species of stones, which resemble each other, had the same origin, or the conglomerate kind arose from the disintegration of the unstratified simple species which we described at the first, I leave to some more fortunate geologist to describe, who may have opportunities of visiting and attentively examining the localities where the laterite is found, to decide the momentous question.

The only information I can contribute I have already given in the foregoing paragraphs: that is, that in more than one locality, both on the low lands and the hills of India, I have found a modified iron ore, perfectly similar to the laterite, and that, to avoid confusion or doubt, I have called it laterite iron ore. It is not a rock per se, but the result of a modification in the structure of the metallic ore, which forms not only enormously thick beds and filons, but also whole hills, among the formations of this part of the globe; which modified iron ore, either as such, or in the state of conglomerate, resembles the laterite of Malabar and of the Carnatic.

Manganese near the Lake and at Kaitce.—I am not positive continues Dr. Benza regarding the existence of manganese on these hills: my friend

* It would be worth enquiring whether the laterite mentioned by Dr. Christie as occupying both the coast and the summits of the ghats, be of the same composition and nature, because in his account of this rock it seems that he is describing a conglomerate rock; particularly that in the Darwar district, where he says that, at the summit of the ghats, the rock is found, it is associated with the hematitic iron ore, as well as on the Neilgherries.

Captain Russell sent me also specimens of two kinds of iron ore, one of ore half smelted and one specimen of made iron all from that range of small hills running north and south in the Dhona talook between Kurnool and Ghooty. The same range in which (viz. 24 miles from Kurnool and 3 from Yeldoortee Ramalecottah) the diamond mines are. Along the whole of that range are numerous smelting stations, but the iron is the same. The ore is most plentiful, in some places literally hiding the soil. There is a considerable demand for the iron for agricultural implements.

A good deal is also made in the Nalla Mulla near the Gazalpilly Ghat, and all along to the south towards Cuddapah.

A list of the specimens of iron ore from the district of Kurnool now in the Museum will shortly be published.

MALABAR

is situated on the western coast of India between the 10th and 17th degrees of north latitude and 76th degrees of east longitude. The length of this province is 148 miles, and the average breadth 55 miles, and has a superficial area of 6,060 square miles with 1,318,398 inhabitants: to the north it is bounded by the province of Canara, to the east by those of Coorg, Mysore and Coimbatore, to the south by the Cochin Rajah's territories, and to the west by the ocean.

Its general aspect is marked by the range of mountains known as the Western Ghats which run almost parallel with the sea coast, though in several places these branch westward and form large valleys: abreast of Calicut they recede to the eastward, and the ghats on the north join the higher mountains of the western face of the Neilgherry and Koondah mountains. For revenue purposes this province is subdivided into two portions north and south Malabar, with the following 17 talooks.

Belutnaad	Cochin	Palghat
Calicut	Coorbernaad	Sherunaad
Cartennaad	Cootnaad	Temulpocorum
Caway	Cotyam	Walloowanaad
Chernkul	Ernaad	Wynaad.
Chowghat	Neddinganaad	

Iron and gold seem the only two metals hitherto discovered in Malabar. Dr. Buchanan (Journey) was the first to bring the existence of the iron ores of Malabar to notice, and it is one of the provinces to which the E. I. Iron Company's monopoly extends and in which their operations are now being carried on to the largest extent. There has not been much added to our

knowledge of the iron ores of this collectorate since Dr. Buchanan's time, and the specimens of ore that have been now sent to me do not show that the ores there are any thing very superior: the facilities for river and sea communication and the proximity of dense jungles are, however, of very great value, perhaps more than counterbalance the comparative inferiority of its ores.

In his journey through south Malabar Dr. Buchanan (Journey vol. 2 p. 386) found near Colangodu four forges supplied with iron ore. The ore was the usual black sand, and was found mixed with clay in strata near the river. He likewise (vol. 2 p. 436) reports having found, in Velater 34 forges for smelting iron; he states that he examined one of these furnaces and mentions that in all the hills of the country the ore is found forming beds, veins, or detached masses, in a stratum of indurated clay (afterwards described) and of which the greater part of the hills of Malabar consist. This ore is composed of clay, quartz in form of sand, and of the common black iron sand. This mixture forms small angular nodules closely compacted together, and very friable. It is dug out with a pick-axe, and broken into powder with the same instrument. It is then washed in a wooden trough, about four feet in length, open at both ends, and placed in the current of a rivulet; so that a gentle stream of water runs constantly through it. The powdered ore is placed in the upper end of this trough; and as the water passes through the heap, a man continually stirs it about with his hand. The metallic sand remains in the upper end of the trough; the quartz is carried to the lower end, and the clay is suspended in the water, and washed entirely away. Dr. Buchanan states that each smelting required 2,160 lbs.; the price, therefore was not quite $3\frac{1}{2}$ d. the hundred-weight and that in this ore the quantity of metallic sand is small, in comparison with that of the earthy matter. He gives (p. 437, 8, 9 vol. 2) a long account of the furnace and the process of smelting the ore there, but the introduction of the European processes of working on the large scale renders it unnecessary to retain these observations as the Beypoor works have already greatly superseded the native furnaces.

His remarks, however, on the ore and its sites are still of value. He tells (Journey vol. 2 p. 440) that what he has named indurated clay is not the mineral so called by Mr. Kirwan, but seems to be the *argilla lapidea* of Wallerius I. 395, and is one of the most valuable materials for building. It is diffused in immense masses, without any appearance of stratification, and is placed over the granite that forms the basis of Malayala. It is full of cavities and pores, and contains a very large quantity of iron in the form of red and yellow ochres. In the mass, while excluded from the air, it is so soft, that any iron instrument readily cuts it, and is dug up in square masses with a pick-axe and immediately cut into the shape wanted with a trowel, or large knife. It very

Colonel Cullen says, that it is found mixed in the iron ore near the lake; and I found straggling pieces of this ore in the valley of Kaitee (No. 31*) which I have not analysed, but which has the external characters of one.

At the foot of the hills, at Sattamungalum, Mr. Ross discovered a valuable oxide of iron highly magnetic with polarity and within the past few months Captain Campbell, whose researches have been very extensively made, discovered an iron ore resembling Sulphuret of Molybdena about four hundred yards from Bombay House.

NELLORE

is a Collectorate lying between the fourteenth and sixteenth degrees of North Latitude with an area of 7,930 square miles and containing 421,822 inhabitants. It is 170 miles long from north to south and 70 broad east and west, and is bounded on the north by the Collectorate of Guntur; on the west by that of Cuddapah; on the south by the Northern division of Arcot and Chingleput and on the East by the Bay of Bengal.

Its subdivisions are into the following 18 talooks.

Buddapooddy.	Ehmanamellore.	Survapully.
Calegherry.	Goondavole.	Sungum.
Cavelly.	Hoozoor station.	Sydaipoor.
Chandaloor.	Nellore.	Talamunchy.
Cottah.	Ongole.	Toomalatalpoor.
Davagodoor.	Ravoor.	Woodiagherry.

The country is covered with groups of small hills and the outline of its geological features which has been given by Captain Ouchterlony in his report shows the prevailing rocks to be Mica and hornblende schists, while the mineral substances which have been discovered hitherto are copper and iron, Dr. Heyne was the first who drew attention to the rich copper ore of this district, but the several attempts that have been made to work it have all failed, for though the ore is really rich and appears in moderately sized veins on the surface, it fines away like veins of silver to a thread as it is followed down. The other metallic ore, that of iron, which forms the subject of this report, does not appear to be very widely diffused and partly from the diminution of the forests and from the increasing import of English iron, furnaces seem to be falling out of blast. The reports, however, show that even with such disadvantages to contend with, the rude imperfect processes of these people produce an iron of a quality superior to and costing less than that imported

* Mr. James Prinsep pronounces this to be decidedly an ore of manganese.

from England. From the reports which Dr. Young and Mr. Crozier have favored me with there seems to be iron ore in several talooks and to be about twenty villages with furnaces, where the ore is smelted; but steel does not appear to be manufactured in any part of the Collectorate.

Dr. Voysey in his Journal mentioned that iron ore was brought down from a hill called Goondum or Mookoosh: magnetic iron ore is also spoken of as occurring at Kunchgarleondah, at Yarekoloo, Goondamadajala in the Company's Territory, at Timmapooram in the Callistry Zemindary, and at Sectarampooram to the west of Gurnampentah.

ONGOLE TALOOK.

Iron ore used to be brought from the village of Cundukoor in the Ongole District of the Padelay Police division and smelted, but the only article ever manufactured was iron, for steel was never made, and the cost of working is stated to have been about 53 Rupees a month: none of these furnaces are at present in blast however, and iron is brought into this part of the Nellore district from villages beyond Cummum, and is sold at from 2 to 2½ Rupees a maund. It is generally made into ploughs, &c. While the furnaces were in blast charcoal was brought from a short distance and sold at 12 annas the toom, but the forests are not extensive now, having diminished considerably. The blacksmiths prefer Indian Iron. The English does not answer their purpose well. The daily wages of a smith varies from 2 to 8 annas.

In the Choonday Police division, (which comprises a tract of land on the western frontier of the Nellore Collectorate situated above the talook of Buddapooddy in the Sub division) there are two Villages Ramalingpooram and Iyarany pullay where Iron ore exists, though it is supposed to be far from abundant. One man by taking a quantity of the sand and washing it repeatedly could collect about a toom of ore in a day. It used to be smelted in those villages and was sometimes also taken to a distance, but the work is now altogether stopped: the expences for erecting a furnace amounted to 6 Rupees; the cost of work to about 60 Rupees for a year. The furnaces alluded to produced about 800 maunds of Iron selling for about 1 Rupee 6 Annas the maund; and it was exported to Cuddapah where it was worked up in making agricultural implements. Any iron now imported into this Police division is brought from the Gogullapully division and charcoal is brought from the jungles in the neighbourhood but the forests are not so extensive now as they formerly were. The blacksmiths, whose wages are 4 annas a day, prefer Indian iron not knowing how to work that of English manufacture.

Iron ore has been mined in a village in the Woodiagherry Talook called Palliumpetty Condah where the process of collecting it is simply by digging,

the layers are about a cubit in depth. In Tukkalapaud a person kept a furnace for some years, but discontinued it lately, owing it is said to the scarcity of fuel; that only used in the Juggiahpett district, or what is considered best there being the wood of the "Chundoo" which is not plentiful in that part of the country.

In Moonegaul another furnace was kept by two Mussulmen, but they have also given it up and left. It is said that 8 maunds of stone broken up, and smelted with 8 baskets (80 mauckahs or 160 seers) of charcoal give 2 maunds of crude iron, which require to be a good deal purified. According to this system, the cost of producing a pooty is said to be 16 or 17 rupees, the bazar price being 20 or 21 rupees.

They say that 2 bellows men, 1 to supply the furnace with stone and charcoal, and 3 men to break up the stones are required throughout the year for the attendance of a furnace and a smith for 6 months. The pay of the latter is 6 rupees a month, and the pay of each of the former 4 rupees per month. When not engaged at the furnace they are employed in gathering iron stone, bringing in fuel, &c.

The supply of the stone ore for a furnace is 1,050 maunds (I presume that this means for one burning.) From this 350 lumps of 3 maunds each are produced, this fines into 262 maunds of good iron which is $2\frac{1}{2}$ pooties and this at 21 rupees per pooty would be rupees 273 $\frac{1}{2}$ for the produce of a furnace. Captain Cadell remarks that the above information was received from Mr. Ballard the Head Assistant employed in the district and adds that in Bunder the hire of a smith is 4 and 5 annas per diem according to his skill. There is a great deficiency of good workmen from the numbers that have been taken for employment at the Dowlaiswaram and Bezwarrah works. The smiths seem to prefer working Europe to country iron; they say that it works up easier and there is not so much wastage, charcoal made from "Thumma currah" is considered the best by the Bunder smiths. The cost of this charcoal in Bunder is 4 and 5 annas per parrah; country iron is sold in the Bunder market of 1st 2d and 3d descriptions; the difference between the 1st and 2d sorts is very trifling indeed, and the difference in price is only 1 anna the 1st sort costing 1 rupee 5 annas per maund (or 23 lbs.) and the 2d sort 1 rupee and 4 annas.

Voysey also mentions in his Private Journal, that on the road from Ellore to Rama Singhwaram for the first two or three miles open country and thin cultivation on the soil common to the neighbourhood of Ellore. It was succeeded by red soil and pisiform iron ore, similar to that covering the iron clay; at times large pieces of a conglomerate resembling the iron clay of Midnapoor, and red iron ore.

See Tenasserim Provinces and Eastern Settlements.

MOULMEIN.

See Tenasserim Provinces and Eastern Settlements.

MYSORE.

Mysore is a large province of Southern India situated between $11^{\circ} 45'$ and $14^{\circ} 55'$ North Latitude and $74^{\circ} 55'$ and $78^{\circ} 45'$ East Longitude. Its greatest length from east to west is 230 miles, its breadth from north to south 190 miles. It is bounded on all sides by British territory; on the north by the Southern Mahratta country and the Ceded Districts; on the east by the Ceded Districts and North Arcot; on the south by Salem and Coimbatore; and, on the west, by Coorg and Canara. Mysore has about 37,000 square miles; it is arranged in the four divisions of Bangalore, Ashtagram, Chittiedroog and Nuggur. These are, again, subdivided into Talooks, which contain, besides several large towns, an aggregate number of about 30,000 villages, and the population amounts to about 3,000,000 of inhabitants.

Situated also in the midst of the British Collectorates and containing so great a population as three millions, the products of Mysore are entitled to more full consideration here. The country has been governed since 1831 by a Commission composed of British Officers, in the name however of the present Rajah Krishna Raj Wudyar. Its administration is therefore entirely in the hands of the British, and on this account, a recent order in Council has been issued to allow its products being admitted into England on the same terms as those of British Colonies. A net work of made roads with bridges and drains is spread over the country. The soil is in most parts favorable to forming this means of social improvement but the extreme ruggedness of the country renders road making expensive; constant bridging is necessary on all the lines and presents the Engineer with many difficulties. All outlay in this respect has, however, been amply repaid by the progress of the country consequent upon improved means of transit; in places where wheeled bandies were formerly unknown long lines of them are now to be seen.

All the wild animals of Southern India are to be found in certain parts of the Mysore territory: the country is also prolific in domestic animals, a good hardy breed of horses is reared, sheep are abundant in many parts, and have been much improved of late years by the introduction of imported Merinos, and the bullocks bred in Mysore for draft have long been held in high estimation for their strength and endurance.

In describing the Paumoor Police division, the following is given as the process of manufacturing iron at Guttupully and Ayanacota in the Rajah of Venecatagerry's property, and at Maslavaripollem adjoining Irlapaud.

The ore is procurable near a hill south of Wootocoor in the Paroor division. When the miners have been paid in advance it costs about four Rupees a candy, but in cash transactions five or six Rupees are paid, and it is brought to the furnaces on bullocks for Rupees 1-10-8 per candy. It is cleaned at the furnace and in this process the impurities which form a fourth part are removed. The smelters form a party of six or twelve men, arrange themselves into two sets, exclusive of two iron smiths, and the whole are paid in shares, the head man of the set getting two shares, and one share being allotted to each of the others, and to each of the smiths, though these last also receive two additional shares each for their tools. The usual proceeds from each share amount to about Rupees 32, and as the preparation for the work begins in November and the whole process ends in August, the receipts on each share are about Rupees 3½ a month. This amount however is clear, because the shares are allotted after deducting the expence of the charcoal; the duties to Government and repaying with interest the money borrowed. Of the ten months in which they are employed, the first five are occupied in making charcoal and the remainder in smelting. The manufacturers have a house to hold their tools in with a thatched building adjoining it, for the forge. About four baskets of charcoal are required to smelt half a ton of ore, and from this quantity about 8 viss of metallic iron is produced, which is sold at Rupees 1-5-4. Thirty such lumps are obtained from one candy of ore.

A list of the specimens of Iron ore from the district of Nellore now in the Museum will shortly be forwarded.

NIMAR.

The first intimation that reached me of the existence of Iron ores in Nimar, was by the following remarks in one of the public papers.

"In the districts of Mundlairsir, a portion of the territory ceded by Scindiah for the pay of the Contingent, exists a bed of iron ore said to be of almost unequalled richness. We are not in possession of the minute information we have received from some other districts, but the country along the banks of the Nerbuddah from Hosungabad to Mundlairsir is covered with the mineral. Specimens have been examined by professional mineralogists, who have declared them to be of a richness almost unknown in the most favoured iron districts of Europe. From Burwai, a place some twenty-five miles east of Mundlairsir, to Hosungabad, the iron is raised in considerable quantities, but in the wretched fashion we have so frequently described. In Nimar, as every where else, the

native system involves the maximum of expenditure, and the minimum of result. Every circumstance, however, is favourable to the introduction of European methods of manufacture. The richest of the mines are in the neighbourhood of Poonassa, and at Poonassa there is a great bed of limestone, which as a flux would be invaluable. Fuel is plentiful and cheap. The south bank of the Nurbudda is, as it was in the days when it was ruled by Hanuman, an almost impervious forest, and along the north bank, from Burwai to Nimawar, wood for charcoal is abundant. The place appears already to have attracted the attention of Europeans, and a geologist employed by a private Company has recently examined the country around Poonassa." After observing the above, I applied to Sir Robert Hamilton for further information and met with that ready aid which he has given to all my plans, receiving from him the following letter from Captain Keatinge to his address.

"The capabilities of the Nimar district for the erection of iron works on a large scale are so great that it seems perfectly extraordinary that nothing has yet been done towards working the mines. Taking one district Poonassa, as an example, it is in a country where iron ore crops out on the surface at intervals of some miles all around. It is almost on the direct line of communication from the Bener Coal mines to Surat so that if all our hopes of Railway communication in India are not to end in disappointment, it will have a direct Railway communication with these most splendid coal mines. But for the present the supply of charcoal is extremely large, Poonassa being surrounded with jungle, and the forest on the north side extending from Burwai to Neemawar, while a most extensive bed of magnesian limestone crops out within two miles of Poonassa.

The Native iron works in Nimar are principally situated at Canteoot, and Chandgurh. Poonassa has been deserted for years and though there are the remains of numerous furnaces no iron has lately been worked till a gang of prisoners were stationed in the Fort of that place for the purpose.

The native method of working iron in Nimar is so much worse even than that of other places that iron from the Tendekera mines near Hoshungabad passes through Poonassa for sale at Indore, Mundlairsir and Mehsawer. The Gonds who alone make iron, are a most improvident and drunken caste: one man with his family goes to the jungle to cut wood, then makes the charcoal, then proceeds in an opposite direction to dig ore, and having thus collected the materials smelts some iron, and again goes to the jungle to collect fuel, the furnace in the meantime getting thoroughly cold. But with all these disadvantages it is found to be a more profitable employment than agriculture and the iron has a most ready sale. I have heard a very competent judge state that if the poorer ores of Europe which now produce thousands of tons of metal

small pieces little larger than a bean are then introduced. The furnace is then filled up with charcoal, and as this burns down, the ore and charcoal are introduced alternately until about 36 lbs. of ore and 4 baskets, each being a measure of about $2\frac{1}{2}$ cubic feet, of charcoal, are introduced. In two hours the melting is completed, which is ascertained by introducing a small rod of iron through the blow pipe and examining the adhering iron. The bellows are then withdrawn, the front of the furnace broken down, and a mass of iron and slag extracted.

This is first beaten with heavy wooden clubs to get rid of a portion of the slag, and then with axes, used as cold chisels, the mass is cut into two pieces. At this period the mass weighs about 18 lbs., but when re-heated in the open hearth and worked into 2 small bars it loses about $\frac{1}{3}$ of its weight from the forcing out of the slag and other impurities, so that the whole produce from 36 lbs. of ore is only 12 lbs. of good malleable iron, or $33\frac{1}{3}$ per cent. which appears a very low return from such rich ore. When the charge is withdrawn from the furnace, the front is built up again, a fresh pipe introduced, and the furnace again charged, and in this way they have, on an average, four drafts per day. There are various qualities of ore in the district, but the treatment of all is alike, nor does there appear much difference in the results as to quantity, though some little as to quality. The workmen state that the quality of the ore varies a little with the quality of the charcoal and the care with which every opening to the furnace, except that of the blast pipe, is closed, but the above quantities are the general average. It would appear from this that generally much of the ore goes to waste, which will account for the small return."

Having furnished the above information as to the Bellary process of manufacturing iron, I now proceed to furnish the following statement with extracts from a memo. by C. Pelly Esquire, shewing the sites of iron ore in the Bellary District: as well as the places where furnaces are in blast.

yearly were treated in the same manner as the Poonassa ores by the Natives, the result would be a mere slag containing no available metal. I have stated above that some prisoners are employed at Poonassa in making iron. The experiment is however only just begun and no results have been obtained worth reporting on. Poonassa is upwards of 50 miles from Mundlaisur, and as I have no European assistant to aid me in the undertaking I fear too much must not be expected. The employment of the tread hammer (Dakee) has however been attended with great success.

A *copper mine* is said to exist in his Highness Helkar's country under the ghauts North East of Poonassa, and quite out of my district. I sent however for specimens of the ore, but the pieces that were brought to me were a light coloured igneous stone, containing no copper.

The accompanying answers to Surgeon Balfour's questions contain as much information as I possess on the subject.

Answers to Surgeon Balfour's Questions.

At Poonassa, Cantcoot, Burwai, Chandghur and thence up the Nerbudda to Hindia the supplies of iron ore are quite inexhaustible, and the ore is smelted at Cantcoot, Chandghur and Poonassa though at the latter place it is done under Captain Keatinge's direction by prisoners.

At Chandghur and Cantcoot 6 to 10 seers pucca Iron are sold for a Rupee.

The article manufactured is malleable iron with an admixture of steel. The most primitive catdan forge being the only furnace used.

Wheel tyers and agricultural implements are the only articles it is manufactured into.

Charcoal is to be had in the immediate neighbourhood at the rate of 5 maunds the Rupee, and of it is used about five times the weight of ore, which varies with the size of the furnace.

Jungle very great. No apparent decrease save at Poonassa, which is owing to the extending cultivation. Not to the manufacture of iron.

The blacksmiths prefer Indian iron, the English iron they find cold short and too hard.

From 4 to 6 annas per day is the wages of a blacksmith; much improvement would result from the making of roads; increasing the size of the coal-fings. Using the fan to be worked by manual labor, and the stamper, such as is used in the native paper factories and the latter I have introduced at Poonassa with much success and enlarging the furnace, reducing the boshes and keeping it charged day and night; these are the only cheap improvements.

About 25 to 30 per cent of metallic iron is produced from one smelting.

PEGU

is the latest of the conquests of the British in India occupied by Madras Troops. The only rock specimens received from it are portions of fossil trees, and the only mention made of the presence of iron ores are in remarks by Captain Young of the Bengal Engineers, on the laterite which abounds in the neighbourhood of Rangoon; it contains 46 per cent of peroxide of iron and 32 per cent of metallic iron, and in Captain James' opinion is well worth smelting. Before describing that ore it is necessary to mention that the hilly country of upper Ava ceases with the promontory of Keyouktaran near Lunzay below Prome, from which place to the sea, the Irrawaddy flows through a rich alluvial delta. Unlike that of the Ganges, however, this is varied by occasional rising eminences and ridges, and upon one of these the great Pagoda of Rangoon is situated, the plat-form of which is 160 feet above the river, the Pagoda itself rising 320 feet above that again. These eminences are chiefly, if not entirely composed of laterite, the lower plain country of clay and sand: each occasionally predominating, and the former sometimes of a very rich aluminous kind like pipe clay. The surface of the soil is always clayey or alluvial, but in making cuttings, as in digging tanks or for roads, it is usual to find the soil at a small depth becoming gritty or gravelly. On examination this is found to arise from numerous concretions, similar to kunkur, some of a brick-red, some of a black colour, in some places the red predominate, in others the black, forming strata running in waving directions through the soil: and the colours are exhibited owing to the nodules being cut through by the tool in the act of digging.

The nodules themselves when picked out of the earth are aggregations of the local coloured clay around nuclei of the black matter in the centre, and around that the redder material: both having strongly the appearance of owing their origin to an infusion of iron in the soil.

Deeper down, the nodules speedily become more numerous, until at last the whole (from the nodules joining and adhering tolerably firmly together, leaving at the same time numerous interstices irregularly shaped between them) assumes the appearance of a nodular clay iron stone or, as it has been called, an iron bound breccia. In this shape it may be dug out and handled in lumps or masses, but these may be readily broken with the hammer, or even by hand. In a more advanced state, it becomes still more compact and rock-like, united together and heavier, and in short has all the characteristics and appearances of the more vesicular or spongiform species of laterite. In other places and under other circumstances, its structure becomes more uniform and compact, and of this kind is that of the hill on which the Rangoon Great Pagoda itself stands, and that from Bassein, where also, it appears to be generally redder in colour.

The climate is favorable to agriculture, and many portions of the country are highly cultivated, but in some parts the population is still thin and scattered: this is attributable, no doubt, to the desolating effects of the wars of the last century, and also to the anarchy which preceded the assumption of the country in 1831. Population and agriculture, are, however both rapidly on the increase as is evident from the restoration of villages which formerly lay in ruins from disputed claims to land which had been waste for years, and to revenue privileges which have been forgotten or have become obsolete, and also from the unparalleled increase of the revenue which has taken place since the assumption of the country, notwithstanding the abrogation of upwards of six hundred imposts of various kinds.

Garden cultivation has greatly increased and has become a source of considerable profit, the climate having been found highly favorable to the growth of many of the fruits and vegetables of Europe.

The principal imports are sea salt, cotton and cotton thread and the principal exports, jagherry, sugar, betel nuts, tobacco, silk and coffee.

The Mysore country may be described as an elevated table land, of which Bangalore is the highest point, its elevation being about 3,000 feet above the level of the sea. Its general character is undulating, with numberless abrupt rocky hills, both insulated, and in groups scattered over the face of the country, with the addition of much wood and jungle in the neighbourhood of the Western Ghats.

There are several rivers on the face of the country and about 20,000 tanks: the soil is not fertile in the open country to the eastward, but is rich and highly productive in the vicinity of the Western Ghats.

Granite, hornblende and sienite, may be said to form the basis of the country but laterite is found in some places. Of the minerals little is known but asbestos exists; also magnesite and Corundum and, it is said chrome iron ore, occurs: gold has been long known to exist in the beds of rivers and the country has been supposed also to contain silver and antimony. Iron ore is everywhere abundant, and is converted into excellent steel, and it is to this product, that I will confine my remarks in the following report.

During the past fifty years the products of the Mysore territory have received the attention of several enquirers amongst whom were Drs. Buchanan, Heyne, and Clarke, and Captain Newbold, all of whom have placed on record much connected with the ores of iron and the products manufactured from them. I am also indebted to Captain Pearce, Dr. Kirkpatrick and Captain Cunningham of the Mysore Commission for recent and valuable information.

So long ago as 1801 Dr. Buchanan (*Journey* vol: 1 p. 32) mentioned that, in every part of the country, the black sand ore of iron is brought down by the torrents; but that it was smelted in such places only as abound with woods. It is called Nalla isaca, in the Telinga language; Cari usu in the Carnataca, and carpu Manul in the Tamul dialect. His own subsequent researches as well as the enquiries of his successors, have established the fact that there exist other iron ores besides that black sand, and that these are procurable and are smelted in each of the four revenue divisions into which Mysore is now arranged, viz. Ashtagram, Bangalore, Chittledroog, and Nuggur for the sake of perspicuity, therefore it seems advisable to arrange all the existing information, under these four heads.

ASHTAGRAM DIVISION.

Of this division little is known, but Dr. Clarke, (*Geology of Bangalore* p. 115) has mentioned that ore occurs on the road to Nungengode: where the hornblende predominated over the chlorite or talcose chlorite, and that, on the road side, he picked up specimens of magnetic iron ore, with some of micaceous iron ore. He likewise asserts (p. 117) the existence in the compound attached to the Residency at Yelwal of a good deal of chromate of iron, which was discovered by Captain Haldane, the Officer commanding the Resident's escort; and states that it is lying in pieces on the ground, and near it a rock of hornblende slate of a green colour. Towards Hoonsoor, much magnetic iron ore is found on the road. Near this place the country is more jungly and Hoonsoor itself lies rather low, with rising ground on all sides, and hilly to the south and west, some of the hills being covered with low jungle; the soil both black and red.

BANGALORE DIVISION.

More is known of this division for even in Dr. Buchanan's time (*Journey* v. 1. p. 151) Chinapatam was celebrated for the manufacture of steel wire for the strings of musical instruments, which were in great esteem, and were sent to remote parts of India; and this branch of trade is understood to be still carried on there and the following very distinct account of it was given to Buchanan by Colonel Close, who procured it from Mr. Ingledew, Surgeon to the Resident in Mysore.

"The mode of preparing country steel, before it is drawn into wire is by taking any quantity, and heating it in a charcoal fire until it be red hot; when it is taken out, beaten into a long thin plate upwards of an inch in breadth, and rolled up into an oval or round form, leaving a small space between each of the folds. It is, then, put into the fire again, well heated, and

Samples of this lateritious rock must no doubt have been among the specimens sent home by Mr. Crawford in 1826, and is supposed to be that called "breccia" by Dr. Buckland, in his most interesting papers on Mr. Crawford's fossils and specimens, as he writes of this, that it is cemented sometimes by carbonate of lime, sometimes by hydrate of iron, and where this iron is very abundant, it affords concentric ochreous concretions dispersed irregularly through the breccia.

A detailed analysis of specimens of the rock made by Captain James is given below* and it would appear from this that the rock is chiefly silica and iron bound together, by some agent acting chemically on it.

Specimens of rocks of various kinds are found at Rangoon, but the only one in situ is the plastic clay, like pipe-clay, which occurs to the north of the pagoda mixed with strata of a rough silicious sand, inclined at the angle of 15° to the N. E.

Marble and alabaster from the Ava (Sagaing) quarries are plentiful, the former, which Chantrey pronounced to be equal to the finest Carrara, is particularly so but the latter, which is equally beautiful and pure, is less plentiful.

Limestone is not found nearer to Rangoon than the Martaban district and the mountains in the neighbourhood of Pegu whence it is imported and used in great quantities for the temples. It is also found about Prome.

From the same part of the country (Prome), comes a variety of sandstone which is used for domestic purposes by the Burmese. Some are freestones of a fine clear even colour and very easily cut.

There have also been found boulder specimens of travertines and a roofing clay-slate but whether these will be found hereafter upon the country or not, he cannot say. Chlorite used as slate-pencil by the Burmese is found near

* Mean result of three analysis of laterite from Burmah.
Soluble in Acids.

Peroxide of iron.....	46.270
Alumina.....	3.783
Lime.....	.742
Magnesia.....	.089
Silica.....	.120

Insoluble in Acids.

Silica (dissolved by Potash).....	6.728
Silica (by fusion).....	30.728
Lime, Iron and Alumina.....	2.728
Combined Water Alkalies and Loss.....	6.802
	100.000

The following is an extract from Captain James' letter "I send you an analysis of the laterite which I have made very carefully.

"It is the mean result of three analysis, all of which came within a fraction one of the other, you will perceive by the quantity of iron it contains that it would be well worth smelting if coal and limestone could be obtained in its vicinity.

"It yields about 32 per cent of metallic iron, and I shall smelt a small piece I have remaining to see what quality of iron it is."

Prome. A handsome sycnite also occurs, which will likely be met with near Ava, and what appears to be a decomposed granite which comes, he has told, from Shoegan and Lao country. This he has found but one specimen of. It contains much felspar and at one time he thought he detected grains of gold in it which seemed a not improbable occurrence. Captain Young further expressed his conviction that when we got better acquainted with the northern districts, coal which belongs to the formation would be found, and added to the already large mineral wealth of the country, which, including Lao and the Tenasserim provinces, supplies gold, silver, rubies, sapphires, copper, zinc, tin, lead, iron, petroleum, antimony, marble, alabaster, &c. &c. If to these be added its teak, cotton and indigo, it should, with the aid of such a water carriage be a profitable and valuable acquisition to the Indian empire.

This anticipation would appear to have been already realised, for the discovery of a vein of coal about five miles below Thyet Mew and only two miles from the banks of the river, is announced by a Rangoon correspondent of the *Bengal Hurkaru*. Fifty maunds of this coal were tested on board the *Mahanuddy* and favorably reported on by the Engineer. In another paper is as follows:—From Burmah we have a file of the *Pegu Gazette* to the 18th April. It mentions that coal has been found at Theyet-myo;—"an immense vein which extends, along a tract of country for upwards of ten miles. A large quantity of this is represented to be procurable from the surface without any material difficulty, but from the survey which we understand has been made, it is conjectured that the supply consequent on the working of mines in the vicinity, would be almost inexhaustible. The coal obtained from the locality indicated, is described to be of a quality superior to the Burdwan coal and but little inferior to the English. Doubtless after mining, the lower strata would be found to be better than either, as the specimens already seen have only been procured from the surface. This valuable discovery, we believe, was made by a subordinate of the Survey department who reported it to his immediate official superiors, but the specimens of the coals were sent to the Deputy Commissioner at Prome (Capt. Ardagh) from Theyet-myo by Capt. White, the Brigade Major at the latter station.

RAJAHMUNDY.

This collectorate occupies about one hundred miles in length and eighty in breadth of the Northern Circars, being bounded on the north by Vizagapatam; on the south by Masulipatam; on the west by Hyderabad, and on the east by the Bay of Bengal. It embraces an extensive delta of 500 square miles and has an area of 6,050 square miles: with a population of 1,001,236 inhabitants. In its western parts it has high hills and noble forests and the aspect of the country is particularly picturesque in the neighbourhood of Rajahmundry and

soon after becomes as hard as brick, and resists the air and water much better than any bricks made in India. He had never observed any animal or vegetable exuvia contained in it, but had heard that such have been found immersed in its substance. As it is usually cut into the form of bricks for building, in several of the native dialects, it is called the brick-stone (*Itica culla*). Where, however, by the washing away of the soil, part of it has been exposed to the air and has hardened into a rock, its colour becomes black, and its pores and inequalities give it a kind of resemblance to the skin of a person affected with cutaneous disorders; hence, in the Tamul language, it is called *Shurū cull*, or itchstone. The most proper English name would be laterite, from "Laterites" the appellation that may be given to it in science.

Malabar northern part.

Walacherry.

In north Malabar (Journey vol. 2 p. 494) at no great distance from the office, at Walacherry, he found much iron ore, resembling that of *Angadapuram*, in a hill called *Poicum* which was smelted exactly in the same manner as he had described at Angadapuram. The man who smelted it said that he put into his furnace 390 nullis of the washed, and the produce of the smelting was 6 tulams of iron, worth 8 or 9 fanams a tulam or from 48 to 54 fanams. The iron was better than that made at Angadapuram. As to the extent to which iron is at present produced, it is not necessary to remark that the E. I. Iron Company at Beypoor will greatly supplant all the small furnaces in their neighbourhood. Mr. T. J. Knox, however, informs me that in south Malabar iron ore is procured in several places principally situated to the south west of Palghat. The quantity of ore a man may gather by digging in a day varies very much, from as little as 36 lbs. to as much as 240 lbs.; that obtained from the bed of a river being considered of an inferior description, the iron made from it sells for half a rupee a maund when other sorts fetch 1 rupee. About 2,300 maunds of the best sort and 2,400 maunds of second sort of iron are made yearly at one place and sold for local consumption. Some of the best sites have for some time been abandoned, having been let to an agent of the Iron Company who has, however, never worked them. 100 lbs. of ore on an average yields 14 lbs. of iron. Labour is cheap and so is charcoal.

Dr. West also in a highly interesting report mentions that iron ore is found in one little hill called Indockard situated within the limits of Tellicherry, but it has apparently never been mined and from all accounts the manufacture of iron seems never to have been carried on in this part of Malabar.

Ernaad talook.

There are iron ore mines in the Ernaad talook near Calicut and iron is manufactured there in small quantities by the natives, who, however, are unable to smelt the solid lumps of ore. They provide an iron tool about a cubit in length and re-

pair to the hill where the ore is found and set about digging at the veins. The solid lumps they reject and gather only the pulverized ore, which when a sufficient quantity is procured they convey to some stream as they always take care beforehand to choose only such spots for their labours as have a stream or other reservoir of water close by. The ore is then thrown into a large vessel or trough made of the bark of a tree and repeatedly washed until it is cleansed of all extraneous substances, after which it is carried to the furnace, dried and may then be considered ready for smelting. The furnace of the native iron smelter is always close to his mine and is built with clay, in shape almost conical, its height varying from 6 feet and under; the earth of the furnace is generally square and measures 1½ foot in length by 1 in breadth; it has but a single tiny hole opposite to the side where the furnace is tapped, and through this with a pair of sheep skins in imitation of hand bellows a continual blast is kept up; the charge is 3 baskets of charcoal in proportion to every basket of ore and nearly 12 hours elapse before this is smelted and converted into metallic iron. The quantity of iron produced out of one of these furnaces at a time seldom exceeds 9 maunds; its quality is also inferior and is therefore not used by the natives in manufacturing rough implements for agriculture. No quantity of it is exported for foreign use. The erection of a furnace costs at the furthest 6 or 7 Rupees and on an average a man may be able to gather no more than 1 or 1½ maund of the pulverized ore daily, i. e. allowing for the wastage in washing &c. There are mines of this ore at Terook near Beypoor and on the Verkella hill at Calicut, but these are mined and worked by a branch establishment of the Porto Novo Iron Company opened at Beypoor in the year 1846 since which the manufacture of iron by the natives has been considerably on the decline. The blacksmiths prefer the iron produced in the foundry at Beypoor as being of a more malleable nature than that manufactured by the native process, besides which the expenses incurred in the latter are somewhat more than the rates at which the former is sold.

The charcoal prepared by the natives is after a very simple process; they dig a pit about 6 feet in circumference and 4 in depth which is filled up with logs of wood cut about a cubit or more in length closely stacked and then fire the heap, the pit is at the same time covered with wet sod and in this manner the wood is allowed to burn for some time, after which the pit is opened and a quantity of water sprinkled to put out the fire, the charcoal is then gathered and a pit of the size above described generally yields about 4 or 5 baskets of charcoal, and that of the worst description for the wood literally, is never charred by this process but actually allowed to dilaze and burn.

Mr. Conolly has likewise favored me with the following interesting report on the iron resources of Malabar.

in the hilly tracts both to the north and east of it. The view from the town, which is pleasantly situated on the Godavery, is very fine and the scenery further up the river is beautiful. The country near the banks where the river emerges from the hills is here and there thickly wooded, and the magnificent teak forests of the Godavery have been noticed by every traveller who has visited the locality. In the upper part of the district too, away from the Godavery, the scenery is very striking, and the face of the country wild and picturesque in the extreme. Hill streams rush down the slopes and gorges with immense rapidity in the season of rain and freshes, and one of them called the Jaldiroo, deserving the name of river, is rarely entirely dry throughout the year. The talooks above the influence of the Godavery anicut are dependent upon rain for their supply of water and their tanks and reservoirs. There is but one really large tank in the district, at Lingumpurroo, which is formed by a large artificial bund thrown across a gap in the hill. It supplies the chief villages in that talook and is usually nearly filled by the rains of the S. W. monsoon. When completely full, it contains a supply sufficient for the year.

The face of the country below the anicut is very different. Flat plains extending for miles and miles. Nothing takes the eye in the delta of the Godavery, but the exuberance of the cultivation and luxuriant vegetation on every side: fine tops of mango and tamarind trees, broad sheets of transplanted paddy, plantain gardens and sugar cane fields, the islands of the Godavery covered with the far-famed Lanka tobacco: the natural rivers of the delta improved or diverted from their straggling course; irrigating and navigable canals intersecting the country in every direction; high bunds thrown up to protect the lands from the inundation of the river and the encroachments of salt water creeks: here and there parts swamps partially reclaimed already, and in course of being drained of their superabundant water. These are the chief objects which attract the attention in the lower talooks of the district or those which are under the direct influence of the Dowlaishweram dam. There could scarcely be imagined a greater contrast than that which is presented by the exterior aspect of the two tracts—the one left almost untouched in the beauty which nature gave it: the other flat and uninteresting as it might appear to the observer, is improved, enriched and fertilized by the hand of man.

The facilities which are afforded for commerce, by the Godavery river that passes through it, are very great. Of its mineral products little or nothing is as yet known. Information was given by Dr. Voysey of the existence of red iron ores at Ashwarrapoor, but Dr. Heyne, so long ago as 1795 in Dalrymple's *Oriental Repertory* (Vol. 2 p. 485), described the iron mines of Lechempooram: and subsequently, in his tracts, he republished (Tracts p. 218-226) these observations. He tells us that Lechempooram, is a small village in the Polavaram district about fourteen miles south west from Rajahmundry, the adjacent coun-

try being gently sloping and undulating and by far the greater part of it was then covered with jungle. The soil was gravelly, of a red colour, and had the aspect of sterility. He found the people in this village extremely willing to show and explain every thing concerning their iron works. The iron which they produced was considered as the finest in every respect for tools, razors, &c., hence the demand for it was great.

Stones containing iron ore in considerable quantity are found every where near the village, from six to eight fathoms under ground, imbedded in a lithomargic earth, the reaching of which is a sure sign of being near a bed of iron stone. These stones lie in beds of a small extent of irregular thickness, and various in their breadth from side to side; though this is never very great. They mined downwards in a perpendicular direction, till obliged by the different directions of the beds to alter their course accordingly. The breadth of their perpendicular shaft amounted to about 2½ cubits, and small steps were cut out in the sides for the convenience of descending. When they had exhausted a bed of iron stone, they abandoned their mine without any further trial, and dug another in a different direction, the ground in this place and the ore itself, being of a very soft nature, no other instruments were required for working their mines than a pointed pick axe. The ore and extraneous stones were drawn up in baskets the latter (consisting chiefly of clay) was separated, and the former broken by mallets to the size of a hazel-nut.

This ore had much the appearance of a yellow and brown ochrey clay. It appeared also to contain a mixture, or rather coating, of calcareous earth. When reduced to powder it acquires a red colour, and exhibits many sparkling particles.

The miners prepared the charcoal which they required for smelting this ore by burning the wood of the sundra chettu (*Mimosa sundra*) which furnishes a solid, good charcoal. But it was rather scarce in the vicinity of this village, and its conveyance of twenty-four or thirty miles, from the nearest place where it may be had in abundance, was very expensive.

Dr. Heyne also tells us (Tracts p. 226) that Ramanakapetta is a village situated six miles to the northward of Nuzid. The road to it lies chiefly through a jungle. Iron mines lie on the north, a mile from the village, and half a mile from the hills. The ore constituted a bed immediately under the soil, and did not exceed a foot and a half in thickness. It consisted of small rounded stones lying loose and unconnected with each other. It did not appear to contain any calcareous matter mixed with it. Though the ore did not exactly agree with any common iron in Europe; yet it approached nearest to hæmatite. When moistened it adhered to the lips; it had a fine grain, was easily reduced to a fine powder, which effervesced slightly with acids, and Dr. Heyne was disposed to consider it as a hydrous carbonate of iron, similar to those which are so frequent-

hammered out as before. This process is repeated eight times, by which the weight of the steel is reduced to one-fifth of the original quantity. When this is done, it is ready for being formed into wire, and is again heated, and beat into small square rods. It is heated again, and drawn through a small hole, in a plate of common steel, into wire by means of pincers. In this plate there are several holes, of various dimensions, for the purpose of gradually reducing the wire to the size required. After it has been once drawn, it is necessary to heat it again, before it can be drawn a second time, which is done through a hole somewhat smaller than the former one. It afterwards requires no farther heat; but is drawn eight or ten times more until it be sufficiently fine; and this is partly ascertained by the sound it gives when struck by the finger on being stretched out. At the time of drawing it through the plates, a small quantity of oil is applied to it, to make it pass easily.

"The length of time taken up in making four pieces of wire, nearly of the same weight, and as fine as the larger of the specimens" (its weight 169 grains, its fineness 2 grains a foot,) "from the time of commencing the preparation of the steel, will occupy one man four days. One Rupee weight (177 grains) of this wire sells for one Sultany Fanam (8d.) The price of the smaller one is double the other, being much finer.

"The steel of the Bazar, or market, is sold at the rate of one seer for one small silver fanam (or near 3½d. a pound). When refined, and ready for being made into wire, one seer might be purchased for eight Sultany Fanams (or 2s. 1½d. a pound); but there being no demand for it, it has no sale."

Dr. Buchanan mentions (Journey vol. I, p. 170) that the road to Magherri passed through a wild but romantic country, which consists of low hills, intermixed with little cultivated vallies. The summits of all the ridges of hills are bare rocks of the granitic porphyry, and often rise into high sharp peaks, or immense masses of naked stone. By far the most remarkable of these is occupied by Savana-durga, which the army of Lord Cornwallis took by assault. On his way he examined some iron forges, of which there were many in that hilly tract of country, and from a man, who employed twelve labourers, he procured the following account of the operations performed on the ore. "The iron was made partly from the black sand which is found in the rainy season in the channels of all the torrents in the country; and partly from an ore which is found at Ghattipura, two coss from Magadi. During the four months of heavy rains, four men are able to collect as much sand as a furnace can smelt in the remainder of the year. In order to separate the earth and sand, which are always mixed with it in the channel of the torrents, it requires to be washed.

The smelting furnace was made in the front of a square mound of clay, sloping up gradually from behind forwards, and Dr. Buchanan gives the following description of it. In the front, the mound is twenty-two inches high, and three feet broad. In this, from top to bottom, is made a semi-cylindrical cavity about a foot in diameter. On the ground, in front of the cavity, is laid a stone six inches high, a foot long, and a foot broad. Contiguous to this is placed another stone a foot square, and two inches thick. On the top of this is fixed a small piece of timber behind which rose another mound of clay sloping upwards gradually, and widening as it receded from the furnace. On this rests the bellows, of which there are two. Each consists of a whole buffalo's hide, removed without cutting it lengthwise. Where it had been cut at the neck, it is sewn up, so as to leave a small opening for a wooden muzzle which is made fast to the piece of timber before mentioned. The hinder part of the skin is slit vertically, and the one side was made to lie over the other. In the middle of this outer side was fastened a ring of leather through which the workman passed his arm, and seized the upper angle of the skin which served as a handle. When he drew back his arm, the opening in the hinder part of the skin dilated, and admitted the air; when he forced his arm forward, the opening was closed up, and the air was forced through the muzzle. The lower part of the bellows was retained in its place by a rope fastened to the lower angle, and supported by an elastic piece of timber, which was fastened to one of the posts of the hut, like a turner's lathe. The muzzles of both the bellows are inserted in one common tube, which is made of baked clay, and is placed in a sloping direction, so as to pass through a mass of moist clay, that occupies the front of the furnace above the first mentioned stone. Above this is placed a large tile and the empty spaces between this and the mound are filled up with moist clay. The furnace is now cylindrical, and open at top, on which is placed a chimney made of baked clay, in the form of two truncated cones joined together by the apices. Of these the upper cone is by far the shortest. From this it must be observed, that the whole lower front of the furnace is moveable; and when it has been newly built up a little charcoal is burned in it for an hour, to dry the moist clay by which the various parts are connected. The rents formed during this operation must be carefully closed with more clay and the furnace is then ready for immediate use.

For smelting the black sand he described the following as the process. "A quantity of the sand was measured out, and divided into three parts, each of which he found to weigh a little more than 25 pounds 11 ounces avoirdupois. Three baskets of charcoal are then set aside, of which each contains about a bushel. Two of the baskets of charcoal are then put in by the top of the chimney, and above these one third part of the sand. The fire is then kindled,

ly employed for smelting in Europe. The furnaces before the famine at the close of the last century amounted to forty.

The most recent information regarding the iron ores of this district has been sent me by Mr. Prendergast and Mr. Taylor to both of whom I am much indebted. It would appear that there is not, at present, any furnace in blast in the whole of the Collectorate but that iron ore is still found in the talook of Thadimulla where there are two sites, one in Parimpetta a hamlet of Tirmalaya-pollem, and another in land belonging to the above named village of Lutchmepooram 30 miles from the Godavery and 50 miles from the Nizam's frontier, the sites have no specific names, and that both were quarried formerly. In the former place the ore is found within two fathoms of the surface, and in the latter from four to six fathoms.

In Parimpetta hamlet a labourer can collect from the mine about 20 maunds of ore per day. It is dug up with mometies and crowbars; his hire is 4 annas per diem; at Lutchmepooram the ore exists at so great a depth that three persons are required to work the mine, one to dig, one to put the ore into a basket, and one to draw it out, and about 8 maunds can be so collected per day.

The quantity of iron imported annually is reported to amount to about 2,000 candies, chiefly European iron from Calcutta, Madras and other ports; but partly also from the neighbouring districts of Masulipatam and Vizagapatam, as well as from the Nizam's territories. The price of the former iron is from 35 to 40 rupees and that of the latter from 20 to 30 rupees. European iron is used in ship building and for nails, hinges, &c. and the Indian iron for ploughshares, pickaxes, billhooks, crowbars and other implements of agriculture.

The large importation of European and Indian iron of superior quality at low prices is stated to be the cause of the cessation of the manufacture of iron in this district.

When iron was manufactured at the above two places it is said that they used to procure charcoal of chundra and velemakoo wood from the places in the hills called Cunnappooram, Vadantapooram, Nagavarum, Enagalymettah &c. The former price is not known. It is also stated that from 9 to 16 maunds of charcoal were expended for one smelting.

The forests in the neighbourhood of the places where iron was formerly manufactured are extensive: they supply the firewood used in the sugar manufactories of Messrs. Arbuthnot and Co. and other gentlemen and for the ancient works. A man can make from 1 to 3 maunds of charcoal per day.

European iron is preferred for ships and buildings and Indian iron for ploughing implements: the former because of its malleability and the latter because of its thickness.

The daily hire of a blacksmith is from 3 to 6 annas.

REWA CAUNTA.

The following is from a recent letter dated 10th August 1852, from Major G. Fulljames, Political Agent Rewa Caunta to Arthur Malet, Esquire, Chief Secretary to Government Bombay. It was sent to me by Sir R. N. C. Hamilton, is of great interest and the portion of it relating to iron ores was drawn up for the purpose of affording information regarding the Geological formation of a portion of the Rewa Caunta District: it continues as follows:—

From this paper you will observe that I have discovered iron ore in four separate localities, Narookote Zillah, Pahlumpore, Leemodra, Bheelode, and also satisfactorily ascertained that at all the places except Bheelode it has been in former years most extensively worked.

Only one of the localities, that in the Narookote Zillah, belongs to the British Government: of the others, Leemodra and Bheelode belong to the Rapa of Rajpeepa and Pahlumpoor to the Goodra Punch Mahal. The former and latter localities are under seventy miles from the sea at Tankaria Bunder; the second and third localities are within three and twelve miles of the Nerbudda river which is navigable to the sea.

As far as I am able to judge from such experiments as my limited means have enabled me to make, I should give the preference to the ore from Pahlumpoor, but I am quite satisfied that the yield from any of them would, under European skill and experience, prove remunerative. It is true we have not yet met with coal in the same localities nor has it yet been discovered on the western coast that I am aware of, but we have fortunately an abundant supply of jungle wood in the localities and for miles round where the ores exist.

While at Champaneer my people discovered, under a heap of rubbish in a deserted kottar or magazine, some wrought iron balls and lumps of iron. These latter had evidently from their crude shape been smelted either there or at some place close by and I am led to believe this iron is the produce of the Pahlumpoor ore, the village where it is found being only $7\frac{1}{2}$ miles distant.

Should this surmise be correct we can form an opinion of the iron likely to be turned out from this locality. I had one of the balls drawn out by a blacksmith to a rod about $\frac{1}{4}$ inch square, and it proved tough iron and worked without difficulty, more resembling Swedish iron than the common English iron which is sent to India, and which must be denominated cold short for it has so bad a fibre that it is only used for the most common purposes and where neither strength nor toughness are necessary.

The period when the iron ore both at Pahlumpoor and in the Jambooghora districts was worked, must remain doubtful but it may have been when the

Soc. Tr. p. 548 No. XXXVIII.) Mr. Wedderburn mentions that iron ore is not worked on the east of the Nalla Mulla hills in the sub division of Cuddapah—and the probability is against its existence as the ore is all brought from Coilgoonda and Doovoor talooks, of the principal division, on the west side of the hills and he has favored me with the following list of the places where it is smelted in the sub division of Cuddapah.

1. Cumbum talook—at Cottacotah.
2. Doopand do. at Ramapallem where iron sand only is smelted.
3. Budweil do. at Ramapoor a hamlet of Cottacotah.

Iron is made from a kind of iron sand (No. 1.) in Doopand Talook. This has a reddish appearance, and, when sifted, about 6 or 7 per cent. of metallic particles remain. This sand, found in small quantities, is collected at Davaloory, and smelted at Ramapallem—about 2 maunds or less (46½ lbs.) of this metallic sand (No. II.) ore made into 25 lbs. of iron (No. III.) the expense of making which is Rupees 1-14. It is sold for Rupees 2 per 25 lbs. It is made as below. A hole a span in depth is dug on the ground, round 3 sides of which a ridge of earth is made, upon this ridge a crucible is laid, on the top of which there is a small hole over the crucible the upper half of a chatty is placed and filled with charcoal and the cleaned sand which when smelted, flows into the crucible: about 9 lbs. of sand and 25 lbs. charcoal are put in each time, after repeating which 5 times, a maund of iron is produced. This is again heated 6 times and hammered to make the specimen No. III. in which process there is a loss in weight of 20 per cent. The whole process occupies 5 days and the result sells for Rupees 2 per maund: steel is not made in this Division.

A specimen of ore (No. I.) brought by coolies over the Hills from Yelgaondah in Doovoor talook (a distance of 30 miles) where it is excavated to about a man's depth the same fused (No. II.) and a piece of wrought iron (No. III.) prepared in the village of Ramapoor, suburb of Cottacotah in Budweil talook, were forwarded to me. The smelter thought that that ore contained 33 per cent. of pure metal. The upper soil where it is dug is red and ore is occasionally found on the surface, but it is generally excavated.

The account of working the Forge is given:

Cost of 44 lbs. ore.....	0	1	4
Do. of carriage of do.....	0	4	0
Do. of crushing of do.....	0	6	3
Do. of 50 lbs. charcoal.....	0	5	4
Do. of charcoal and hammering.....	0	8	0
	1	5	11

The selling price of iron so prepared (No. III.) is Rupees 1-8-11 by which it appears there is no profit; sometimes the ore is richer, which would decrease the expense, which is perhaps overstated by the manufacturers.

From Mr. Murray, also, a valuable collection of 188 specimens was received of the various rocks and ores found in the Cuddapah district. Amongst these were two bags containing iron sand, one cleaned and the other not, from which iron is manufactured in *Goorumcondah* and *Muddepully*; also a small packet containing some good specimens of pyrites and another having a few crystals found in the bed of a bank near Muddenpully.

The specimens of pyrites which Mr. Murray sent are not unworthy of attention because the abundance of this ore of iron, there, induced the natives to burn it to obtain sulphur. Dr. Malcolmson long ago (R. Geolog. Soc. Trans. No. XXXVIII. form 1837 p: 543) made known that to the south and east of Cuddapah, a narrow valley, nearly 150 miles in length extends through the limestone, the strata of which are in some places nearly vertical, but form rounded hills. In others they are capped by sandstone, which exhibits mural precipices of much grandeur, and almost or entirely inaccessible. The strata, for the most part, dip to the N. W., resting on the granite of the Carnatic. This rock is penetrated by many dikes of greenstone, which have evidently been instrumental in elevating the stratified rocks to their present singular positions. Little has yet been ascertained regarding the thickness of these strata, which differ much even in the same range of hills. The only minerals they have been ascertained to yield, are varieties of quartz and iron pyrites, the latter of which is so abundant in a few localities, that sulphur is manufactured from it.

Another product from treating iron pyrites is sulphuric acid. Dr. Key (Manual of Chemistry p. 148) mentions that instead of sulphur, iron pyrites (Sulphuret of Iron) has been of late years very extensively employed in the manufacture of sulphuric acid. When that mineral is calcined in such a manner as to have free access of air, the whole of its sulphur burns off as sulphurous acid, leaving a residue of red oxide of iron. The only objection to this process is the presence, in all ordinary varieties of iron pyrites, of arsenious acid in small quantities. Nearly the whole of the arsenious acid, however, is condensed in the flues of the pyrites burners, so that the sulphuric acid produced contains seldom more than a mere trace of it. A similar detail is given by Dr. Royle (p. 31) that author mentioning that sulphuric acid used to be made in England by burning the imported sulphur with a little nitre. After the great increase which took place in the price of sulphur some manufacturers employed that obtained from pyrites which often contains arsenic as an impurity.

Mahomedans held possession of Champaneer. This place was captured by Mahomed Begra in A. D. 1484-85, some 368 years since. The city of Ahmedabad was founded by Ahmedshah in A. D. 1426-27 and it is stated in history that many of the inhabitants of Champaneer were forcibly driven to Ahmedabad for the purpose of increasing the number of its inhabitants and rendering it more flourishing by introducing the manufacture of silk brocade for which Champaneer was renowned.

Champaneer must have remained after its capture a number of years inhabited by wealthy Mahomedans, judging from the handsome Mosques and large tanks still to be seen in different directions. All are built of sand stone, of a similar formation and colour to the stone employed in such buildings in the city of Ahmedabad, and the nearest locality where I have yet seen this sand stone in situ is at the least thirty miles distant.

The ancestors of the present Rajahs of Chota Oodeypoor and Barrea, were the former Rajahs of Champaneer, and we have authentic information they had possession for some 240 years previous to its capture by the Moslems. This would give a period of at least 600 years when the use of iron and steel was absolutely necessary to the Chohone Rajpoots to enable them to erect the fortifications and other stone buildings on the Parvaghur mountain, beneath which Champaneer is situated, as well as for cutting their way through the solid rocks as they were compelled to do in many places.

From the best information I have been able to procure I am led to believe that Champaneer has been deserted by the Mahomedans for some 200 years and it is very probable after this event took place and supposing they were the parties who smelted the iron ores, that all operations ceased. Had the works been carried on up to a later date there would be some tradition among the people, but all are most ignorant of iron ever having been made in these parts.

As regards the ore in the Narookote Zillah, distant from Champaneer only about 12 miles, I have no hesitation in recommending further search and trial of the ore being made if it were only for the purpose of getting rid of the jungle which is now abundant as to render the climate so unhealthy that few but the Bheels can reside there with impunity. It would also be most advantageous for the extension of cultivation.

The 1st and 2d paragraphs of the Honorable Court of Director's letter which accompanied your's of the 21st February 1851 leads me to hope that Government may be induced to approve of the above suggestion and authorize me to make an effort to test the capabilities of this part of the Presidency in producing an article that now that railroads are introduced into this side of India must year by year become of more importance both for facilitating the extension of railroads as well as for opening this source of manufacturing industry for the advantage of the country.

Having satisfactorily proved the existence of iron ore in different localities under this Agency as well as that very extensive workings of this ore have at one time been in operation, from the large mounds of slag or refuse which are still to be seen, we may be permitted to assume that such workings were remunerative, and if such was the case under native manufacture what would these works not be under the skill, science, and energy of European superintendence, aided by machinery.

In Cutch, with the sea on two sides of it, and therefore with every facility for importing iron, it is still manufactured and although great difficulty is experienced in obtaining the necessary quantity of charcoal it affords the workmen a remunerating price.

In the early part of 1851, when in Bombay, I made enquiries regarding some iron works established at Bheelapoor on the Malabar Coast and was surprised to find on calling at Messrs. Remington and Co.'s office, that they were then shipping a quantity of the Bheelapoor pig iron for the English market, where it brought a remunerating price. Some of the iron I saw, but had no opportunity of seeing it tested in any way.

Extensive works at Porto Novo, on the Madras Coast, have for many years past been in active operation, and I see no reason why such works should not succeed in these districts.

I beg to annex a description of the ores found at Pahlumpore and Narookote as also some experiments I have made with them and only regret I have not had more time at my disposal and the means to test their value by actual smelting them. This I intend however doing as opportunity offers and I can make arrangements for a furnace and crucibles.

I have made no experiments yet with the Rajpeela ores but their value may be assumed from the analysis of slag kindly made by Doctor Haines as per 73 para in the accompanying paper wherein it will be seen the slag alone gave 28-96 per cent. of protoxide of iron, a quantity which in England would be considered sufficient to render the ore valuable to work.

Without excavating it is impossible to say what the depth or extent of strata containing the iron ores may be or what rock or strata it overlies, it was for the purpose of making this examination that in my letter No. 299 of the 4th Instant, I solicited sanction for an outlay of rupees 500.

SALEM

is a Collectorate in the centre of the southern parts of this peninsula, bounded on the north by Mysore; on the east by South Arcot; on the south east by Trichinopoly; and on the south west by Coimbatore. The district is 185 miles

and urged with the bellows. When the fire subsides, one half of the remaining charcoal, and another third of the sand, are put in; and, when those have again subsided, the remainder of the sand and charcoal is added, and the fire is urged six hours and a half from the commencement. The front of the furnace is then broken, and on removing the walls a mass of iron is found at the bottom, which is taken out with forceps, and cut into two blocks weighing each half a maund, or a little more than twelve pounds two ounces. By this it would appear, that the ore produced no more than about 31½ per cent; and the iron so produced, although malleable at first was extremely impure. Tippoo took it from the workmen at 3 fanams a maund, or 9s. 3½d. a hundred-weight. He gave them, however, great employment; as he made his shot of this iron, by hammering, for the fusion was never so complete as to allow it to be cast in moulds.

Iron forge.—In order to render this iron more pure, and to fit it for being wrought up into the implements of husbandry, it is taken to another house, and repeatedly forged. In this house also, he mentions that there are two bellows, but they are smaller than those in the smelting house: and the mound, on which they are supported being low, a pit is formed behind it, in which the labourers stand to reduce them to the proper level. The muzzles of the bellows, are inserted into an earthen tube, which conveys the air into the furnace through one of its side-walls. These walls are two masses of clay, one cubit long, ten inches high, and four inches thick; and are placed on the floor, parallel to each other, at the distance of a foot, on these is laid a flat cover, made of baked clay, and about an inch and a half in thickness. In its hinder part is an oblong opening, sufficient to admit one of the blocks of iron. The fore part of the furnace is secured on the top by a moulding of clay, which is somewhat ornamental. Before it is placed a stone a cubit long, twelve inches broad, and three high. Except what is shut up by this stone, all the fore part of the furnace is open. The hinder part is entirely shut with clay, except a small opening by which the ashes and vitrified scorice fall into the ash pit.

A block of iron from the smelting house having been put into the centre of the furnace, it is filled with bamboo charcoal, and strongly heated; while another block is put into the upper opening to receive some heat as a preparation. When the first block is properly heated, it is placed on an anvil and receives a few strokes of a large hammer from three workmen, who stand in three cavities formed round the anvil, to reduce them to proper level, and who thus knock off some ill smelted portions, and much of the adhering scorice. With a kind of hatchet the block is then cut into three wedges; and in this operation the workmen show much dexterity. The second piece is then put

into the centre of the furnace, and a third piece is placed in the upper opening of the furnace; while these are heating the three wedges are again made red hot, and well beaten on the anvil by the three workmen with large hammers. In this state the six wedges produced from one smelting weigh 24 seers, or a little more than 14½ pounds avoirdupois and are sold to the blacksmiths who are, however, obliged to heat and beat the iron three or four times, before it is fit for making the implements of husbandry. The weight of the six wedges is then reduced to fifteen seers, or a little more than nine pounds; and they were sold at from two to three Fanams, or from about 1s. 4d. to 2s. that is from about 16s. 6d. to 24s. 9d. a hundred-weight. From this it appears, that the quantity of good malleable iron produced by this means, was not quite 12 per cent. of the weight of the ore.

Steel.—The same persons made steel in the following manner. Good clay is mixed with an equal quantity of the charcoal that is made from paddy husks: and, having been well moistened with water, is thoroughly mixed, by being trodden under the feet of oxen. It is then picked clean, and made into cupels, which are dried one day in the shade, and next day in the sun. A fireplace is then made, in form of a parallelogram, by placing two stones one cubit long, and two inches and a half high, parallel to each other. At the distance of a foot above the stones is placed a wall of clay eight inches high. One end is shut up, in the same manner, by stone and clay, the other is built up with clay alone to the height of two cubits. Through this is inserted a tube for two bellows. Each of the cupels is now loaded with a small piece of iron, from one to one and a half seer (9½ to 14 oz.) in weight, together with five small pieces of the Tangayree wood (*Cassia auriculata*). Three rows of the loaded cupels are placed one above the other, so as to occupy the whole area of the furnace; the room of one cupel only being left empty, opposite to the muzzle of the bellows, in order to give access to the wind. They are covered with two bushels of charcoal, and burned for six hours, a third bushel of charcoal having been added, as the former two were consumed. The pieces are then taken out and hammered into small square bars, having been heated with charcoal of the Sujalu (*Mimosa Tuggula* Buch. Mass.)

Manipulation of the ore.—The operation for smelting the ore is exactly the same as that used for the black sand, except in the cleaning of it. The ore is first reduced to powder with an iron bar, and then the earthy particles are washed away in a wooden trough; when it becomes exactly like the black sand, and is called by the same name, Adara. The collecting of it is attended with less trouble than that employed to collect the black sand, but the carriage to any considerable distance prevents it from being used in general; as the workmen must live where the farmers will give them employment in their vacant time.

in length by about 80 in breadth, its area is 8,200 square miles with a population of 9,46,121 inhabitants, and it has been arranged into the following fourteen talooks:

Name of Talooks.	No. of sites where ore is found.	Name of Talooks.	No. of sites where ore is found.	Name of Talooks.	No. of sites where ore is found.
Ahtoor	8	Ossoor	16	Tengarascoilah	3
Darunpoory	2	Paramutty	1	Trichengode	2
Dankencotiah	1	Razapoor	4	Tripatoor	1
Kistnagherry	2	Salem	2	and	
Namul	3	Senkagherry	1	Womaloor	1

Part of this district (Salem proper) is in the plains of the Carnatic and is only a few hundred feet above the level of the sea, but the Barah Mahal is an extensive and rich table land about 500 feet higher than Salem, and the Belaghaut talooks are on a level with the country about Bangalore which they resemble in climate and appearance. From the different elevations of the several parts of the district, the physical aspect of the country varies considerably. In its more prominent features, besides many detached hills of considerable elevation, there are four large ranges which rise to the height of five and six thousand feet above the level of the sea. The Jewaddy hills are situated on the eastern side of the Barah Mahal; the Shervaroy near Salem; the Patcha Malay in Ahtoor, and the Cotte Malay and Shenda Mungalum range in the south eastern corner of the district. These are all inhabited and extensively cultivated and the climate, always cold and bracing, is, for the greater part of the year, considered salubrious. These hills all produce abundance of valuable timber of different kinds besides a good deal of teak, sandal and black wood: much of the northern part of the district in which is the eastern ghats, together with a large tract of country at their feet, is spread over with low rocky hills covered with low jungle. This is especially the case with the eastern part of the range where the ascent into the Mysore is very gentle. More towards the east, where the passes become steeper, the jungle is much higher and contains some fine and valuable trees, but this part is little inhabited as it is subject to fever.

Excepting corundum, chrome iron ore, (a mineral found associated with the magnesite formation and which has been discovered there), and oxydulous iron, and beryl the district is not known to possess any economic mineral product. Its ores of iron and the iron and steel manufactured from them have, however, long been famed; and early attracted the attention of Mr. Heath and Captain Campbell both of whom in describing the native processes in Salem have written largely on the general subject of the iron manufacture in Southern India. Salem is one of the districts to which the Iron Company's monopoly extends. They do not, however, seem to have ever smelted iron there, but have

carried the ore to other places. The earliest intimation given of the existence of ores of iron in the Barah Mahal was by Dr. Buchanan but he does not seem to have been aware how numerous the sites are. I am indebted to Mr. Dalyell for the following very important return giving in a tabular form information regarding the mines, in all but four of the Salem Talooks. Mr. Dalyell remarks that the whole of the furnaces throughout the district are of extremely small size and that the cost of the charcoal used for smelting could be greatly diminished by improving the roads from the forests. He is of opinion also, that, though the jungles are not extensive and are said to be diminishing, there need be no apprehension of a deficiency of charcoal for many years to come.

From this return it will be observed that the miners collect from one to four maunds of ore in a day; in some places requiring to dig pits for it, and in others gathering it on the surface of the ground, or in the beds of streams. In the 8 talooks enumerated, 51 sites are given, and in all the villages adjoining a site of ore, furnaces appear to be in blast; but their small size and simple structure may be estimated by the fact that the cost of erecting one varies from 4 annas to two rupees; the quantity of ore they are capable of containing being from 5 to 6 viss i. e. 15 to 18 lbs. Most of the forests from which the supply of charcoal is obtained, are near the mines, and the farthest off is only 10 miles distant; but in every place those forests are diminishing.

The ores excavated in the Salem Collectorate consist of oxydulous iron and the black ferruginous sand so common in the beds of streams of Southern India. It was the former which Mr. Heath first worked, at Shendu Mungalum in latitude 11-21-30, north and longitude east 78-17-30 (see Asiatic Society Journal Vol. 1 p. 253), and it is from these magnetic ores of iron that the wootz or Indian steel as well as malleable iron by the direct process is made by the natives.

The iron ore is stated to form hills of considerable size; it is in small grains imbedded in quartz and occasionally in regular octohedrons. When cleaned from the quartz it is found with, it consists of 72 per cent of iron and 28 of oxygen and traces of manganese and lime without any admixture. Some of the crystals sent are covered with a white micaceous coat which, by the natives, is esteemed a sign of superiority: the specific gravity of the octohedral crystals was found to be on an average 5.1 to 6.0, which is rather more than is allowed in mineralogical works. Mohs, the most accurate physiognaphist, calls it 5.096 Phillips, only 4.4.

On reference to the manuscript Journals of the late Dr. Voysey, from which an extract is given in the foregoing pages, it appears that in the Godavery iron works, ores of iron sand, and iron clay are used, which are more easy to reduce than the pure magnetic oxide although far less rich in metal.

In discussing the native process of manufacture in Salem, Mr. Heath was

IRON RESOURCES OF MALABAR.

Vast as the resources for iron making are in Southern India, perhaps in none do we find so happy a combination of all the necessities to the native smelter, as in Malabar. The primary formation (Plutonic) of the district, offers in abundance to his wants, almost every description of ironstone that may be desired, from the solid block of pure oxide of iron, down to the fine black sand, which almost universally finds favor with the iron producers of this district. His fuel is unlimited, often judiciously located at the edge of a dense and inexhaustible forest, he knows no fear of short supply. He wisely selects the "Irrool" tree for reduction into charcoal. Its well known weight, closeness of texture and hardness of grain, recommends it alike to the smelter and the builder. The iron maker generally purchases his requirement of charcoal and of iron sand from the people of the neighbourhood at the rate of $1\frac{1}{2}$ anna per basket (65 lbs.) of charcoal; and $2\frac{1}{2}$ pies per measure (10 lbs) of cleanly washed iron sand.

His furnace is egg-shaped, as per sketch annexed, and his operations are conducted under a spacious, high and well thatched shed.

This native furnace differs widely from the still more primitive forges of Salem and Coimbatore, which are circular, exceedingly small (say one fourth the size of that used in Malabar) are blown by one instead of two pairs of bellows, and seldom rejoice in a roof over head.

The quantity of iron stone which one man can collect in a day varies it may however be assumed at 120 lbs. The ore is picked out with a rough instrument, generally a piece of bamboo pointed at one end, and is then freed from all foreign matter by washing. It is not often smelted upon the spot where it is dug. In some instances it is purchased by the smelter at the mine, in others, it is carried on head by the miners to the furnaces and there sold.

The name of each site where a furnace exists is given in the statement B. Drawings of the furnaces and of the apparatus employed in smelting the ore and working the iron, the expense of erecting a furnace and of the cost per month of working it, also the quantity by weight of ore that one furnace contains, is appended to statement B.

The names of the talooks and villages where iron is produced plentifully, are marked in statement A. The quantity of iron produced yearly in the district, may be estimated to be about 475 tons. The selling price of iron, averages from 12 annas to one rupee and a half for a toolam, equal to 28 lbs.

NOTE.—Query 1. The information required will be found in statement A. and specimens of ore accompany.

The name of each locality where ore is mined, is marked thus * * in statement A.

or say 60 rupees per ton. About 300 tons of iron is sent yearly from the Wallowanaad talook to Cochin.

There is only one description of iron manufactured and the process by which the ore is converted into iron is as follows; A quantity of charcoal is first thrown into the furnace, and upon this a certain weight of ore, and as the materials descend the coal and ore are renewed. This process is continued until the usual quantity of iron has been deposited in the bottom of the furnace. After allowing the furnace sufficient time to cool, its front is removed; the "loupe" withdrawn, broken into pieces, and the different qualities assorted. The iron is either used for making up implements on the spot or is sent to a distant market. Native steel for edging ordinary tools, is prepared direct from the crude "loupe" or mass as it is drawn from the furnace. The lump is never uniform in quality, but presents various degrees of carbonization. Portions may always be selected more peculiarly adapted to the production of steel, which indeed approximate so nearly to steel itself, that they require only to be beaten out and tempered to form that metal in its primitive state. The manufacture of cast-steel does not however appear to be practised (as in the case in Salem) by the native smiths of Malabar, but of the suitability of the materials which exist at their disposal, no doubt can be entertained. They lack only the mysterious and enchanted leaf, which in Salem steel conversion, exercise in the eyes of prejudice, its magic influence.

The quantity of "old iron" imported during a year may be taken at about 35 tons. It is obtained from the United Kingdom, Bombay, Travancore, and the Maldives. Its tariff price is 28 rupees per candy of 500 lbs. or 125 rupees per ton. It is used for shipping, building, and making working implements.

The accompanying statement C. contains the names of all the tools and implements manufactured from the iron of the district, with the selling price of each.

The charcoal which is employed in smelting the ore, is brought from distances of from 1 to 8 miles. The average price of coal at the furnaces is $1\frac{1}{2}$ anna per 65 lbs. The quantity used for one smelting is stated in para 14.

The forest in the neighbourhood of the furnaces are extensive, and there is no perceptible diminution in their extent. The amount of charcoal one man can make in one day is about 65 lbs.

The immense saving of labour to the smith in forging a manufactured bar suited to his work, never fails when it can be obtained, to find preference, but the almost universal use of native iron, except at the Beypoor works, affords but few opportunities to the native smith to test his choice.

of opinion that the steel which they produced was the result of a double process, the first converting the ore into iron and the second resulting from the application of some green leaves of the *asclepias gigantea* and he considered that the importance of these green leaves in the process was indispensable for the conversion into steel. Captain Campbell, on the contrary, considered that in the first smelting the iron produced was more or less steely some parts being, at least, three fourths steel. The Bengal Asiatic Society considered some specimens sent to them for examination in illustration of the native operations as interesting on account of the ignorance which still prevailed in Europe on this subject. In the Asiatic Society's opinion, according to the author of the treatise on manufacturing iron and steel, in Lardner's Cabinet Encyclopedia, the then latest authority on such subjects, the right nature of Indian steel seemed to be still as much an enigma as ever, nothing having been added to our knowledge since Dr. Pearson's paper on the wootz steel in the philosophical transactions, Vol. XVII. There it is asserted that the steel is made directly from the ore by fusion, and that it has never been in the state of wrought iron. The metal has evidently been fused, says Dr. Pearson, but the grain of the fracture is such as I have never seen in cement steel before it has been hammered or machined, and he suggests that the variegated appearance of articles manufactured from it is owing to portions of the oxide of iron having escaped metallization when melted up with the rest of the matter: this is the view taken by other witnesses also of the nature of the damask steel's wavy lines (See Royal Asiatic Society's Journal.)

Dr. Voysey, however, expressly describes the compact texture and brilliant white color of the iron used for conversion into steel and in confirmation Mr. Heath sent "the actual crucibles with broken fragments of iron bars charged ready for fusion, along with uncharred wood and green leaves; the wood used for the purpose is that of the *cassia auriculata* and the green leaves are those of the *asclepias gigantea*." The cementation takes 24 hours, and the fire is then urged so as to fuse the steel. On breaking the crucible it is found in a hemispherical button, radiated on the surface as from crystallization: it has gained somewhat in weight, it is very hard, and requires to be annealed three or four times, covered with clay, and exposed to a red heat for 12 or 16 hours. This would be an argument that too great an absorption of carbon had taken place, and that the metal was in fact cast iron, 100 grs. of Mr. Heath's wootz, however, when dissolved in sulphuric acid, left but a grain of carbonaceous matter which is less than the usual proportion.

The brittleness of the wootz steel has been notorious ever since Damascus blades have been known in Europe and Asia. Tavernier describes the difficulty of working up the metal in his day as precisely what was experienced in the specimens formerly sent to the Asiatic Society of Bengal. The steel sus-

ceptible of being damascened comes from Hyderabad (q. v.) which is taken to Persia; it is met with in commerce in lumps about the size of a half-penny cake, they are cut in two, in order to see whether they are of good quality, and each makes half the blade of a sabre. He adds, that if the European methods of hardening this steel were followed, it would break like glass. Reaumur and others have always alluded to the same difficulty of forging it.

The cause of the brittleness has been attributed to the over carbonization, alluded to above.

It was with this magnetic oxide of iron that the Porto Novo Company, twenty years ago, commenced the manufacture of iron by charcoal in the European methods and a considerable quantity has been sent to Britain but chiefly in the form of pig iron. This Company and Mr. Fischer sent to the Great Exhibition a carefully selected series of the ores of Salem and of the products obtained in the various stages of manufacture. The collection also illustrated the native methods of iron and steel working and showed in the opinion of the Jury that two distinct operations were involved, the formation of blooms or lumps weighing at most 22 lbs. and the refining, or rather forming these into flat bars from ten inches to a foot long. The Jury remark (Report Vol. 1 p. 14.) that this iron is always steel like, some bars being true steel. The work resembles that of the Catalonian forges, except that it is on so small a scale, and the process might be partly understood by considering the size of the blooms, but additional proof was obtained as to this mode of working, as they found in the Indian collection a series of models executed in the country, of a considerable number of industrial processes, amongst which is one of the forges of Salem. By looking at this model the Jury considered that a sufficient idea might be obtained as to the nature of the iron manufacture.

The forges, the jury remark, appear to be temporary establishments, capable of being conveyed about from one place to another. The hearth, hollowed out at the bottom, is round, and may be about 18 to 20 inches in diameter; it is surrounded by a rim of earth about six inches high, in which are the tuyeres: supplied by two pair of bellows of the shape of leathern bottles. The dimensions of the blooms led them to suppose that only one is made at a time, the bars, which are placed on the walls of the hearth, and would be partly covered by the fuel, show that the forging is performed at the same time that the bloom is obtained. Two blacksmiths, with a man to work the bellows, complete the number of those employed in one of these little establishments, and the forging is done entirely by hand. The ore, which is principally a metalloid form of the kind called oligist, is broken into small fragments, none of them larger than a walnut, and few larger than a hazel nut, before it is smelted.

The collection in the Great Exhibition also included buttons of cast-steel from 2 to 2½ inches in diameter; this material being the wootz; so celebrated

Two other men one from Ghettipura, and one from Cutlu on the road to Bangalore, confirmed the above account. Each smelting according to them, takes nearly 68 pounds of black sand. This difference from the other account, Dr. Buchanan considered as probably arising from his having weighed the former when very moist, and this when dry; for the workmen always put the sand into the furnace, after having thoroughly soaked it with water. According to this account however, the ore gives rather more than 37 per cent. of the crude iron, and a little less than 20 per cent. of iron fit for the use of the blacksmith. For this purpose, after it has been split into wedges, it requires to be four times heated and hammered.

Dr. Buchanan (Journey Vol. 1. p. 179) went from Magadi to Ghettipura to inquire after the iron mines there and found the ore in several places, and also the pits, from which the people were then taking it to supply their furnaces.

Much steel was formerly made at Ghettipura, from whence it derives its name, which signifies literally hard town. It is a small village situated by the compass W. S. W. from Savana-durga, and is distant from Magadi about seven miles. Near it are many cultivated fields intermixed with low rocky hills. The ore is found both in the fields and hills.

The iron ore of the fields consists of small irregular masses separated by thin layers of earthy matter, and is found in beds from five to ten feet deep, which have only been wrought in a few places where they come so near the surface that they have been discovered by the plough. It is probable, that by digging deep they might be found to be of great extent. The small masses are easily beaten into powder, and then the black sand is readily separated, by washing, from the clay and sand that are the other ingredients in their composition. This ore is of two kinds; one decomposing into red ochre, the other into yellow. Intermixed with both these kinds of ore, which are called female stones, are many lumps of what the natives call male stone. It appeared to Dr. Buchanan to be composed of the same materials with the female stone, but is so hard, that the imperfect manipulations of the natives cannot reduce it to a powder, and of course they cannot separate the earthy matter. It is, therefore, looked upon as useless, fluxes being totally unknown to the miners of Mysore. The female stone appeared to Dr. Buchanan to be the male in a state of decay.

The iron ore of the hills is also male and female; the latter being the only one used; and this was also, in his opinion, the male in a state of dissolution. The male stone in the hills bears a much larger proportion to the female, than it does in the fields. This ore also was found on digging a very little depth into the soil and seemed to be the source from whence most of

the black sand of the country was washed by the rain. It appeared to differ from the quartz impregnated with iron, mentioned in the account of the Pedda Nayakana durga ghats, only by containing a larger quantity of metal. The female stone is very easily reduced to a powder, and the iron sand is readily separated, by washing from the quartzose sand, which is the other ingredient in the ore. It is not so rich in metal as the ore found in the fields. These two ores are called Aduru Cullu, or stones containing iron sand.

On the surface of the hills is found another iron ore called Ipanada which is scattered among the gravel in small lumps from the size of an egg downwards. They are a pure ore, and are put in the furnace without any preparation, except breaking the larger pieces into bits about the size of a filbert. The quantity of Ipanada required for one furnace is exactly the same, by measure as that of Aduru; but the weight of Ipanada is of course less, there being more space occupied by interstices, from the greater size of the pieces. The produce of iron from both is the same. The surface of the lumps of Ipanada is often covered with a kind of black enamel.

Dr. Buchanan mentions (Journey vol. 3. p. 424) that between Malawully and the Madura river were two villages, Bana-samudra and Halasu-hully, at which iron ore was smelted. The ore came from mines near Chenapatam and Ramagiri.

CHITTLEDROOG DIVISION.

In Dr. Buchanan's time (Journey vol. 2 p. 16) iron was smelted in various places of the Talooks, or district of Madhu-giri, Chinnarayan-durga, Hagalawadi, and Devaraya-durga. In the first two districts the iron was chiefly made from the black sand which the small torrents that are formed in the rainy season bring down from the rocks. In the two latter districts, it was made from an ore called there Cany Callu, which is found on the hill Kinalay Guda, near Muga Nayakana Coast in the Hagalawadi district. A little of the same iron ore is also procured from a hill, called Kaymatty near Mascoonda in the district of Chica Nayakana Hully.

The manner of smelting the iron ore, and rendering it fit for the use of the blacksmith, was the same here as near Magadi. The stone ore was made into iron exactly in the same manner, as the black sand, the quantity put into the furnace, and the produce, being nearly the same. The iron from the stone ore is reckoned better for all the purposes to which malleable iron is applied, but it sold lower than the iron made from the sand; for this last is the only kind that can be made into steel. For making steel, there were in this vicinity five forges; four in this district, and one in Deva Raya Durga it was used for making stone cutters, chisels, sword blades, and the strings of musical instruments. Dr. Buchanan (Journey vol: 2. p. 35) on his way from Siru

in India for the preparation of Damascus blades, there is nothing to show directly in what way they have been prepared, but it is impossible to doubt from their form that they have been obtained in small crucibles.

The correctness of the surmise is shown by No. 3 of Mr. Dalryell's plans in which will be observed the crucibles are arranged round, inside. I do not think it necessary to furnish any further information on the subject of the ores and iron and steel of Salem, but Mr. Heath's and Captain Campbell's papers are of great interest, and as many may wish to peruse them they are appended.

1. In the KODLEGHEE TALOOK, iron ore occurs only, on one hill, in the village of *Jammanathanahully* (No. 1.)

2. In the HURPONHULLY TALOOK, there are two sites, one on a hill called *Moothooroya condah*, situated in the jungle near the village of *Arasanahaul*, (No. 2); and the other on a hill called *Tholagy konda* situated half a coss distant from the village of *Tholagy*—(No. 3.)

3. In the HOOVINHUGGALY TALOOK, iron ore occurs in a hill called *Bettathaina Konda* situated in the jungle of the village of *Seger*, (No. 4.) and in a hill called *Hoothigoodda Mahamanahully* in the limits of the village of *Harada* (No. 5.)

In the lands belonging to the Rajah of SOONDOOR, which are enclosed by the Bellary District and border on the talooks of Koodleghee and Hoovinhuggaly, (a) iron ore is found in a hill called *Hadaharagunny Murdoe*, situated within the limits of the villages of *Cummathadhahurvoe* and *Nundhihully* lying towards the east of the Comarazawny Hill (No. 6.); also (b.) in a hill called *Sallaykolladayanoo* situated within the limits and towards the west of the village of *Soobroyenhully* belonging to the Rajah of Soondoor and towards the east of the village *Sunnysechully* in the *Koodleghee talook* (No. 7.) also (c) in a hill called *Ramaumullah* belonging to Soondoor (No. 8.) and also (d.) in a hill situated in the limits of the *Marashimah Samy Pagoda* in the Soondoor country (No. 9.) and iron ore is abundant in all the above places.

Iron sand from which iron is produced is found in the following places.

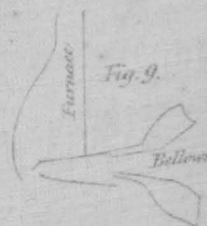
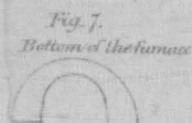
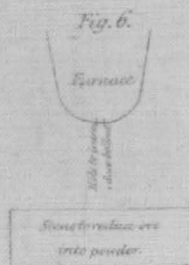
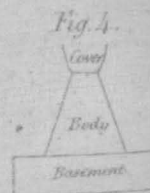
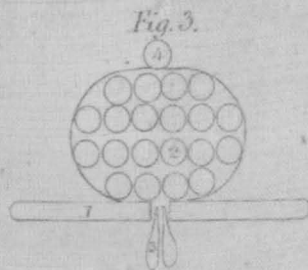
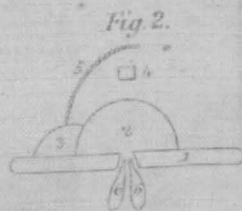
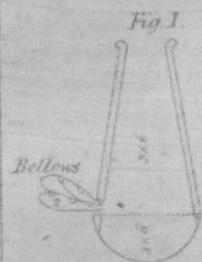
In the *Raidroog Talook*—there are two, viz., one in a nullah near the village of *Yatacul* (No. 1.) and the other in a nullah near the villages of *Durmapoorce*, *Veerahpoorum* and *Bundhanacull*, situated about two or three miles from the village of *Nallapoorsam* (No. 2.)

In the *MUDURK SEERAH TALOOK*—there are fifteen places, viz. (a) in nullahs in the jungles of the following villages, *Sindhigirry* (No. 3.) (b) *Goon-damalah* (No. 4.) (c) *Muheoy* (No. 5.) (d) *Senkaragul* (No. 6.) (e) *Ramegirry* (No. 7.) (f) *Rollahbetta* and *Rollah* (No. 8.) (g) *Jungumurrahully* (No. 9.) (h), in nullahs from the hill at *Huthanagirry* (No. 10.) (i) in the outskirts of the village of *Yainakoontah* (No. 11.) (j) in the hill at *Choragirry* (No. 12.) (k) near the hamlet *Poojarechully* of the village *Makalagutta* (No. 13.) (l) near the hamlet *Kerraywoliganahully* of the village *Makalagutta* (No. 14.) (m) in nullahs in the jungle of the villages of *Hirraythoorpee* (No. 15.) (n) near the village of *Kyakathee* (No. 16.) (o) the village of *Alhoor* (No. 17.) (p) and near the village of *Niddamemdy* in the *Penacondah talook* (No. 18.)

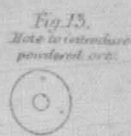
In the *KODECONDAH TALOOK*—iron ore occurs (a) in some of the small nullahs that lead to the *Rungareddy tank* of *Kondhapoorum* and some other places in the neighbourhood (No. 19.) also (b) in some of the small nullahs in

SALEM.

FURNACES.



It sunk A test below the surface.



Smoke hole and to introduce ore.



Figs. 1, 2, 3, 4, 5, 6, belong to Thiruv.
to Denkanasally.
to Tirupur.
to Parumattiy.

Figs. 7, 8, 9, belong to Nainapur.
to Salem.
to Tengeri Ghat.
to Aumail.
to Tirupur.

to Seringapatam passed over Doray Guda, the hill producing iron ore; Doray Guda, is about a mile in length, from five to six hundred yards in width, and is divided into three hummocks. The northernmost of these is the most considerable, and rises to the perpendicular height of four or five hundred feet. It is situated in the Hagaluddi district. It is the only hill in this vicinity that produces the iron ore; but as the same hill in different villages is called by different names, Dr. Buchanan at one time imagined that the mines had been numerous. The people there were ignorant of there being any other mine in this range of hills; but he afterwards found this to be the case. At Conli this hill is called Doray Guda, which name he adopted. On all sides it is surrounded by other low hills; but these produce no iron: and, he thus continues "the whole strata of these hills are vertical, and like all others that he had seen in the country, run nearly north and south. When they have been exposed to the weather on a level nearly with the ground, which is generally the case, the strata divide into plates like schists, and seem to crumple very quickly. In a few places they rise into rocks above the surface, and then they decay into roundish or angular masses. All that he saw were in a state of great decay, so that it was difficult to ascertain their nature; but he had no doubt that they were either earthy quartz, or hornstone variously impregnated with iron, and perhaps sometimes with manganese. Within, the masses were whitish, with a fine grained earthy texture; but outwardly they were covered with a metallic efflorescence, in some places black, in others inclined to blue.

A ledge of this rock passes through the longer diameter of Doray Guda, and seems to form the basis of that hill; but the whole superstratum, both of the sides and summits, seems to be composed of a confused mass of ore and clay. The surface only was then, wrought; so that very little knowledge could be obtained of the interior structure of the hill. In its sides the miners made small excavations, like gravel-pits, but seldom went deeper than five or six feet. On the perpendicular surface of these the appearance is very various. In some places the ore is in considerable beds, disposed in thin brittle vertical plates, which are separated by a kind of harsh sand, yellow, bluish, or green. In one place he observed this sand of a pure white, and forming little cakes, readily crumbling between the fingers. In other places it is hard, forming irregular concretions, with various admixtures of earth, clay, and ochres. This kind has a tendency to assume regular forms, botryodal, and reniform, which inwardly are striated with rays diverging from a centre; sometimes plates are formed of this kind of ore, which consist internally of parallel striae. Another from the ore is bluish, and very brittle. The whole is mixed with what the natives call *cari-cul*, or black-stone, which is brown hæmatite. This is also scattered all over the surface of the ground, and there especially

assumes botryodal and reniform shapes. By the natives it is considered as totally useless. In some pits he could observe nothing like a regular disposition of the component parts, in others, the various substances were evidently stratified, both in straight and waved dispositions.

The manner of mining the ore was extremely rude and unthrifty. A man with a pick-axe dug on the side of the hill, until he got a perpendicular face five or six feet wide, and as much high having before it a level spot formed from what he had dug. Before him he had then a face containing ore, more or less intermixed with clay, sand, and hæmatites, and covered with two or three feet of the external soil. He then scooped out the ore, and matters with which it is mixed, and having beaten them well with the pick-axe, and rubbed them with his hands, he picked out the small pieces of ore, and threw away the hæmatites, sand, clay, ochre, and large pieces of ore; assigning as a reason for so doing, that, as he could get plenty of small pieces there was no occasion for him to be at the trouble of breaking the large ones. The crumbling ores are also much neglected, as they are transported with difficulty. The renter stated that the furnaces supplied from hence were six in Tumkur, ten in Hagalawadi, seven in Chica Nayakana Hully, and three in Sira; but he concealed part of them.

No tradition remained concerning the time when this mine began to be wrought, for the natives think that ore has been taken from it ever since the creation of the world; or, as they express themselves, since the hill was born, and, in Dr. Buchanan's time above 100 ass-loads were daily carried from it and he thought it probable that the miners had even then repeatedly gone over the surface. At each time the natives removed only a very small proportion of the iron; and after a certain number of years, new decompositions, and re-compositions of the materials seem capable of rendering the surface again fit for their manner of working.

The miners had a tradition, that formerly there had been dug into the southern face of the largest hummock an immense cavern, from whence the whole neighbourhood was supplied with ore. The roof of this was said to have given way, and to have buried the miners of seven villages, with all their cattle. The appearance of the hill confirmed the truth of this tradition, there being then evident proofs of a part of it having fallen in; and in the perpendicular surface, left by this convulsion, may be seen the mouth of a cavern, probably a part of the old mine. The time when this happened, was likely, Dr. Buchanan thought to have been very remote; as, lower down than this convulsed surface, there was another mine, which the natives believe to be a natural cavern, and into which, not without some reason, they are afraid to enter. Indeed none of them have attempted it; for they are persuaded that it extends a great way into the earth, which made him curious to examine it.

The daily hire of a blacksmith employed at the furnace, is from one to 4 annas, the smiths employed in towns earn from 3 to 8 annas a day.

The modes by which the process of native manufacture might be cheapened are various, but they require the application of different principles and the erection of machinery.

The mining of the ore is at present performed in the most rude, but probably in the most economical manner. It costs prepared and delivered at the furnace rupees 2-10-0 per ton.

A decided saving in waste of charcoal during its preparation might be effected were the natives to char their wood in large covered heaps as practised by the Indian Iron Company, and at the same time a large and more powerful coal would be produced. It may be estimated that to produce one ton of charcoal by the native open burning process is consumed 2 tons of wood more than by close burning in large heaps.

It is borne on the head from the jungle to the furnace, probably for the native the least costly carriage.

It may be found that where water power is not available, and the native unable to meet the outlay of machinery, the present system of blowing is most economical.

By a differently constructed fire and the application of machinery, much waste of ore might be saved.

It would not pay to construct roads for the transport of the very small supply of ore and fuel required for a native furnace.

At each smelting which occupies about 3 days and 3 nights 680 lbs. of crude iron is produced, but the quantity varies with the size of the furnace and other circumstances, the particulars of cost are as under.

Charcoal 4,093 lbs. at 1 anna 6 pie per 65 lbs.....	5	14	6
Iron stone 3,000 lbs. at 2½ pie per 10 lbs.....	3	8	3
Labour (3 men by day and 3 by night) rent of bellows, &c. &c.	4	13	0

Total cost per 680 lbs...Rupees 14 3 9

or per ton Rupees 46 14 0.

The furnace is blown by 16 small tugaree each ½ inch diameter and all placed in the front of the furnace.

To produce 1 lb. of iron are consumed, of charcoal 6lbs. and of iron stone 4 lbs.

The crude product of the smelting furnace loses in forging into smith work on an average nearly half. In other words to produce one lb. of smith work are required of crude iron 2 lbs.

It will be perceived that at a selling price of 60 rupees and assuming the cost price 50 rupees per ton, a profit is derived to the smelter of 10 rupees per ton.

(Signed) H. CONOLLY,
Collector.

Calicut, 24th June 1854.

SAUGOR AND NERBUDDA TERRITORIES.

Much of these territories are in the military occupation of the Madras Presidency, and up till the beginning of this year the troops there were supplied from Madras with all the stores and implements of iron and steel that they required. To carry to so great a distance by land articles which can be procured on the spot of a better quality than anything that England can send forth and cheaper even than articles of a similar nature cost in England was a waste which I trust this report on the iron ores and iron of these territories may remedy.

The Saugor and Nerbudda Territories consist of various non regulation provinces under the rule of the Supreme Government of India, and of several native principalities with which the Company have alliances.

These territories are situated between $21^{\circ} 30'$ and $24^{\circ} 35'$ north latitude and $77^{\circ} 15'$ and $81^{\circ} 51'$ east longitude and are bounded on the north by Riwar, Maihyar and other small states of Baghelcond: on the west by the Bhelsa Pergunnahs of Scindia, Bhopal, and, south of the Nerbudda river, by the Hurda Hindia Pergunnahs:—on the south by the Nagpore and Hyderabad Territories and on the east by Nagpore, Kunria and parts of Riwar. Their total area may be roughly estimated at about 30,000 square miles. The tract over which these territories extend may be described as a table land (the most elevated indeed of all the table lands of Southern India), the northern border of which is usually termed the Vyndhia range of mountains while the southern border bounds by its cliffs the valley of the Nerbudda, with which it runs nearly parallel and at a distance never exceeding a few miles. It is in the lower portion or spurs of this elevated land that the well known quarries lie.

Like to the edges of the elevated lands of Southern India receiving the names of the eastern and western ghats, so edges of the table land now being described receive particular appellations: where the table land leaves the Nerbudda at its junction with the Hiran it is called the Bhandar mountain, running parallel to which is another small range the Kaimur.

The table land of these territories presents a great variety of surface, hill and dale and valleys with running streams, and is in many parts covered with forests of considerable extent and density.

South of the Nerbudda, another table land of great extent, the northern edge of which is usually termed the Satpura range, presents itself, running parallel to the rivers at a distance never exceeding twenty or thirty miles, but in a wavy outline, often advancing on the river as at Jubbulpore where it almost touches its waters. Below Jubbulpore the rocks of the Bhera Gurh, (where the river flows in a deep narrow stream, between two perpendicular cliffs of snow-white magnesian marble) have long been a favorite object of admiration.

The miners had evidently wrought into this part of the mine from the westward; and until they came to the ledge of earthy quartz, or hornstone, before mentioned, they had carried on a regular face of considerable width and depth. This ledge cutting off the mine, they had by the side of the barren rock made a horizontal cavity into the hill, and thus formed a cavern about fifty feet long twelve feet high, and nine wide. They had then probably met with some obstruction; for under this they had formed another mine, which cut off the communication between the ground and the first mentioned cavern. Dr. Buchanan entered the den and found the sides of the mine to consist partly of the ore, and partly of the rock already mentioned, which is much intermixed with the caricular or brown hæmatites. The place was perfectly dry, but the work was deserted probably when the poor people in the higher mine suffered. Ever since that event the miners had contented themselves with working on the surface, and even there they were in constant fear.

Dr. Heyne also (Tracts Page 358 to 364) gives an account of the method, of making steel in the Mysore country. He says that the place where he first saw steel manufactured was a small village among the hills south west of Chittledroog, in the Salem pergunna. The iron from which it was made came from Malsinganahally, a village at a small distance from the former. The preference given to the product of that work seemed however, owing only to its vicinity as iron was made from the same kind of ore at fifteen other places in this district, and exactly in the same manner. The place where the ore was found is a hill near Kalwarangapampetta farm, whence it was conveyed on asses to the different iron furnaces in this district. He found it near the furnaces in small tabular pieces of a brown ochrey colour, with shining particles scantily interspersed, nearly friable and of an earthy fracture. It was not magnetic, and appeared to Dr. Heyne either decomposed hornblende, or iron glance, which is very common there. It yielded about 0.269 of metal.

The following was the process of making iron then followed. It commenced with filling the furnace with charcoal and, continues Dr. Heyne, "after it is heated, which requires an hour, a basket of ore, containing about 33lb. reduced to pieces of the size of a pea, is put into the funnel and covered with charcoal; an hour afterwards a similar basketful of ore is put in and this addition repeated three times at the stated intervals: care being taken that it is always covered with charcoal and the furnace supplied with sufficient quantity of this article. About an hour after the last replenishment the process is finished, which lasts altogether from five to six hours. It must be mentioned also that after the third addition of ore, a small hole is made at the lowest extremity of the temporary furnace, to let out the dross. After the charcoal has been consumed, the temporary part of the furnace

is pulled down and the iron collected at the bottom of it is taken out with a long forceps, carried to a small distance, and beaten with large wooden clubs. During this operation a great quantity of scoria are seen running from the porous mass of iron.

When the red heat is nearly over, it is cut into three pieces. In this state it is very porous, and worse in appearance than any crude iron of European manufacture.

To prepare it for the market, it is several times heated to whiteness, cut into thirteen pieces of about 2lb. each, and hammered into cylindrical pieces of eight inches in length. It is in this state a good soft iron answering all purposes for which it is wanted in cultivation and building. The maund of this iron (27lb.) was sold for about two rupees.

Steel.—In order to convert the iron into steel each piece is cut into three parts making fifty-two in the whole, each of which is put into a crucible, together with a handful of the dried branches of tangeda (*Cassia auriculata*), and another of fresh leaves of vananguly (*Convolvulus laurifolia*). The mouth of the crucible is then closely shut with a handful of red mud and the whole arranged in circular order with their bottoms turned toward the centre in a hole made on the ground for the purpose. The whole is then filled up with charcoal, and large bellows are kept blowing for six hours, by which time the operation is finished. The crucibles are then removed from the furnace, ranged in rows in moistened mud, and water is thrown on them whilst yet hot. The steel is found in conical pieces at the bottom of the crucibles, the form of which it has taken, the upper or broader surfaces often striated from the centre to the circumference.

In some crucibles, half of the iron only was converted into steel, and others found empty, the melted metal having run through a crack in the crucible, and decuded useless.

He could not discover any slag at the top of the metal although it had lost about one-fifth of its original weight.

These conical pieces were sold at the price of fifteen gold fanams the maund, about ten shillings and eight pence for 27lb. Sometimes they were heated again and hammered into small bars of four or five inches long.

He considered it as probably not quite indifferent what crucibles are used in this operation: at all events he thought that they must be able to stand a strong fire. The loam employed for these crucibles was of a brown red colour, of an earthy appearance and crumbles between the fingers mixed with white sand and some shining particles it had no earthy smell when breathed upon nor did it effervesce with acids.

The basis of the northern range of table land is sandstone, in many places of a finely laminated texture and long used as a roofing slate and for sculptures. This rock however varies in texture and the beautiful carvings of Gyrapur, Oodipore (chota) and other antiquities having been executed in it. In other places it becomes argillaceous. From a little to the west of Rahli, to the western limits of the Saugor district, the above formation is entirely overlaid with basalt, the sandstone only occasionally making its appearance above the surface in hillocks or small ranges: of the structure of the Satpura range, immediately south of the Nerbudda river, less is known, but it is described as of overlying basalt. The rocks in the valley of the Nerbudda itself consist of sandstone; coarse conglomerate; limestone; dolomite; steatite; mica, clay, and chlorite slates; and basalt; which may all be seen in the vicinity of Jubbulpore.

It would, perhaps, be difficult to over estimate the value to the Indian Empire of this great tract of country; much has been already done for it in the active men who have ruled it, as Commissioners, and much may still be hoped for from the establishment, by Lieutenant Winscom at Jubbulpore, of a Museum. Coal has been found, amongst other places, cropping out at Lanbitha Ghaut 7 or 8 miles below Jubbulpore. A coal vein was discovered in the Rewan Pergunnah of Chandia Kanria, which adjoins Kumbhi on the north east, and also in the Hushungabad district, on the south bank of the Nerbudda. Iron has been found in great abundance and in many places.

Beyond the limits of the Pergunnahs of Kumbhi, Sehora and Garina, the soil is sandy and all the ranges are of sandstone, partaking of the character of the Kaimur and Bhandar, but having much iron within their confines. The most remote point in the district where traces of iron ore are observed is almost at its extremity, north east of Sahagpoor and beyond the Sone river, where there are excellent iron mines in a sandstone district. But the most important occurs from 20 to 30 miles north east of Jubbulpore, in the Kumbhi Pergunnah, where a black iron sand is quarried and becomes an article of extensive traffic under the name of Dhao. It is smelted in the vicinity, principally at Baghraje, and is largely manufactured into all descriptions of native utensils, chiefly at Panagar the first stage towards Mirzapore: also into guns at Burela and Katangi, which are well known; the above vein, which seems to take, in common with most of the other formations, a direction more or less parallel to the Bhandar, crosses the high road about Ghulsapoor in the form of laterite. It appears again at Benaiki, 6 miles west of Jubbulpore, in the character of laterite; and, at Punsar, 4 miles further on, an insulated hill rises, and a rich black ore occurs in contact with sandstone. But it is not worked as the natives assert that it flies to pieces in the furnace and is excessively brittle. The mines of iron at Tendookhera in Hushungabad, on the north bank of the Nerbudda, are celebrated.

Few specimens of the iron ores of that district have reached me and these from Sir R. N. C. Hamilton; but the geographical department in the Museum, has been enriched by a large and beautiful collection of its other rocks and minerals which Captain Campbell liberally presented to it.

The latest information collected on the subject of the iron ores and iron of the Saugor and Nerbudda Territories, is contained in the following report by Lieutenant G. V. Winscom, officiating Superintending Engineer.

In each of the executive ranges of the Saugor Division iron ore abounds and is of very superior quality, well fitted for all kinds of tools, and, in one or two instances, for rolling into bars of any size.

Jubbulpore range.—In the vicinity of Jubbulpore there is a very considerable iron trade carried on, especially at Punnaghar, 11 miles from the cantonments, upon the Mirzapore Road. The whole geological formation for some miles round Punnaghar is ironstone of the several varieties of red hematite, but the chief lodes occur at Lakri 12 miles, Bhela 17 miles, Gootna and Agguriah 20 miles, and Jowlee 25 miles from Jubbulpore. The mines of Lakri are not much esteemed owing to the ore being mixed with sulphur and other heterogeneous substances which involve the necessity of roasting and of fluxes but the ores are good, being a compact protoxide of iron intermixed with radiated hematite. Bailar, Agguriah and Gootna, are considered excellent mines, the ore in all is iron mica, but at Jowlee is the best lode, it is the ochrey variety of red protoxide of iron, intermixed with specular iron and free from argillaceous mixture.

At a place called Minsar, W. of Jubbulpore, a different kind of ironstone is found to that which abounds in these parts: when put in the furnace it splinters and flies with such violence as to be deemed useless by the natives.

The furnaces are conical erections about 8 ft. high with an earthen tile perforated with holes at the bottom, out of which the metal runs when melted. Common hand bellows to urge the flame is all that is used and charcoal is the fuel employed. From such crude furnaces of course much loss ensues. The Kherree produced in the neighbourhood of Punnaghar is an excellent substance for pointing cutting instruments.

Seonee district.—Iron ore likewise exists in the Darassi talook about 12 or 20 miles S. S. E. of Seonee, and at Lohara about the same distance to the E. S. E. of Kuttinghee, (Hurowli.)

The iron is brought in cakes varying in size called Tappia or Dyvya to the Jubbulpore Bazar and sold at about 17 seers for the Nagpore rupee, it is extensively used for cooking utensils, wheel tires, pickaxes, manoties, &c. and sold thus made up at an average rate of 3½ seers the rupee (Nagpooree.)

Saugor range.—The iron used in the Saugor range is brought from Sathli

A list of the specimens of iron ore from the district of Cuddapah now in the Museum will shortly be forwarded.

CUTTACK

is not a Madras, but a Bengal Collectorate, extending from the frontiers of Ganjam to the Subanreka 180 miles, with an average breadth from the sea, inland, of 110 miles. It has an area of 12,661 square miles and a population of 2,793,893 including in this, the districts of Balasore, Cuttack, Hidgolee, Koondah, Midnapore and Pooree; but it has Madras Soldiers in its cantonments: it immediately runs on the borders of the Madras territories, has Ganjam on its southern boundary, and Hyderabad and Nagpore away to the westward; on the sea coast and for about 20 miles to the westward the country is low and covered with wood, but further westward it is hilly: the importance of its products to the trade of the Madras Presidency is therefore great, and it may be useful to furnish information regarding its iron and coal.

The earliest intimation that I have met with, of the existence of iron ore in Orissa is in Heyne's Tracts (p. 292) but the Journal of the Asiatic Society (vol. 8, page 137) contains a very interesting report on the coal and iron mines of Talcheer and Ungool by Mr. M. Kittce, from which the following account is furnished.

He left Cuttack on the 14th March 1838, and proceeded by regular marches through Dherkuomal, direct from Kuckur on the Mahanuddee to the Brahmanee at Atturva.

From Atturva he proceeded up the South bank of the Brahmanee to Talcheergurh, and after duly examining the coal beds he proceeded to Mungulpersad, a stockaded village on the borders of Ungool, the distance seven miles in a westerly direction, over an undulating country, with, generally speaking, indifferent soil and much shingle.

He remained one day at this place, and having inspected the coal beds, &c. returned by a more direct route through the states of Talcheer and Ungool to the bank of the river (at Mungulpur) along which he proceeded, via Natures, Nagoath, Chundpal, Kapeepoor, to Kowatbund, near to which place the river enters the plains, throwing off that branch called the Kursoo, which is the only navigable channel to the sea. He reached this place on the 26th thirteen days from the date of his leaving Cuttack, and his remarks are as follows:

"The country is neither so mountainous nor jungly as it is represented to be, but for the most part, much neglected; although the soil appears generally good, and productive.

"The lands in the immediate vicinity of the Brahmanee are very rich, great quantities of cotton, sugar-cane, castor-oil plant, linseed, &c. &c. are grown for home consumption, as well as for exportation.

A great deal of very fine tobacco is grown along the banks and on the muddy deposits of the river, and such lands fetch an exceeding high rent; notwithstanding which the profits on this article of commerce are very great.

Wheat and barley are cultivated in small quantities, and what little I saw appeared to grow most luxuriantly; maize, &c. is also grown on the high lands by the meaner classes, but rice is the chief article of food.

The land in Talcheer and in Ungool is not so good as in Dherkuomal; and the trees are stunted in growth owing to the shingle, laterite, and sandstone rocks which are near the surface. There is more jungle and waste lands on the opposite side of the river.

From the third march from Atturva to the plains (commencing at Kowatbund) the level lands vary much in extent, the hills in some places coming within 3 or 400 yards of the river, and in others receding for two or three miles, forming no connected chain, but all more or less isolated (apparently of volcanic origin), the land between them being perfectly level, except where ravines or beds of laterite and kunkur occur to interrupt it. At Atturva the hills recede gradually, till at Kurugpursad they branch off in a south-westerly direction, through the state of Hindole into Ungool, towards the Mahanuddee; the hills on the opposite side of the river also recede in a north-westerly direction towards Keonjur and Bounnaragurh.

Shortly before reaching Kurugpursad the country commences to be undulating, and extensive beds of shingle occur, with red marl sandstone rocks are met with at Mungulpur, protruding through the soil, which are very close grained and white; granite also sometimes occurs in huge detached masses, which have a very singular appearance, particularly at Kukurdung in Ungool, where they rise in detached blocks of sixteen and eighteen feet in height, and of most fantastic shapes, somewhat resembling the Stonehenge. The land on the north bank of the river is likewise undulating, with rocks. No hills of any magnitude are to be found within twenty or thirty miles of Talcheer and the coal localities visited by me."

From Talcheergurh to Mungulpersad, a distance of sixteen miles or more, he saw much shingle and rising ground, on which there is iron ore and laterite, also kunkur (calcareous nodules) and sandstone rocks.

The information obtained regarding the Hingolee mines, was from an ascetic, to whom he made a suitable present. He also heard of coal and iron mines in Bounnaragurh, from a merchant of Cuttack, and despatched an intelligent peon to examine them, and to bring specimens, &c.

and Tendookharie to the south; Soonrye and Somdah in the Saugor territory; Chutturpoor and Keerapoor on the Cawnpore road, and from Jubbulpore.

Tendookharie mines.—The iron obtained from Tendookharie and from Jubbulpore is most esteemed and any quantity desired is to be procured in the Saugor bazar. It is brought to market in cakes called Duryah weighing from 6 to 10 seers, which sell at from ten to 25 seers the rupee according to the quality. The Tendookharie ore is specular iron mixed with a great deal of iron clay. It is not short, from it a very handsome suspension bridge 200 feet in length was made on the spot about 24 years ago by Colonel Presgrave. For such constructions it is very valuable as these mines are much thought of and the chief in the division; the following account of them (obtained from Overseer Bailey) may be interesting.

Tendookharie is a straggling village about a mile and half long by half a mile broad situated on the bank of the Gogra river.

The smelting furnaces of which there are fifty are only worked for about 100 days in each year as they are stopped during the monsoon, and most of them during the sowing and reaping seasons, no coolies being then procurable for digging ore. During my visit but 6 furnaces were at work.

The pits, from which the ore is dug, are distant about two miles and a half from Tendookharie, and are in general about 25 feet deep.

They are worked as follows, 2 coolies (each receiving 5 pice a day) dig a hole of about 8 feet square and continue sinking till they come to the bed of ore. The whole of the ore in the bottom of the pit and for about 2 feet all round under the clay is taken out and the pit is then abandoned and a fresh one commenced.

The ore is taken from the pits to Tendookharie on buffaloes: a buffalo takes about 3 maunds of ore, and for each trip 3½ pice is paid.

When ore is sold in the bazar it sells for 5 buffalo loads per rupee.

The furnaces are worked from about 8 A. M. to midnight, and are then let go out; in the morning the produce is drawn, the furnace repaired and again set going.

To attend the furnace and break the ore into small pieces three coolies are required who receive 5 pice a day each.

At each melting 21 baskets of ore of 15 seers each and the same weight of charcoal is expended, and from this about 60 seers of cast iron is got.

The furnaces are worked by the common country bellows in the usual manner.

The charcoal used in the first smelting is the very commonest procurable.

To make malleable iron the cast iron is again smelted with teak charcoal and is then the common bazar iron.

There are two descriptions of iron made in Tendookharie or rather two

descriptions of furnaces. One much larger than the other. The iron made in the large furnace is sold at Nagpoor rupees 7 per goand of 3 maunds: that made in the small furnace at 5 rupees per goand.

About 4,000 maunds of iron or 142 tons is made yearly at Tendookharie.

Mhow range ore, where obtained.—In the Mhow range, specular iron ore of the finest quality is found at Poonassa, Kautkote, Harwai, Chandghur, and thence continually up the Nerbudda as far as Kindia, the supply is quite inexhaustible.

Near Chandghur 3 beautiful lodes cross the Nerbudda of the most superior quality, containing about 62 per cent of iron.

At present it is chiefly used for wheel tyres and tools of various kinds, and is made by the Gondos who have no systematic way of working, and only work when they feel inclined to. In the Mhow bazar the best is sold at 9½ rupees per maund of 80 lbs. Inferior kinds are sold at 7 rupees. English bar iron is also procurable in the Mhow bazar at from 7 to 8 rupees, but the quality of the iron is inferior. At Chandghur and Kautkote from 6 to 10 seers, pucca iron, can be got for the rupee.

The style of furnaces is much the same as those in the Jubbulpore and Saugor ranges. Charcoal is procured in abundance close to the mines and costs about a Rupee for 5 maunds. The quantity of charcoal used in smelting is about five times the weight of the ore.

In conclusion, the whole Division is rich to the greatest extent in iron ore, and in the vicinity of nearly all the mines, limestone in any quantity, which could be used as a flux, is procurable.

The greatest natural advantages are afforded and so rich are the ores themselves that it has been stated by a very competent judge, that if the poorer ores of Europe, which now produce thousand of tons of metal yearly, obtaining great profit, were worked in the same crude manner as the natives work these, the result would be a mere slag worth nothing whatever.

A Jubbulpore letter of date 9th June 1855 says;—"Mr. Hunt, the Railway Contractor, is here examining the iron and coal mines, and he will, I have no doubt, erect a large foundry here, as he is much pleased with what he has seen, and has sent up for two practical men to go into the bowels of the earth to see that it yields as much minerals below as it does on the surface. I trust it will, for a large iron foundry conducted with English enterprise and English capital will be a great matter for Jubbulpore. Mr. Hunt leaves this in a few days for Calcutta, to make the necessary arrangements for organizing an efficient European Establishment, which he intends to send here immediately to commence operations. Mr. Hunt has been heard to declare that the iron mines

From this the finer particles used for crucibles are separated by water, which keeps them suspended for some time during which it is drawn off and left to deposit them.

The dried sediment of many of these washings is compact, has a liver brown colour, with some shining particles; of the consistence of chalk; a conchoidal fracture, feels soft and soapy and takes a polish from the nail. It makes a pretty good brown paint. The crucibles are made of this by moistening it and mixing it with the husks of rice. It is then dried in the open air.

The stone used in the construction of the fire places of the iron and steel furnaces is called ballapam* by the natives. Another place where iron and steel is manufactured, and where he attended the process, was Kakerahally, a small village on the road from Bangalore to Seringapatam. The iron ore used there was the magnetic iron sand. In this place before the iron was made into steel it was heated, hammered and reduced into eight pieces of eight inches length, and two inches breadth, and half an inch in thickness. It was then still so brittle that it broke under the hammer. Its grain is coarse and white. Twenty eight rupees weight of it was put into a crucible, and upon it a handful of the dried branches of cassia auriculata. This was covered with the green leaves of the convolvulus lanrifolius (tallaku), and the opening of the crucible was closed with a handful of loam.

The furnace consisted of a hole in the ground about $\frac{1}{2}$ foot deep; one foot broad where widest, and $\frac{3}{4}$ foot at the opening. This hole was filled with charcoal, and in and about the opening of it seventeen crucibles were placed; these were covered with a heap of charcoal, and bellows were kept playing on

* Note.—This is a name applied to all stones of the magnesian order which have a soapy and greasy feel and little hardness. Here it is a position of a leek green colour easily scraped with the nail into a greenish white powder, longitudinal fracture inclining to the even, with abrupt irregular rugosities, faintly striated, cross fracture, irregularly slaty, foliated, lustre silky, verging to the semi-metallic; specific gravity 2.782 to 2.862, the thermometer being 81°; opaque; exposed to the air its surface is corroded, the colour changes into red, it easily crumbles to pieces and its appearance becomes more slaty.

Along with it is found asbestine of a light green colour. The fracture of the mass undulating; it is composed of needle and arrow formed crystals, confusedly aggregated; the former are often scapiform. It has a harsh feel, cannot be scraped with the nail, but easily with the knife into a white powder; lustre glassy, translucent; specific gravity 2.594.

The rock of the mountains on which these stones are found consists chiefly of the following kind of stone:—in its sound state it is in the gross slaty, longitudinal fracture, undulating or even cross fracture hackly. External colour a silvery green, and where decomposed red; silky verging to the semi-metallic; hard; gives fire with steel; specific gravity 2.64 less its shining greenish colour, though it is evidently mixed with a great quantity of red; of this stone is derived, the red loam of which the crucibles are made, which in the wet season is washed down on the plain.

it until the contents of the crucibles were liquified, which was known by its perceptible fluctuation when taken out for the purpose of trying it. Dr. Heyne mentions that the operation seldom lasted longer than three hours; and was usually made four times in the course of the day, and three times in the night.

The loss in twenty-four rupees was only 1½ rupee weight and less. The steel was found in conical pieces striated at the broader surface. When it had run accidentally through a crack in the crucible, it was recast again and sold to the goldsmiths who used it in making fire-works.

One hundred pieces, each weighing about twenty-eight or twenty-nine rupees, were sold for four Cantaray pagodas, i. e. fifteen pounds cost about seven shillings.

Dr. Heyne remarks that the principal point for making steel by fusion seems to consist in the exclusion of atmospheric air from the crucible, and the use of fresh vegetables instead of charcoal by which means, it is probable, a higher temperature is obtained than could easily be procured by the use of common charcoal. Hence the iron is more certainly fused and at a smaller expense. The crucibles are made here of a stiff loam mixed with the burnt husks of rice.

The grain of the steel is much finer than that of the ore; but there still appears spots which are not well fused.

He fancied that the iron manufacture here was a kind of natural steel; but a drop of diluted nitric acid left a whitish green spot, a sign, according to Kirman, that it is iron. On the steel of this place a brownish black was produced.

The specific gravity of the finest steel is 7.852 but he found the product here only 7.664.

Captain Newbold (Geology between Mangalore and Madras Page 26) also mentions that in the Chittledroog division, on the border of the Ashta-

* Cassia auriculata (tangedu of the Telugu) is one of the most common shrubs on the coast; but grows most luxuriantly on black soil. It is used in medicine but more for tanning.

The extract, which it yields in great abundance and most readily and which he recommended as a tanning material in lieu of terra ferrea, was rejected at first as useless by persons engaged practically in this manufacture at Calcutta, but since used by the very same persons in the Madras sanery, which has been established. It is rather scarce about Bangalore, and by no means luxuriant.

The *Convolvulus lanrifolius* is a new species that contains some milk; it grows in most part of Mysore and many other inland countries.

Dr. Heyne did not think it very material for the manufacture of steel except that it furnishes uncharred vegetable substance.

in the vicinity of this station contain nearly 95 per cent of pure metal, and are the richest in this respect of any he has hitherto met with."

TANJORE.

The eastern half of this Collectorate is a flat alluvial delta completely irrigated by the several branches of the rivers Cavery and Coleroon; but the rest of the province, which lies south of the delta, is on a considerably higher level, its surface undulating and comprising many varieties of soil.—Tanjore has an area of 3,900 square miles; and a population of 1,128,730. It is situated in the Carnatic, between the 9th and 12th degrees of North Latitude, and the Capital is in 79°-11 E. Longitude. It is bounded on the north by the Coleroon river which separates it from the Collectorate of South of Arcot on the south and West by Madura, the Ramnad, and Shevagunga Zemindaries. On the north west by the Collectorate of Trichinopoly and the Tondimans country and on the east by the sea and is divided into the 17 Talooks of

Codavassel	Myavaram	Tranquebar
Combaconum	Numillum	Tritapooddy
Cottallum	Paupanassem	Trivalore
Hoozoor	Parrallum	Trivandy
Keevalore	Puttoocottah	and
Manargoody	Sheally	Vellungamaun.

There are no ores in Tanjore, but the following statement from Mr. Forbes will be interesting to all who desire to learn where the province is supplied with iron from.

Statement of the quantity of iron imported by sea into Tanjore during last year (1853) with its selling price on the coast, where it is used in ship building, and at the two principal inland towns, where its use is confined to ordinary purposes.

Statement showing the quantity of iron imported and the duty levied from 1st January to 31st December 1853.

Whence Imported.	Quantity of iron imported.			Amount of duty leviable.		
	candy.	m	s	Rupees	A	P
Columbo	14	19	8 $\frac{1}{2}$	37	6	3
Penang	232	5	7 $\frac{1}{2}$	289	11	11
Singapore	12	16	20	18	14	7
Jaffna	1	2	4	2	4	9
Moulmein	13	4	20	11	13	3
Mauritius	37	4	15	37	1	1
Karriacul	16	14	20	17	14	2
Total	323	6	15	415	2	0

At Tanjore country iron is sold at 5 $\frac{1}{2}$ seer per double fanam or R. 22 a. 10 p. 1	per candy or 20 maunds.
At Negapatam English do. at 3 $\frac{1}{16}$ seer per do.	or 38 $\frac{1}{2}$ rupees per baram or 800 seers = 1 candy.
At Combaconum country do. at 5 do. per do.	or 25 rupees per candy of 800 seers.

TENASSERIM PROVINCES AND EASTERN SETTLEMENTS.

The territories of the East India Company to which the designation of the Tenasserim provinces and the Eastern Settlements has been given lie along the Malayan Peninsula or form islands and an Archipelago in its adjacent waters, and have come into our possession at different times. They are all under the controul of the Supreme Government, but are held by the Madras Army, which makes it requisite to notice their iron products here.

Since the Tenasserim Provinces came into our possession in 1826, by the treaty of Yandaboo, about 3,000 Madras Troops have been distributed at Moulmein, Amherst, Tavoy and Mergui. These provinces, lying between latitudes 10° 50' and 17° N. and in longitude 98° and 99° E. are from 25 to 50 miles broad and 250 miles long and may be characterised as hilly and covered to the water's edge with impenetrable forests through which only paths have as yet been formed. Their shores are washed by the Bay of Bengal and there is a group of Islands called the Mergui Archipelago, from 15 to 20 miles off the coast.

The soil is light and sandy and the rocks consist of sandstones and limestones upraised by granite. There are hot springs on the Palook river between Mergui and Tavoy, of a temperature of 194° and the important mineral products, coal, iron and tin, have been found in abundance; and gold, antimony and lead are also said to occur.

For the knowledge which is extant of these products, the country is indebted, chiefly, to the exertions of *The Honorable Mr. Blundell*, and to Captain Tremmenheere's published reports, though from other sources it has been long known that the metals are found in more or less abundance throughout this peninsula.

MALACCA.

Malacca forms part of the East India Company's possessions termed the Eastern Settlements; it is situated on the Malayan peninsular, in latitude 2° 14'

A.

Talook.	Village.	Name of each site.	Remarks.
1. Koormenad...	1. Nadavalloor.....	1. Kolekullioo - - - - -	
		2. Eddacara-cadoo - - - - -	
2. Shernaad.....	2. Olavatoor.....	3. Kolady Hill - - - - -	
	3. Nulloor.....	4. Komburecoonoo - - - - -	
3. Walloowannad	4. Neemany.....	5. Chathaparamba - - - - -	
		6. Thirteer coonoo - - - - -	++
	5. Vallumboor...	7. Madahcoonoo - - - - -	++
		8. Chettyancoonoo - - - - -	++
		9. Arrat coonoo - - - - -	++
	6. Arakoorshy.....	10. Kolapath coonoo - - - - -	
	7. Arkaparamba...	11. Marathumpara coonoo - - - - -	
		12. Cotam kalary coonoo - - - - -	
		13. Palapal coono - - - - -	
		14. Karingaly karooparamba - - - - -	
		15. Kahany coonoo - - - - -	
	8. Chetalloor.....	16. Pranacotoo coonoo - - - - -	
		17. Moodacumpooroothoo coonoo - - - - -	
	9. Pandikad.....	18. Theyambaddy coonoo - - - - -	
	10. Vettiathoor...	19. Kalarakoo parambu - - - - -	
		20. Thirvalapi ta coonoo - - - - -	
	11. Thachamparah.	21. Kotathan hill - - - - -	
		22. Venaddy paramba - - - - -	
		23. Moylancoonoo paramba - - - - -	
		24. Chendipa hill - - - - -	
	12. Karivattum...	25. Choondam puddy coonoo - - - - -	
		26. Nelly coonoo - - - - -	++
	13. Mangadda.....	27. Iringattoo paramba coonoo - - - - -	++
4. Ernaad.....	14. Ellaugoor.....	28. Polavankavoo hill - - - - -	++
	15. Chengara.....	29. Angatha koonoo - - - - -	
	16. Arriabra.....	30. Chummam coonoo - - - - -	
	17. Triculangode...	31. Korasary petta coonoo - - - - -	++
5. Temelpoorom.	18. Taroor.....	32. Piakodu paramba - - - - -	++
		33. Vettookad paramba - - - - -	++
		34. Thalayan cadoo paramba - - - - -	++
		35. Kardy coonoo paramba - - - - -	++
		36. Mavoothakodu paramba - - - - -	++
	19. Vadakancherry.	37. Manathoomkarra Nellom - - - - -	
	20. Mangalom.....	38. Parala coonoo paramba, - - - - -	
		and several other places in the Modapalloor Hamlet - - - - -	
	21. Vadavanoor...	39. Three miles along the Choolyatty river - - - - -	++

(Signed) H. CONOLLY, Collector.

* * Where iron ore is mined.

† † Where it exists plentifully.

north and longitude $102^{\circ} 12$ east. It is slightly cleared near the sea coast, but covered with dense forests in the interior and in its rains and temperature it is almost similar to Singapore. It contains 800 square miles and 33,806 inhabitants.

Its soil is lateritious, and the Honorable Mr. Blundell has favored me with specimens of its tin which occurs in great abundance. Gold is likewise obtained by washing in the streams. Captain Newbold (*Malayan Peninsula* p. 68) mentions that a small quantity of iron is found in the interior of Quedah and that Siam and Billeton produce this metal in abundance. Of other parts of this peninsula we are told (*Dalrymple's Oriental Repertory*, vol. 1 p. 173.) that Cochin China produces great plenty of iron ore.

MERGUI.

About 10 miles S. W. of the town of Mergui, is an island, comprising a hill about 200 feet in height, formed apparently of iron ore. The island is perfectly accessible to boats of every description, and you land on large masses of rock, which prove to be the iron ore from which the soil has been washed away. The hill rising abruptly from the water, may be about a mile in circumference, and is wholly formed of the ore, having a rich bed of soil. A similar island, equally accessible, is formed about four miles to the southward of the one above mentioned. It is not known that this ore has ever been worked, and the process seems unknown to the people of Mergui.

Limestone is found in several accessible localities on the main branch of the Tenasserim river, not far above the old town of that name.

Dr. Evezard mentions that Podan-or-tha, Isam-pah-yea-mea-key, are the places where iron ore is said to be the most abundant, a man can pick up as much as he likes at Podan-or, of the brown hematite, No. 4, which from its being the most easy of reduction was formerly smelted by the Shans and Burmese. He adds as follows: I have dispatched through the Commissariat Department specimens of all the ores of iron I have obtained; each of them labelled with the name and site. There are said to be the remains of old furnaces still standing at Podan-or. Of the cubical iron pyrites from Potan Island I gathered and washed with the help of a cooly about a pound in half an hour, much more could be gathered no doubt in that time with proper implements. Some delay too was occasioned by the cooly being afraid of removing what the Burmese call Nuggie-Re, or Dragon's excrement as the Dragon like a true Burman revenges any attempt to clean away his native filth. The Burmese are fond of wearing this marcasite in their ears and for necklaces; and used formerly to obtain it

from Bengal. I fancy that when it was discovered here the fear of making it too cheap suggested the fact of the Dragon.

About a thousand viss of steel are annually imported from Bengal and England at half rupee a viss retail price: this is considered cheap and quite sufficient to supply the province, and it is used for making dahs, axes, hammers and fish spears, teising or sickles for cutting paddy and shades.

Formerly, enough iron was manufactured here to supply the whole place, but since the English have had possession cheaper and better has been imported.

The ore is procurable at the rate of one rupee per hundred baskets.

The forests are extensive not diminishing: one man can make 3 or 4 baskets of charcoal in a day. I should mention that there are extensive deposits of coal in this province, a survey of which is about to be made by Professor Oldham, Superintendent of the Geological Survey of India, who is expected shortly from Calcutta for the purpose of deciding whether or not it will be worth again working to make up the present deficiency in the supply of coal to steamers in the Eastern seas. I have the honor to send you specimens from the principal coal fields.

English iron is preferred and the smiths state that their general experience leads them to this, and when further pressed for reasons for their preference, mention that it is more malleable, finer grained and wastes less in working than the Bengal; that the Bengal wastes one-half and that a hundred parts of the English are only reduced to eighty parts by working.

There are not above 3 or 4 blacksmiths in the place and consequently, as they all tell me, their wages are literally as much as they can get and vary according to the comparative appreciation in which their work is held: and each man tells me he can get a higher price than his neighbour it is impossible to arrive at the truth. Two rupees a day however appears to be the lowest for the coarser kinds of work. The finer works in steel such as the dahs, are made by the goldsmiths who charge an enormous price, it is obvious that where so little is done there is plenty of room for improvement but I have failed in persuading a Pangi, who has smelted a little iron from Podan-or to make a blast furnace under my directions. All he wants to know is "the way the English melt iron without heat. With heat Burnah is best." I have however nearly persuaded an intelligent blacksmith that I have charmed the Dragon away and that I can show him how to turn what he has left to good account by making it into sulphur and sulphate of iron, both which are dear in the bazar: I shall also endeavour to teach him to case harden. I have also the honor to send you some Tin ore with specimens of some of the principal neighbouring well known rocks, &c. and in conclusion shall be happy to give you any further information you require and from time to time transmit to you any valuable ores of other metals &c. which I think must exist in this province.

gram division, in the vicinity of Kootul, a village lying between Turivicary and Severn droog, on the right bank of the Arkavusty and in the beds of its tributaries, a highly magnetic iron sand is found. A small quantity that he took from the bed of the rivulet was mingled with a sand in which were seen grains of quartz, felspar, and fragments of mica the alluvial debris of the surrounding hills, whence it is washed by the rills which have their sources therein. In the rains, he was told, additional supplies of ore are brought down. This ore, which consists of small ferruginous angular grains having a partially metallic lustre, with edges somewhat worn down by attrition is collected, washed from the sand and other impurities, and brought to Kootul to be smelted. A native can collect and prepare a basketful (about 1½ or 2 maunds) per diem; this he sells to the smelter for five pice. Two *phuttis* or large basketfuls of charcoal are required to reduce this quantity to a metallic state, which cost the smelter five pice more. From this, the product in pure metal is from half a maund to a maund. The price of a maund of the metal in the rough on the spot, is 1½ rupee. Taking the average of metal produced to be ½ of a maund, a surplus will remain to the smelter of 12 Annas 2 Pice or about 300 per cent. Out of this it must be recollected that the daily hire of two bellows-men, the erection of the furnace and smelting shed, the bellows and supplying a fresh tube to conduct the blast into the furnace renewed at each operation, are to be accounted for. There are two furnaces on the spot, and five at a little distance. In each from 1½ maunds to 3 of metal may be smelted during the course of a day. The process is simple and has been often described, the ore he saw reduced to a metallic state in less than a couple of hours. Four or five forges are close at hand where the iron is forged into nails and bars. In the latter state it is sold at from 1½ to 2 rupees per maund. The ore is procured and smelted in this talook at Hurti, Kunchakanhully, Timsunder and Naiganpully and in various places in other talooks. That from Chickanaighully in the Chittledroog division is both cheap and of good quality—it is used for agricultural implements, &c. on the spot, as well as in the surrounding villages, and for shoeing horses, for which purpose a considerable quantity finds its way to Bangalore.

On the summits of some of the rising grounds near Turivicary are some groups of a rock that might almost be termed a medium between gneiss and granite. It resembles the latter in external character, unstratified appearance and disrupted form; while it approaches the former in the laminar nature of its crystallization the direction of which precisely coincides with the direction of the gneiss strata in the vicinity, viz. nearly due north and south. It is composed of both a white and reddish felspar, quartz, and mica; the latter in lamellæ. The laminar shape of the quartz is best seen in the weathered

specimens. This mineral occurs in aggregated grains having a resinous or colophonitic colour and lustre.

The foregoing remarks will have shown the character of the ores found and worked in the Chittledroog Division, and I can now add the following Report on the furnaces which are at present at work in the manufacture of Iron and Steel in the Hosadroog Talook, which Captain Cunningham has sent me.

Iron ore exists and is mined in the following places of this talook.

1. "*Kunnee-kulloo Gunnee Goodah*" (meaning Rock where Iron Ore is mined); in *Nahgara-heday Goodah*, close to the village of Kittar-hulle; whence the ore is obtained in dust and conveyed to the founderies at Dodaguttah, Jonkull, Goolce-huttee, Dooga-wahrah, Mahvana-kuttay, Oogeena-kuttay, Daveegerray and Soutayna-hulle, situated, respectively, at the distance of nine, twelve and fifteen miles.
2. "*Kunnee-kulloo Goodah*" (meaning Iron Ore Rock); close to Gahray Goodah; whence the ore is conveyed to the founderies at Kullava-nahgaka-hulle, Taneegay-hulle and Keyahsara-hulle, situated at the distance of about three miles.
3. "*Yeechayguttada Kunnee-kulloo Gunnee*," whence the ore is conveyed to the founderies at Lokada-holaloo, Bammanna-kuttay, Halay-hulle, and Gilleekayna-hulle, situated at the distance of six miles. The ore is obtained here without much trouble, on mining to one man's depth.
4. "*Buntanah-gahvee Kunnee-kulloo Goodah*;" close to the village of Buntanah-gahvee; whence the ore is conveyed to the founderies at Honayna-hulle, Rungavana-hulle and Hoolce-kuttay, situated at the distance of eight miles.

The ore in the three former places is of a yellow colour and of a blackish hue in the latter place. Two specimens (marked X and Z.) are sent.

Three men collect five ass-loads of ore in one day. Each ass-load is equal to two maunds. One man digs this quantity in a mine, with a "*monay-goodlee*" (pointed native pickaxe), while two men bring it to the furnace, where it is sifted in the wind, in order to remove the dust from the pure ore, which is carried away on asses and stored, for the purpose of being smelted at the founderies in the eighteen villages above named where labourers and fuel are to be had. It is not smelted where it is mined, as men and charcoal are not always procurable there.

There are three kinds of furnaces, or founderies, viz. a foundery for making ploughshares called "*Goolavena Homalah*;" a foundery for making mamooties (hoes) called "*Saneekay Homalah*;" and a foundery for making

thirds. As before mentioned, the quantity of ore for one smelting is 3 measures (weighing 29lbs. 12oz. 1dr.) and the quantity of metallic iron derived therefrom is $3\frac{1}{2}$ viss (or 10lbs. 12oz. $10\frac{1}{2}$ drs.)

And if 100lbs. of metallic iron be subjected to the smith's forging process, it will yield 33 $\frac{1}{2}$ lbs. of bar-iron. A mass of metallic iron weighing 3 to $3\frac{1}{2}$ viss will produce $1\frac{1}{2}$ viss bar-iron, (which is 3lbs. 13oz. 5drs.) the loss in the process being calculated to be two-thirds—the quantity of bar iron produced from the ore is thus 17 per cent.

No. of workers, &c.	No. I. Memo: of expenses of collecting 1st class iron dust and smelting it in the furnace for making metallic iron, for one day.	Amount.	Remarks.
		Rs. A. P.	
5	Women, will collect $37\frac{1}{2}$ measures of 1st class iron dust, if it is abundant in the vicinity of the "Sunnamaley".....	0 7 6	The ryots, (who act as miners,) and their families collect this iron dust at their own option and also conduct, themselves, the smelting process. It is no loss to them.
1	Cleaner, (N. B. 18 measures of cleaned iron dust will result.)	0 1 3	
12	Furnace coolies.....	0 3 0	
48	Measures of charcoal.....	0 2 8	
	Total.....	1 2 10	
	Memo. It gives exactly 18 viss of metallic iron in 6 masses of the description already explained, which are sold by the miners at	1 0 0	
No. of workers, &c.	No. II. Memo: of expenses of mining 2d class iron stone-ore and smelting in the furnace for making metallic iron, for one day.	Amount.	Remarks.
		Rs. A. P.	
2	Miners, (including hire for their implements and tools,) who may gather 15 baskets of iron stones.....	0 6 0	The same remark of No. I., are applicable to this.
1	Pulverizing cooly (it will come to $7\frac{1}{2}$ baskets of iron dust, each basket will hold 5 measures, total $37\frac{1}{2}$ measures).....	0 1 3	
1	Cleaner, (it will give 18 measures of cleaned iron dust ore).....	0 1 3	
2	Furnace coolies.....	0 8 0	
48	Measures of charcoal.....	0 2 1	
	Total.....	1 2 7	
	Memo. Same as above.....	1 0 0	

No. of workers, &c.	No. III. Memo: of expenses of working 6 masses of metallic iron, being 18 visses in weight, and one day's produce from a smelting furnace, for the purpose of working it to a bar-iron.	Amount.	Remarks.
		Rs. A. P.	
1	Smith 2d class.....	0 4 6	
1	Hammer man.....	0 3 6	
1	Bellows man.....	0 3 0	
30	Measures of charcoal.....	0 13 3	
1	Basket of husks of paddy.....	0 0 2	
	Total.....	0 12 5	
	Memo: It produces 6 viss of bar-iron (baraz value at $8\frac{1}{2}$ viss for Rupees 3-8-0) Rupees 2-6-4 $\frac{1}{2}$		
	Amount of cost of 1st class iron dust as per Memo. No. I..... Rs. 1 2 10		
	do. do. for working into metallic iron as per No. III.....	0 12 5 $\frac{1}{2}$	1 15 4
	do. of cost of 2d class iron dust as per Memo. No. II.....	1 2 7	
	do. do. for working into metallic iron as per No. III.....	0 12 5 $\frac{1}{2}$	1 15 4
No. of workers.	No. IV. Memo: of rates of coolies for the workmen and of prices for the materials below specified, which are considered to be sufficient.	Amount.	Remarks.
		Rs. A. P.	
	"Women coolies (to collect iron dust 1st class," including hire for their simple implements,) each at.....	0 1 6	
	Pulverizing coolies, to reduce iron stone into powder, do.....	0 2 6	
	Cleaners of iron dust..... do.....	0 2 6	
	Miners, for digging and sorting iron stone, not including hire for their tools and implements..... do.....	0 3 0	
	Furnace coolies (not including charges for furnace and bellows do.....	0 4 0	
	Blacksmiths, (working at their shops) 1st class..... do.....	0 5 6	
	do. do..... 2d class..... do.....	0 4 6	
	Hammer man (attached to a smith's shop) do.....	0 3 6	
	Bellows man (..... do.)..... do.....	0 3 0	
	Charcoal 1 Parah (of 40 measures) per Parah.....	0 1 9	
	Husks paddy 1 basket..... per Basket.....	0 0 2	

ingots of steel called "Ookeena-guttee Homalah," and a list of the 70 tools &c. used in them will be found in an appendix.

In the villages where iron is produced in this talook, the names of which have been specified in the first paragraph, there are twenty nine "Goolavana Homalah." If the business be conducted well, the quantity of iron produced in each "Homalah" per day is 20 "palahs" (bars) weighing 4 seers each, in all 84 seers equal to 2 maunds. At this rate 600 "palahs" of iron equal to 600 maunds is produced monthly, or 7,200 "palahs" equal to 720 maunds per annum. Maunds are divided into loads of 8 maunds each, so that one "homalah" produces annually 90 loads. At this calculation, the twenty nine "homalah" of this talook would produce 2,610 loads of iron annually. The "palah" or bars are 12 inches in length, 2 inches in breadth and 1 inch in thickness, and are made into ploughshares. When cut into pieces and sold to the "Ookeena-guttee Homalah" they are called "Guttee-toondoo" (ingot-pieces). The iron is sold at 8 rupees the load of 8 maunds. When the business is dull iron is produced to a less extent.

The consumption of the iron produced in this talook is to the extent of nearly 1,000 or 1,500 loads for the "Ookeena-guttee Homalah" in the Heri-hoor talook. The remaining loads are partly sold in this country and some are taken away by merchants who come from the northern countries of Guj-jaindra-gudda and Covilla-bahadara-Bunday.

Masses (of iron) are first produced in the "Kooloomay" (furnace), and pieces of ingots in the "Guttee-koolooma" (ingot-furnace).

Iron is made by the following process. In the shed or room of the furnace, called "Kooloomay-munnay" in the spot where the furnace is erected, a platform is made $1\frac{1}{2}$ yards in length, $1\frac{1}{2}$ yards in breadth and 1 yard in height. Two "balapah" stones (potstones) are buried and a mass of earth "goommee" placed thereon and plastered all round. The large bellows are fixed to the furnace, and one maund of charcoal is put into the "goommee" with half a maund of ore. Fire is then added and the bellows worked, when the smelting commences. Charcoal and ore are continued to be thrown in and the bellows worked, till five maunds of charcoal and three maunds of ore are used. The consistency of the smelted ore being ascertained, a ball of iron weighing $2\frac{1}{2}$ maunds is produced; which, on being cut into two pieces and beaten, weighs 2 maunds. If the pieces be put into the forge and converted into "palahs" (bars), 10 "palahs" each measuring 12 inches in length, $1\frac{1}{2}$ inches in breadth and 1 inch in thickness, are made to a maund, and they are sold in this state.

Steel is made by the following process by which the number of crucibles used for one smelting, is fifty-four. Two and a quarter seers of

pieces of iron ore are put into each crucible, which is then filled up with "Ooganeebullee" (the plant termed *monispermum glabrum*) and "thungadee-chuckay" (bark of the eared Cassia—*Cassia Auriculata*) and plastered over with earth. The fifty-four crucibles are then piled one upon the other, charcoal filled in, fire added and the bellows worked. The consistency of the smelting being ascertained, the crucibles are removed, cooled with water and broken; when round balls of steel weighing $1\frac{1}{2}$ and 2 seers each are found in most of the crucibles, some of which however are spoilt.

Two specimens of the above iron and steel are sent (marked A. and B.) (A.) one iron "palah" (bar) (Canteray Fanams 0-4 $\frac{1}{2}$ vis (B.) one steel ingot (Canteray Fanams 0-10 $\frac{1}{2}$ vis.

The price of the second sort steel ingot is two annas.

No iron is imported into this Talook from any foreign Division or Talook.

The articles made in a "Goolavana-Homalah" are, "palah" (bars), pieces for making steel, and ploughshares. Nothing else is made.

The articles made in a "Saneekay-Homalah" are

"Saneekay" (Mamootie hoe,) "Tavah" (Frying pan,) "Careeyoovah Balmay" (Frying pan,) "Coodah" (a thick flat plate of iron, put on the bottom of an instrument used for clearing noxious roots, weeds, &c. from standing corn, and levelling ploughed grounds,) "Atchoo" (cart axles,) "Halee" (plates used as fellics for cart wheels.

At the village of Peratahmala-Singunnahullee, in the Heri-hoor Muttadoo Talook are made

"Doda Copreegay" (large boiler or caldron)

"Goondahloo" (globular water tub)

The "Copreegay" is large and shaped like a "balmay" (frying pan.)

Models of the undermentioned eight articles are sent.

"Saneekay" (marked C.)

"Careeyoovah Balmay" (D.)

"Atchoo" (E.)

"Goodlee" (F, native pickaxe.)

"Yellay Goodlee" (G. flat pointed pickaxe)

"Hunchoo" (H.)

"Coodah" (I.)

"Halee" (J.)

The above Models cost two Rupees.

* ("Hunchoo" and "Tavali" are synonymous.)

Talook.	Village.	No. of Furnace.	List of each Furnace.	
Koormenaad....	Naddavoor.....	1	Chekalote. - - - - -	The expense of erecting a furnace with a shed over it is 5 Rs. The cost of working furnaces per month is from 10 to 30 Rs. according to size.
	Mummanda.....	1	Nummanda. - - - - -	
	Coonathra.....	2	Modakalloor. - - - - -	
Shernaad.....		1	Olavatoor. - - - - -	Ditto. do. do. do. is 6 Rs. cost of working a furnace per month about 20 Rs.
Walloowanaad.	Nemany.....	2	Thotingal-paramba. - - - - -	The expense of erecting a furnace with a shed in the Nemany, Wallamboor, Arakaparamba, Chethalloor, Pandekad, Kareavutty, and Mangada Villages is 10 Rupees. In the Arakoorshy and Thachampara Rs. 16-15-5 The cost per month of working a furnace average from Rs 17 to 52 according to the size of the furnace.
		2	Coondala.....Do. - - - - -	
		2	Cholaka.....Do. - - - - -	
		2	Vallam.....Do. - - - - -	
		2	Palanjerry...Do. - - - - -	
		2	Vadakythro...Do. - - - - -	
		2	Areepoothoo...Do. - - - - -	
	Wallamboor....	2	Chengotoothodyyaga parambil. - - - - -	
		2	Anakalingul. - - - - - Do. -	
		2	Kelcarany, - - - - - Do. -	
		2	Kotalam. - - - - - Do. -	
	Arakoorshy....	2	Manamputta. - - - - - Do. -	
		2	Karara coonoo. - - - - - Do. -	
		2	Poolapoo. - - - - - Do. -	
	Chethalloor....	1	Thotoopulla. - - - - - Do. -	
	Pandekad.....	2	Kakad. - - - - - Do. -	
		2	Moondoo. - - - - - Do. -	
	Kareavutty....	2	Punthapoolapil. - - - - - Do. -	
		2	Thoty kolam. - - - - - Do. -	
		2	Arneka. - - - - - Do. -	
		2	Karayil. - - - - - Do. -	
	Mongada.....	2	Pulle. - - - - - Do. -	
		2	Kurreekakodu. - - - - - Do. -	
		2	Poolakooy. - - - - - Do. -	
		3	Choongathoo. - - - - - Do. -	
		2	Parookoondeo. - - - - - Do. -	
		2	Pandakakoonathoo. - - - - - Do. -	
		2	Karaparambil. - - - - - Do. -	
		2	Punthee koonoo. - - - - - Do. -	
		1	Munnallee. - - - - - Do. -	
		2	Karodykoonoomil. - - - - - Do. -	
	Thachampara..	2	Parakathadom. - - - - - Do. -	
		2	Alinjul. - - - - - Do. -	
		2	Machanthootingul. - - - - - Do. -	
		2	Walapanil. - - - - - Do. -	
		1	Vanaddy. - - - - - Do. -	
Ernaad.....	Allangoor.....	1	Ellamburra. - - - - - Do. -	In this Talook the expense of erecting furnaces varies from 12 to 5 Rs. each. The cost of working a furnace per month is about Rs. 52.
	Changara.....	2	Changara. - - - - - Do. -	
	Orovoor.....	4	Orovoor. - - - - - Do. -	
	Mangerry.....	2	Pandaloor. - - - - - Do. -	
	Tricalangode...	1	Karryend. - - - - - Do. -	
Temalapooram.	Allatoor.....	1	Tricalangode. - - - - - Do. -	The expense of erecting furnaces in the Temalapooram Talook is 24 Rupees in the Vadakanjerry village, and Rupees 48, in the other two Villages. The cost of working the furnaces per month is from 2½ Rupees to 28 Rupees according to size.
		1	Thalayankadoo. - - - - - Do. -	
		1	Mooreepara. - - - - - Do. -	
		1	Kedakoonoo. - - - - - Do. -	
	Vadakanjerry..	1	Agathie. - - - - - Do. -	
		1	Panangodu. - - - - - Do. -	
		3	Nadavanjerry. - - - - - Do. -	
	Vadavanoor....	1	Nadapathie kelaka. - - - - - Do. -	
		1	Mambakam. - - - - - Do. -	
		4	Nadavancherrycolleyil. - - - - - Do. -	
		1	Kadancoorchey. - - - - - Do. -	

(Signed) H. CONOY, Collector.

Iron "homalahs" (founderies) have long existed in this talook.

The "Goolavena Homalah" and "Saneekay Homalah" employ persons on salaries, to go to the jungles, cut down trees, burn charcoal and fetch it. Charcoal is not separately purchased by these two founderies, the people of the "Ookeena-quttee Homalah" purchase charcoal.

There are no forests particularly near, in consequence of trees being cut down year after year and charcoal made from them. Trees have to be felled at a distance and charcoal made and brought. One man makes four baskets of charcoal a day, or, eight krishtaraja kolagahs, each basket holding two kolagahs.

The blacksmiths of this talook do not understand working English iron as well as the iron of this country which they prefer.

The wages paid to the blacksmiths in this district, are 2, 3, or 4 annas $\frac{1}{2}$ day according to their work.

One hundred pounds weight of ore on being smelted, yields a ball of iron weighing $83\frac{1}{2}$ pounds. This ball or mass is called an "Ahdeegay."

If the ball weighing $83\frac{1}{2}$ pounds and produced by the smelting of 100 pounds weight of ore, be cut, put into the forge and converted into "palahs" (bars), $32\frac{1}{2}$ pounds weight of good iron is obtained and 51 lbs. weight of dross falls off.

Two specimens of "thooree-gulloo" (sifted ore) and ahyce-gittah (picked scoria or lamina of smelted iron) are sent (marked K and L.)

APPENDIX TO THE CHITTLEDROOG DIVISION.

Tools, &c.—Thirty-four tools or apparatus are used in the "Goolavena Homalah," viz.

- 1 "Doda Iklah" Large tongs, for holding masses of smelted iron in the forge.
- 1 "Satoogah" Iron ladle, for pushing burning charcoal into the furnace.
- 1 "Sareegoloo" Iron rod, for ascertaining the consistency of iron, while smelting in the forge.
- 1 "Oojoovalree" An iron plane for scraping the furnace of the forge.
- 2 "Chamategay" Two iron sledge hammers for beating masses of smelted iron when removed from the furnace of the forge.
- 2 "Doda Kodlee" Two large iron axes for cutting iron masses.
- 2 "Homalada Teedee Lahlah" Two iron tubes fitted into the forge to receive the bellows tubes.
- 1 "Moosay" Earthen crucible.
- 2 "Teedee Lahlah" Two bellows tubes.
- 2 "Iklah" Two tongs: one, for re-heating the halves of the masses of iron in the furnace; and the other for holding the pieces that have been heated.
- 1 "Chukkay Iklah" Tongs for holding the iron beaten on the anvil.
- 1 "Kudday Iklah" Tongs to be held by two persons for holding the iron masses after being heated.
- 1 "Moordenah Iklah" Crooked or bent tongs for holding iron made into ingots.
- 1 "Doda Moordenah Iklah" Large crooked or bent tongs for holding and heating anvils, sledge hammers, &c.
- 1 "Sunnah Iklah" Small tongs for making ploughshares, &c.
- 1 "Uddeegulloo" An iron anvil, buried in the earth, to place iron on while being beaten.
- 4 "Chamategay" Four sledge hammers for beating heated iron on the anvil.
- 1 "Sootegay" A hammer for shapening the edges.
- 2 "Kodlee" Two axes for cutting iron, heated in the forge.
- 2 One "Sareegoloo" and one "Bokugoloo" Two pokers used for pushing charcoal into the furnace and for clearing the bellows pipes to prevent them being choked with smelted ore.
- 4 "Chunday Teedee" Skin bellows, two large and two small sized.
- 34 Total number of tools or apparatus.

There was no road along the banks of the Brahmenec, but an irregular and narrow footpath; indeed there were no hackery roads at all. The only road of any consequence was that leading from Cuttack through Dhenkennal-gurh, past Kurugpursad and Mungulpoor, and on to Boad; it is tolerably wide and smooth, and is much frequented by Bunjaruhs, who bring cotton, iron and turmeric in return for salt and tobacco. From Mungulpoor, onwards, the road is nearly due east and west.

REMARKS ON THE WATER CARRIAGE FOR COAL, &c. &c.

The Brahmenec is navigable for good sized boats from the end of June to the middle of December, and sometimes later. Coal could be laden in small canoes and conveyed to Kurugpursad at most seasons of the year indeed. The Dhenkennal boatmen assert that small boats only can navigate the river above that place at any season owing to the numerous rocks; this is however not to be relied upon, for there are but few, which could be removed at a trifling expense.

From Kawatbund (at the edge of the plains) boats and rafts are floated down that branch called the Kursoca. He further remarks:

"The furthest point towards the sea to which the coal could be taken is Hunscoogola, where large sloops anchor. It would be preferable to make this place a depôt, Auligurh being many miles further up the river. It is to these places that Messrs. Beetsen's sloops come for salt. There is a bankshill belonging to them at Aul, where sloops are built and repaired. The timber is cut and purchased in Dhenkennal, where it is very cheap, and may be had of any size and quality, viz. Sal, Sissoo, Bijesul, Kurumb, Girahn, &c. A native contractor offered to carry the coal from Talcheer to Hunscoogola, at the rate of twenty-five rupees per 100 maunds, or four annas per Maund; the boats making three trips each season. The lading is included in this amount. Mr. Beetsen however informs me that it could be done for one anna per maund, or at the utmost, two annas.

From Hunscoo Mr. Beetsen would contract to carry the coal to Calcutta, or to any part lower down the coast; and from his experience of the natives of Orissa, and his industrious habits, I should venture to recommend any contract for the working of the mines or transport of the mineral to be offered to him.

The iron mines are worked by the different traders, who give grain, tobacco, and salt to the value of one rupee per maund of metal. Should the coal mines be worked eventually, it would be necessary to pay for the labour in like manner, for money is unknown to the lower orders; towries alone are current, and there is a great scarcity of them even. Although there are

but few inhabitants, many poor people from the surrounding states would flock to earn food, if proper protection be afforded them. Some difficulty would be experienced at the outset, but that would soon subside."

ON THE TALCHEER COAL.

"That which I shall distinguish by the appellation of "Talcheer Coal," is found near the town and gurh of that name; the town gives name to the whole district, which is 14 Ooreya coss in circumference or forty-two English miles, more or less.

Talcheergurh (the Raja's stockaded palace) and town (called Patna) are situated on the south bank of the river Brahmenec, on a sandstone rock rising to the height of 20 or 30 feet from the level of the water. The surrounding country is undulating, with a thin stratum of soil resting on shingle, composed of the debris of primitive rocks, iron clay, jasper, &c. Half a mile or less above the gurh, is a small nullah called, "Billajjooree," about fifteen yards wide, with a sandy bed, and dry except in the rainy season after heavy falls in the interior, where it takes its rise and winding considerably joins ultimately with the Brahmenec at this place.

About 40 yards from the mouth of the nullah, coal seams are exposed to view for some distance along the banks, alternately on either side; these seams vary in quality and thickness, and are curved paralld with the undulations of the superstrata. In almost every place where the coal seams cease abruptly, they will be found to rest against the sandstone.

The superstrata generally consist of alluvial soil, shingle, marl, blue clay passing into peat, mixing with shale and coal of inferior quality, beneath which the good coal is found; this again rests on indurated blue clay containing particles of coal, mica, and fossil plants. The stratum is about 1½ foot thick, beneath which a stiff grey clay mixed with sand mica, is found.

I made a perpendicular cut in the north bank, at a spot where inferior specimens had been collected by workmen sent some years ago by Mr. G. Becker, Executive Officer of the division. Having dug down for two or three feet below the surface of the bed of the nullah, I met with a hard blue rock containing particles of coal and fossil plants; in this I bored a hole 1½ feet deep, and blasted it with one pound of country powder, which enabled me to ascertain the thickness, viz. 1½ foot as before said.

The section thus afforded, gave:	10 feet.
Shingle and clay averaging.....	1½ feet.
Blue clay passing into peat.....	1½ feet.
Shale, or slaty coal and lignite.....	1 to 1½ feet.
Good glistening coal.....	

Twenty tools or apparatus are used in the "Sancekay, Homalah" viz.

- 1 "Iklah" Tongs for holding masses called "Kittada Kalwala" (that is masses of scoria or lamina of smelted iron.)
- 1 "Kahso Iklah" Tongs for heating.
- 1 "Doda Moordena Iklah" Large bent tongs.
- 1 "Tagadena Iklah" Flat tongs.
- 1 "Sunna Moordena Iklah" Small bent tongs.
- 1 "Sunna Iklah" Small tongs.
- 1 "Sutteegah" Ladle for clearing away ashes.
- 2 "Teedee Lahlah" Two bellows' tubes.
- 4 "Chamategay" Four sledge hammers.
- 2 "Kodlee" Two axes.
- 1 "Uddeeguloo" Anvil.
- 1 "Bokusgoloo" Poker.
- 1 "Sareegoloo" Poker.
- 2 "Sootegay" Two hammers.
- 20 Total number of tools.

Sixteen tools or apparatus are used in the "Ookeena guttee Homalah" viz.

- 4 "Chukkay Iklah" Flat tongs.
- "Konedee Iklah" Bent tongs.
- 2 "Sutteegah" Two ladles for pushing charcoal.
- 1 "Sareegoloo" Poker.
- 1 "Sahrah hareeyo Chooree" Knife for removing smelted ore dirt that accumulates in the bellows' tubes.
- 1 "Hy-bahchee" Hand-axe.
- 1 "Booda Chamategay" Sledge hammer, used for cutting masses of iron.
- 1 "Sootegay" Hammer, for breaking crucibles.
- 1 "Sunna Iklah" Small tongs.
- 2 "Teedee Lahlah" Bellows' tubes.
- 2 "Teedee Chnnday" Bellows.
- 16 Total number of tools, or apparatus.

The above enumerated tools or apparatus amount in all to seventy in number. Fac-simile drawings of the same, as furnished by the Amildar are appended.

It may be mentioned that the expense of erecting the several furnaces is as follows, for building two rooms for a "Goolavena Homalah" 10 yards in

length, 4 yards in breadth, with walls all round, including posts, rafters, bamboos, thatching with leaves and covering with bamboo mats, Rupees 4.

For building one room for a "Sancekay Homalah," 5 yards in length and 2½ yards in breadth, as aforesaid, Rupees 2.

For building one room for a "Ookeenaguttee Homalah," 12 yards in length, 5 yards in breadth, with strong walls all round, good beams, 'couple,' rafters, bamboos, two-thirds of the roof covered with tiles, one-third with grass, including doors, &c., Rupees 60.

The detailed cost of working the furnaces will be found appended, but in stating the cost per month of working the several furnaces, it is necessary to mention that it is customary to secure the services of efficient men by making them advances of money, which remain due by them during the time they continue in employ, and are recoverable from the parties only when they vacate their situations.

COST OF WORKING A "GOOLAVENA HOMALAH."

Advances.

	Rs.	A.	P.
To the "Homalegah" (forgeman) who smelts the ore.....	60	0	0
To 3 persons to assist him in blowing the bellows at 20 Rs. each.	60	0	0
To 1 man who fetches ore from the mine.....	60	0	0
To 4 men who supply the furnace with charcoal at 30 Rs. each.	120	0	0
To 1 man who digs the ore.....	12	0	0
To 1 "Kummahroo" (blacksmith).....	60	0	0
To 4 sledge hammer men, at 30 Rs. each.....	120	0	0
To 2 bellows men at 10 Rs. each.....	20	0	0
To 2 men who burn charcoal (that is burn wood into charcoal) and fetch it at 30 Rs. each.....	60	0	0

Total of advances Rupees..... 572 0 0

Monthly Salaries.

To 1 man called "Homalegah" (forgeman).....	2	0	0
To 3 men, assistants at 1½ Rs. each.....	4	8	0
To 1 man, who carries the ore.....	3	8	0
To 4 men, who load and fetch charcoal at 1½ Rs. each.....	5	0	0
To 1 man, to dig for ore.....	1	4	0
To 1 blacksmith.....	3	8	0
To 4 sledge hammer men, viz., 2 men at 1½ Rs. each....	3	8	0
2 men at 1½ Rs. each....	3	0	0
To 2 bellows men at 1 R. each.....	2	0	0

C.

List of Iron tools &c. and their prices.

Number.	Particulars.	per each.	Value.	Remarks.
<i>Weapons.</i>				
1	Musket (country).....	1	6 0 0	No. 1. When the lock and barrel are all complete a musket will cost nearly 15 rupees, but this is the average price.
2	Matchlock.....	1	6 0 0	No. 2. When these are of superior quality the cost for a matchlock will be nearly 10 Rs.
3	Agooda cutty (workknife)....	1	0 12 0	No. 3. A workknife set with brass and neatly done will cost about 2 Rs.
4	Todangan cutty (a knife somewhat larger than the pishan cutty).....	1	1 0 0	No. 4. do do do.
5	Sword.....	1	2 0 0	
6	War hatchet.....	1	0 8 0	
7	Spear (triangular blade).....	1	0 8 0	
8	Do (flat do).....	1	1 0 0	
9	Peshan cutty (common knife).....	1	0 4 0	
10	Kathina (small gun).....	1	1 0 0	The price of a large kathina will amount to about 4 or 5 rupees.
<i>Agricultural Tools.</i>				
11	Mamoty (with handle).....	1	0 5 0	
12	Padana kaykot (a species of mamoty).....	1	0 5 0	
13	Coulter.....	1	0 2 3	
14	Mud wall knife.....	1	0 1 0	
15	Scythe.....	1	0 2 0	
16	Hoee.....	1	0 3 0	
17	Axe.....	1	0 3 0	
18	Hatchet.....	1	0 3 0	
<i>Utensils.</i>				
19	Iron urooly.....	1	6 0 0	This capable of boiling 3 measures of rice; for a large urooly capable of boiling 2 parras of rice; the price is 15 rupees.
20	Koriga (iron ladle for serving rice).....	2	0 4 0	The cost for a large one is 1/4 a rupee.

List of Iron tools &c. and their prices.

Number.	Particulars.	per each.	Value.	Remarks.
21	Chatagom (flat ladle for roasting cakes).....	1	0 1 6	The price for a large one is one rupee.
22	Karandy (spoons).....	1	0 1 0	Do do 5 annas.
23	Iron pans.....	1	0 2 3	Do do 8 do.
24	Do oil do.....	1	0 2 0	
25	Do do measure (cooty).....	1	0 8 0	For a large and neatly done cooty the price will be nearly 2 rupees.
26	Do lamp.....	1	0 2 0	
27	Do hand lamp.....	1	0 2 0	
28	Do hanging do.....	1	0 4 0	
29	Do grater.....	1	0 1 0	
30	Do hand do.....	1	0 0 3	
31	Do round betel box.....	1	0 7 0	This is of the common kind, but for a stronger and neatly done box, the price will be about 2 Rs.
32	Do oil ladle.....	1	0 0 4	
33	Do stile or iron pen with a knife at the end.....	1	0 3 0	
34	Do do without do.....	1	0 2 0	
35	Rice pounder pestle.....	1	0 2 0	
36	Betelnut cracker.....	1	0 4 0	
37	Choondan katty (betelnut knife).....	1	0 6 0	
38	Door lock with cross bar....	1	0 8 0	A large one will cost one Rupee.
39	Round locks (similar in shape to letter locks but larger in size).....	1	0 4 0	Do do 2 Rs.
40	Carry katty (cookroom knife).....	1	0 0 6	
41	Razor.....	1	0 1 6	
42	Elephant chain weighing 1 md.	1	5 0 0	The price of a large Elephant chain weighing 5 mds., is nearly Rs. 25.
43	Chisel } Do narrow } Do small }	3	0 8 0	
44	Adze.....	1	1 0 0	
45	Saw.....	1	5 0 0	
46	Dog chain.....	1	0 4 0	
47	Nails of 5 kinds.....	5	0 1 6	
48	Door hinges.....	1	0 4 0	
49	Iron fastening for door.....	1	0 1 0	

	Rs.	A.	P.
To 2 men who burn charcoal and fetch it at $1\frac{1}{4}$ R. each.....	2	8	0
To 1 extra man.....	2	4	0
20 servants or workmen.....	33	0	0
To monthly interest payable to the money lender from whom the amount of advances viz., Rs. 572 is borrowed, at 2 per cent. per mensem.....	11	6	$8\frac{1}{2}$
To proportion of monthly cost for skin bellows, four pairs being used annually, that is, two pairs half yearly at 2 Rs. per pair.	1	5	4
Total Rupees.....	45	12	$0\frac{1}{2}$

No expense is incurred for tools, as these are made by the workmen at the several foundries.

COST OF WORKING A "SANEKAY HOMALAH."

Advances.

To 1 man, who fetches "Homalada Kittah" (scoria or lamina of smelted iron of the foundry), "Thooree Gulloo" (sifted ore) and "Davanada Booraday" (dross accumulated at the furnace).....	20	0	0
To 4 men for working the sledge hammer and bellows at 30 Rs. each.....	120	0	0
To 1 blacksmith.....	60	0	0
To 2 men who burn charcoal at 30 Rs. each.....	60	0	0
Total of advances Rupees.....	260	0	0

Monthly Salaries.

To 1 man, who fetches "Kittada Kulloo" (masses collected from scoria or lamina of smelted iron).....	1	12	0
To 4 sledge hammer men.....	8	0	0
To 1 blacksmith.....	5	0	0
To 2 men who burn charcoal and fetch it at $1\frac{1}{2}$ Rs. each.....	3	0	0
8 servants or workmen.....	17	12	0
To 18 baskets of "Ahyee gulloo" (picked ore), "Thooree gulloo" (sifted ore) and "booraday" (dross), purchased monthly and brought from the "Goolavena Homalah," each basket holding $\frac{3}{4}$ maund, at $1\frac{1}{2}$ annas per basket.....	1	11	0

	Rs.	A.	P.
To picking and fetching twelve baskets of "Ahyee kittoo" (picked scoria or lamina of smelted iron) monthly at two annas per basket.....	1	8	0
To proportion of monthly cost, for cloths given annually to the proprietors of three "Goolavena Homalah," the "Kittoo" &c. of which are required for one "Goodalee" Homalah, at 8 Rs. for each proprietor's cloths.....	2	0	0
To interest payable on Rs. 260, the amount of advances at 2 per cent per mensem.....	5	3	$2\frac{3}{4}$
To 4 pairs skin bellows as detailed above.....	1	5	4
Total Rupees.....	29	7	$3\frac{1}{4}$

COST OF WORKING A "GOOLEENA GUTTEE HOMALAH."

No advances are made.

Monthly Salaries.

To 5 bellows men at Rs. 1 14 each.....	11	4	0
To 1 man, to assist in work, according to the wishes of the "Moktasur" (superintendent).....	2	0	0
To purchase of charcoal at nine cawry loads per day, each measuring 12 Krishtnaraja Kolagahs, aggregating 5 candies and 8 kolagahs, at 2 annas per load, for one month.....	33	12	0
To 21 Krishtnaraja candies of paddy husk per mensem; being at $1\frac{1}{4}$ kolagahs per day for 75 crucibles; at the average of 12 loads of $\frac{3}{4}$ candy each of husk for 1000 crucibles, at 3 Annas 4 Pic per load or Canteray Fanams $10\frac{1}{2}$ viss for 14 kolagahs, in all Canteray pagodas 1-3-12 $\frac{1}{2}$ or Rs.....	5	13	$0\frac{1}{2}$
To 2,250 pieces of iron, at 75 pieces per day @ 24 Rs. for 75 pieces.....	67	8	0
To four pairs of bellows, at the average rate.....	1	5	4
To 2,250 crucibles at 10 Rs. per 1,000.....	22	8	0
Total Rupees.....	144	2	$4\frac{1}{2}$

Three maunds of ore and five maunds of charcoal are used for one furnace in a "Goolavena Homalah."

* Goodalee Homalah and "Saneekay Homalah" are synonymous.

the limits of the hamlets *Mundhalapully*, *Goruntla* and *Goomiahgarreepully*, of the village of *Maidereddypully* on both sides of the river *Chithravuthee*. (No. 20.)

In the *DHURMAVER TALOOK*—there are the following fifteen sites for ore, viz. (a) In the nullahs of *Yanamaladoddy* (No. 21.) (b) *Thoomakootah* (No. 22.) (c) *Panpully* (No. 23.) (d) *Mannanaihenkully* (No. 24.) (e) *Bes-therpully* (No. 25.) (f) *Dhavahdoolabetta* (No. 26.) (g) *Kyraiwoo* (No. 27.) (h) *Narranapoorum* (No. 28.) (i) *Ferraboraypully* (No. 29.) (j) *Lutchumpully* (No. 30.) (k) *Koondhurpy* (No. 31.) (l) *Panlawoy* (No. 32.) (m) *Moorapully* (No. 33.) (n) *Bussahpoorum* (No. 34.) (o) *Garadapoorum* (No. 35.)

The following sites in the *MYSORE COUNTRY* are convenient for manufacturing iron; in the *Muduckseerah talook* situated on the borders of the *Bellary District*. (a) In a village of *Ferragoondah talook*, *Muddigirry*, gravelly iron ore exists, (No. 36) also (b) *Banherolee talook*, *Muddigirry*, (No. 37) the ore being found in small quantities in the rivulets.

The quantity of ore that can be collected varies greatly. In the hill of the village of *Jummanathahully*, &c. in the *KOODLEGHEE TALOOK*, a man by gathering or digging is able to collect two buffalo loads or about eight maunds of ore in one day.

In the *HURPONHULLY TALOOK* a man collects 4 baskets of ore in a day; each basket containing a maund, the quantity collected being estimated by measuring it in pits about two yards deep calculated to contain 4 maunds.

In the *KOODLEGHEE TALOOK* the owners of each of the 5 or 6 furnaces send out one man from each furnace, each man taking with him a pick, a spade, two baskets, and two buffaloes or bullocks with pack saddles. In the mine, they dig and gather the ore in baskets, and pass them by hand along the narrow passage to the entrance outside and placing 6 maunds of the ore in the pack saddles of each bullock, 12 maunds are conveyed to each furnace in a day.

At the mines, in the *HOOVINHUGGALY TALOOK* the ore is conveyed in bags on bullocks, each man gathers two baskets full in a day, and each basket contains about 3 maunds.

There are only two persons in the *RAIDROOG TALOOK*, constantly employed in gathering iron sand, they each have a bullock, and convey the sand to the nearest water where they place it in heaps about three or four feet from the water, they then with little pots pour water on the iron sand, and in three or four washings sweep away all the sand into a pit. The fourth washing leaves 3 baskets of good black iron ore, each basket weighing 2 seers, making 16 seers in all as the gather of one man and a bullock in a day: the same process is adopted in the *DHURMAVER TALOOK*.

List of Iron tools &c. and their prices.

Number.	Particulars.	per each.	Value.	Remarks.
50	Iron oerly with handle.....	1	0 5 9	
51	Tooth picker.....			
	Ear picker.....			
	Tweezer.....	4	0 1 0	
	Knife sharper.....			
52	Hammer.....	1	0 2 3	
53	Anvil.....	1	0 2 3	
54	Tongs.....	1	0 0 8	
55	Sledge hammer.....	1	1 0 0	
56	Small tonga.....	1	0 3 0	
57	Do. sledge.....	1	0 4 0	
58	Smaller do.....	1	0 1 0	
59	Hinges and hooks for door and windows.....	2	0 4 0	
60	Poker.....	1	0 6 0	
61	Choorkookoo (another description of Poker).....	1	0 8 0	
	<i>Iron Pounders.</i>			
62	Large sledge hammer weighing 1 md.....	1	4 0 0	
63	Small do.....	1	0 8 0	
64	Smaller do.....	1	0 4 0	
	<i>Iron Vints for Bellows.</i>			
65				
66				
67	Value of $\frac{1}{2}$ lb. of the 4 sorts of Iron procurable at the different works and Iron ore.....	0	2 0 0	
68	Amount probably required for purchasing certain other tools (the names of which cannot be ascertained and procurable at the fair) to be included in this list.....	0	2 4 6	
	Total....		50 0 0	

(Signed) H. CONOLLY,
Collector

Grey rock with fossils and coal	1 foot.
Ditto ditto with mica	6 inches.
Stiff grey clay with mica and sand (?)	

Digging a few feet apart from this spot, in the bed of the nullah, the coal was three feet below the surface, without the pent and clay, &c., and under the opposite bank the coal is several feet deeper still.

I burnt a heap consisting of several maunds of the different kinds mixed together, the whole was consumed, leaving fine white ashes, but no cinder or coke. The glistening or good qualities emitted much gas, and burnt with a bright flame; the remainder soon attained a red heat with less gas—the whole gave out an intense heat.

The bed of coal thus examined is (as will have appeared) very thin, but I should think that on mining, any quantity could be obtained, and at little cost, from its being so near the surface, and labor cheap in the extreme. It possesses further great advantages in being so near to a navigable river.

I shall treat hereafter on the method of working the mines, and of transporting the coal, &c., in a separate paper at the close of my report."

Coal fields of the Hingolai Taccoorance at Mungulpersad.—Of the two coal fields exposed to view, and which were visited by me, that which I have called the "Taccoorance" is the more extensive. It is laid bare by a broad nullah passing through it, called the "Sungurra" it comes from the hills in Ungool, in a south-westerly direction, and is about thirty yards wide, having a sandy bed. The coal appears on either side alternately, for a distance of upwards of a mile, the beds averaging from five to fifteen feet and more in height from the level of the sand. This coal (like that at Talcheer) rests against the sandstone, and in some places passes into it apparently mixing with it. The quality of the mineral varies very considerably, as will be seen by the numerous specimens presented to the Committee.

In one spot the coal has apparently been reduced to ash, by volcanic action for a space of fifty yards, and upheaved above the common level of the contiguous beds; it is bounded at each extremity by dykes of white rock.

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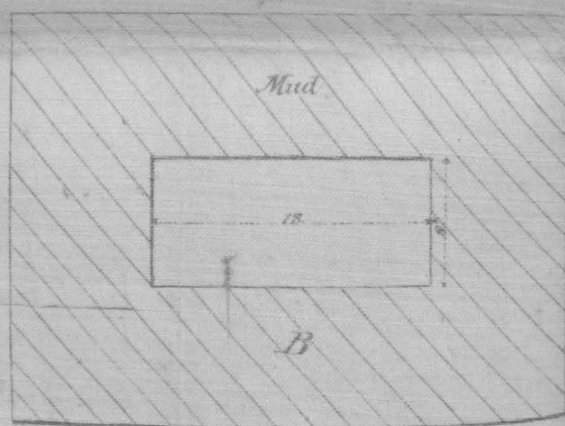
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Malabar



A. Vertical Section of a native Smelting Furnace.
B. Horizontal Section of Charging Mouth.

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In the PENGONDAH TALOOK, in the rainy season, one man can gather about 7 seers of iron sand from different parts of the rivulets in one day.

In the KODECONDAH TALOOK, when it rains hard one man can gather about 1½ pucks seers in a day, the sand is then carried off in the stream of the brook and the ore left: the fine sand is subjected to the same process as in the Rairdoo talook and it is the same in the Maduckseerall talook.

Furnaces.

In the KUMPLY TALOOK, in the village of Camalapoor, there are eight furnaces and the iron sand ore is brought from a distance of five miles.

In the HURPONHULLY TALOOK—there are eleven villages with furnaces viz., *Kullahully*, on the west side of the village, there are seven furnaces, the iron ore being brought from two places five miles distant. *Rungapatnam*, on the south side of the village there is one furnace the iron ore being brought from three places, four miles distant. *Gurbagoody*, in front of the *Hunmuntaroy* Pagoda, towards the east front of the village, there are two furnaces to which the iron ore is brought from two places two miles distant. *Khanahully* near the village on the east side there is one furnace the iron ore being brought from four places one mile distant.

There are sixty-three furnaces in the KODLEGHEE TALOOK of which the following sixty are large viz.

Thomaragoody, one furnace, the iron ore being brought from six places eight miles distant.

Ferrinahully, two furnaces, the iron ore being brought from six places seven miles distant.

Thonaseckerry, three furnaces, the iron ore being brought from six places nine miles distant.

Yerradhaminahully, three furnaces, the iron ore being brought from six places ten miles distant.

Kanakapoorum, one furnace, the iron ore being brought from six places eleven miles distant.

Thagadahaul, two furnaces, the iron ore being brought from six places ten miles distant.

Selliappanahully, five furnaces, the iron ore being brought from six places fourteen miles distant.

Kanganahully, four furnaces, the iron ore being brought from six places fifteen miles distant.

Thokainahully, eight furnaces, the iron ore being brought from six places fifteen miles distant.

Goodakodah, one furnace, the iron ore being brought from six places eighteen miles distant.

Chellamainhully, two furnaces, the iron ore being brought from six places sixteen miles distant.

Mahdhavapoorum, seven furnaces, the iron ore being brought from six places twenty miles distant.

Siddaygullool, two furnaces, the iron ore being brought from six places twenty miles distant.

Chendrasaiahkopoorum, two furnaces, the iron ore being brought from six places twenty miles distant.

Cantrahully, one furnace, the iron ore being brought from six places twenty-two miles distance.

Dhibadhahully, one furnace, the iron ore being brought from six places twenty miles distance.

Woolavasunkatahully, three furnaces, the iron ore being brought from six places twenty-two miles distance.

Pooroborankhully, one furnace, the iron ore being brought from six places twenty-three miles distance.

Soonkanahully, three furnaces, the iron ore being brought from six places twenty-four miles distance.

Maramanahully, one furnace, the iron ore being brought from six places twenty-three miles distance.

Ankamanahaul, two furnaces, the iron ore being brought from seven places six miles distance.

Keeryagunahully, two furnaces, the iron ore being brought from seven places nine miles distance.

Somalapoorum, two furnaces, the iron ore being brought from seven places six miles distance.

Kokoopah, one furnace, the iron ore being brought from seven places eighteen miles distance.

There are also three small furnaces which re-smelt the refuse of the larger furnaces, viz. at *Pooraborumhully*, *Noowhanahully*, *Maramanahully* there is one furnace each and the refuse is brought from Thokanahully seven miles off; Siddaygullool six miles; Mahadhavapoorum eight miles; Selliapanahully ten miles.

There are seventeen furnaces in the HOOVINHUDGALY TALOOK viz., at

Chilakanahully, four furnaces, the iron ore being brought from eight places five miles distance.

Grey rock with fossils and coal	1 foot.
Ditto ditto with mica	6 inches.
Stiff grey clay with mica and sand (?)	

Digging a few feet apart from this spot, in the bed of the nullah, the coal was three feet below the surface, without the peat and clay, &c., and under the opposite bank the coal is several feet deeper still.

I burnt a heap consisting of several maunds of the different kinds mixed together, the whole was consumed, leaving fine white ashes, but no cinder or coke. The glistening or good qualities emitted much gas, and burnt with a bright flame; the remainder soon attained a red heat with less gas—the whole gave out an intense heat.

The bed of coal thus examined is (as will have appeared) very thin, but I should think that on mining, any quantity could be obtained, and at little cost, from its being so near the surface, and labor cheap in the extreme. It possesses further great advantages in being so near to a navigable river.

I shall treat hereafter on the method of working the mines, and of transporting the coal, &c., in a separate paper at the close of my report."

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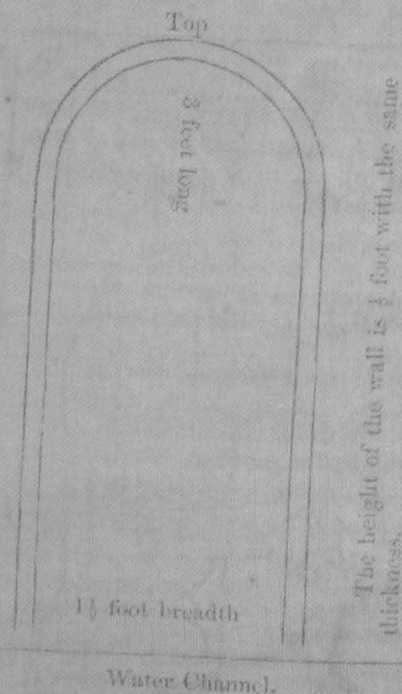
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No. 1.

A rough sketch of an earthen trough with a very gentle slope from the top. This continues in use for many months.



An estimate of expenses to construct an earthen trough.

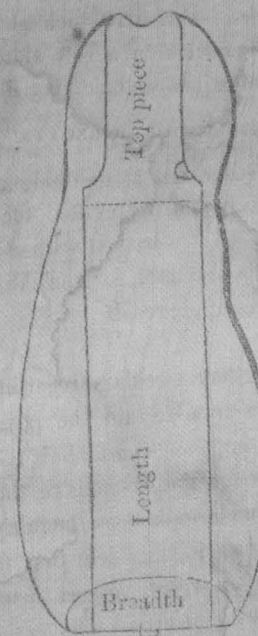
	Rs.	As.	P.
$\frac{1}{2}$ Bricklayers.....	0	2	3
$\frac{1}{2}$ Man Cooly.....	0	1	3
Total Annas..		3	6

No. 2.

A rough sketch of a smelting furnace made of sun dried clay, composed of 2 pieces, the top piece resembling a circular jar and the under piece of a square form.

The top piece measures in length 1 foot and 5 inches and thickness 1 inch, and the under piece 1 foot and 10 inches long and thickness 2 inches: inside contents of the former in circular measurement 51 inches, and the latter is 8 inches across. The under piece is first fixed on the ground, which is previously dug of the proper size, and then the top piece placed on it and plastered over with mud of a thickness from 2 inches at the top to 6 at the bottom, the whole in a circular form.

There is an opening at one side of 8 inches in height and one foot in breadth, at the bottom of the furnace which is closed before the smelting is commenced, leaving a small hole to admit bellows and opened after it is completed to enable the metallic mass to be taken out.



An estimate of expenses for constructing a smelting furnace.

	Rs.	As.	P.
For 1 top piece of a furnace.....	0	1	6
1 Under piece do.....	0	2	6
Plastering over with mud..	0	1	6
Total Annas		5	6

Mr. Sullivan informs me that only one description of furnace is now in use in this Collectorate. He describes it as consisting of two separate parts made of stiff clay in the forms marked A and B: and of the dimen-

IRON ORES OF SOUTHERN INDIA.

patam : on the west by Hyderabad and on the east by the Bay of Bengal : it has an area of 6,600 square miles and a population of 926,930 inhabitants, and is divided into eleven talooks, viz.

Aska	Chitterpore	Moherry
Bodagadah	Goomsoor	Polakee
Chicacole	Itchapoor	Poobacondah.

Purlah Kimmedy and Teekally.

The eastern portion of the Collectorate being near the Bay of Bengal, is low, in many parts ; indeed is only about 100 feet raised above the level of the sea, but it is mountainous towards the west : Mr. Knox informs me that in the Ganjam District, in the present day, there is only one place where iron ore is known to have been worked, and even that, was many years ago. This was at a village called Geongalova near Cota Bomaly, but the man who made the iron is dead, and the villagers say they do not know the spot whence he procured the ore,—the impression however is strong that iron ore exists in this district ; there is a rock near Chicacole, in which there is evidently iron ore and on the other side of the river in the Vizagapatam district, there are unmistakable traces of it.

In Bond on the confines of Goomsoor but within the jurisdiction of the Superintendent of the Tributary Mahals at Cattack, iron is made in three villages, iron ore being found in large quantities in the jungle. It is dug out of the ground and carried to the village where it is smelted. The names of the three villages are Cottidingia, Rongomatteya and Lakkochiri of the Mootah of Balosoor Kooppa in Bond, and the following information refers to the first of these, though it is equally applicable to the others.

Iron ore is procurable in large quantities in the jungle adjacent to Cottidingia. It is not smelted there—but is carried to other places. The workers are Kood ironsmiths who bring the ore in cowries, each cowrie load measures 5 tooms, about 70 lbs.

The charge for bringing a cowrie load of iron ore to the place of manufacture is half a viss of iron or an anna. No tribute is paid to any one for taking the ore.

The distance between the place where the ore is found and that of manufacture is about 2 miles, but in rainy weather they manufacture it in the village about 4 miles distant from the place where the ore is found four cowrie loads of ore are required to manufacture one maund of iron, the cost of which is as follows.

	Rs.	A.	P.
Hire for four cowrie loads of ore.....	0	4	0
Fuel required.....	0	2	0
Hire for pounding the ore for four days at 6 pice per day.....	0	2	0
1 Burnum 1,400 lbs. of charcoal for smelting the pounded ore...	0	4	0
Hire to the smelter for 1 day.....	0	1	0
Hire to the bellows man.....	0	1	0
Total...	0	14	0

The pounded ore is smelted in the furnace and the crude iron is then made into bars in another place—the process of making steel from iron is not known. The bar iron is selling at a Rupee per maund in places within the jurisdiction of Teekaly and the price of a maund of bar iron where it is manufactured is Annas 12. The tools required in manufacturing iron ore ;

	Rs.	A.	P.
Large Hammer	1	4	0
Small Hammer	0	10	0
Tongs	0	8	0
Breaker of lump iron.....	0	4	0
Anvil	3	0	0

Total..... 5 10 0

The ore is dug out of the earth—it is then roasted one day and pounded or bruised on the following. The pounded ore is then poured by degrees on a charcoal fire where it smelts into lump iron. The fireplace is made with earth of a size to contain 5 tooms of charcoal and pounded ore. They begin the process at 7 o'clock in the morning and finish about 12 o'clock A. M., but they work night and day. Each cowrie load of ore produces 2 viss of iron.

A list of the specimens of iron ore from the district of Ganjam, now in the Museum will shortly be published.

GUNTOOR.

The Collectorate of Gunttoor is one of the five districts in the Madras Presidency known as the Northern Circars, the other four being Ganjam, already described, Masulipatam, Rajahmundry and Vizagapatam. It is bounded on the north by the Nizam's territory and Masulipatam, on the south by Cuddapah and Nellore ; on the west by the Nizam's dominions, and on the East by the Bay of Bengal, and has an area of 4,960 square miles with a population of 483,831 inhabitants.

Gallarahully, one furnace, the iron ore being brought from eight places five miles distance.

Gurragum, one furnace, the iron ore being brought from nine places six miles distance.

Heerada, seven furnaces, the iron ore being brought from five places one mile distance.

There are two furnaces in the RAIDROOG TALOOK viz.

One at *Komunupully*, where the ore is found in a gravel from 10 to 12 miles off.

And one at *Mullapoorum* where the ore is found in a gravel from 2 to 4 miles off.

There are 32 furnaces, large and small, in the MUDUGSEERAH TALOOK, viz. two at *Sindhigirry* and the iron ore occurs in gravel from three to four miles off.

Three at *Goondamullah* one large and two small, the ore being in sandy gravel 4 miles off.

One at *Mullaray*, small, the ore being in sandy gravel, 5 miles off.

Five, large, at *Senkaragul*, the ore being in sandy gravel, 6 miles off.

One, small, at *Ramagirry* the ore being in sandy gravel, 7 miles off.

One, small, at *Kollaybetta* the ore being in sandy gravel, 8 miles off.

One, small, at *Gottogporky* the ore being in stoney gravel, 9 miles off.

Five at *Cottagarlagootah* four large and one small, the ore being mixed with sand gravel, 10 miles off.

Three at *Faminagootah*, two large and one small, the ore being mixed with sand gravel, 11 miles off.

One large at *Thirnadadhavarahully* the ore being mixed with sand gravel, 12 miles off.

One large at *Konkulloo* the ore being mixed with sand gravel, 12 miles off.

Three large at *Makalagutta* in sand and stoney gravel, 13 and 14 miles off.

One small at *Hirray Theorpee* in sand and gravel, 15 miles off.

Three at *Kyakahthee* two large and one small in sand and stoney gravel 16 and 17 miles off.

One small at *Runganahaul* in stoney gravel, 37 miles off.

There is but one small furnace in the *Penacondah talook*, viz. at *Nid-daniandy* where the ore occurs in sandy gravel 18 miles distant.

In the KODECONDAN TALOOK there are two furnaces one at *Morumpully* a hamlet of Khondapoorum and one at *Kullakerrah* the ore of both occurring in sandy gravel, about 19 and 29 miles off.

There are five furnaces in the *Dhurmaver talook*, *Jumboogompala* and between the village of *Jumboogompala* and *Kenchumpully*.

A plan was sent of the furnace in which the iron stone ore is smelted and drawings of the apparatus employed in the furnace; also a plan of the furnace in which the iron sand is smelted, and drawings of the apparatus used there.

There are some furnaces in which the iron stone is smelted in the *Koodleghee talook* which, in construction, are the same at all other others, but the working of the iron in those called *Dhoolapookoluny* is somewhat different to the others, the small furnace in the *Muduckseerah talook* for smelting iron sand is the same in construction as the others but the working is somewhat different. The cost, of constructing furnaces and of making the implements used in them, and the rate of labor everywhere differ.

In the *Koodleghee talook* a furnace consists of two separate compartments about 4 or 5 yards apart in one of which the iron stone and gravel are smelted and a lump of iron is produced, this part of the workhouse is called "Hombalum" and at the other part called "Dhavanamoo," the crude mass is beaten out and cut and converted into malleable iron which is formed into picks, crowbars, &c.

Labour is not paid by the month but a certain amount is fixed for each surthee of iron, which contains 12½ Nigums or 150 Maunds, each Nigum consists of 24 Pulloogoo and each Pulloogoo of half a Maund of iron.

The working is suspended for the 3 hot months of the year from want of water, but during the remaining nine months the furnaces for iron stone are worked three times and those for the ore from gravel twice, the expenses attendant thereon are as under.

	Rs.	A.	P.
The expenses for a year are	432	0	0
			Rs. A. P.
For the <i>Hombalum</i> furnace	-	-	68 8 0
Viz. Smelter	14	0	0
Head bellows man who has also to take the place of the smelter when he happens to be absent for which he gets	7	0	0
2 Bellows men at Rupees 6 each	12	0	0
	19	0	0

Guntoor on its eastern portion is low, flat, and sandy: but it is mountainous to the west. The prevailing rocks are the hypogene schists, limestones, sandstones, and mica and hornblende slate, but though copper is said to exist, the only mineral products of value in the arts which have as yet been sent to me are Saltpetre, Lithographic limestones, its marbles and, the subject of the following report, its iron. The Collectorate is arranged into 14 talooks, their names being,

- | | |
|----------------|-------------------|
| 1. Baupettah | 8. Mungalagherry |
| 2. Coorapad | 9. Nursarowpet |
| 3. Condaveed | 10. Ponnor |
| 4. Datchapully | 11. Pruttepaud |
| 5. Guntoor | 12. Reypully |
| 6. Innacondah | 13. Tenally |
| 7. Martoor | 14. Timmercottah. |

The first intimation which I received of the existence of ores of iron in this Collectorate was in 1850 from Major Merland, and specimens of its cubical peroxide of iron were about that time received for transmission to the great Exhibition. On seeking further information of Mr. Purvis and Mr. Rohde, I have received a valuable report from each of them. Mr. Purvis details the localities in which iron ore occurs and is smelted, and Mr. Rohde furnishes a very interesting description of the process of smelting the ore; their respective reports are as follows.

Mr. Purvis gives the following as the places in this district in which iron ore is known to exist.

In the Datchapully talook at the village of Vamagherry, ore is found in considerable quantities near a hill called Yinaparetekonda, or Iron Hill, at the depth of from 1 to 8 yards: specimen of ore marked No. 1.

In the Timmercottah talook, in the village of Tallapully, ore is found in moderate quantities at the depth of about 6 feet, at the foot of a hill situated within the boundaries of these villages: specimen of ore No. 2.

In Nursarowpet talook, in the village of Goteconda, (the village actually in Datchapully talook and close to Vamagherry,) the ore is found from the surface to about 6 feet in depth, it is not very plentiful: specimen of ore No. 3.

The quantity of ore that can be gathered in a day is differently estimated. In the Timmercottah talook two men are able in a day to procure two baskets full of ore. The size of the basket is said to be such as would hold 16 seers of grain. At Goteconda, three men can gather in a day as much ore as will produce two maunds of iron. About Vamagherry, one man can it is said

collect two maunds of ore in a day. The ore is generally dug out with crowbars and is conveyed on bullocks or buffaloes to the following places where it is smelted.

Talook.	Village.	Number of Furnaces.
Datchapully.....	Goteconda.....	
	Janapaud (procuring ore from Vamagherry.)	3
Timmercottah.....	Tallapully.....	6
	Cottapully.....	2
	Nagulaveram.....	1
	Wooppalapaud.....	1
	Cundalacoonta.....	1
	Bodelaveedoo.....	1
	(procuring ore from near Timmercottah.)	
Nursarowpet.....	Goondlapully.....	12
	(procuring ore from Goteconda or Vamagherry.)	

Mr. Purvis regrets not to be able to send plans or drawings of the furnaces or apparatus used, but he considers this of less consequence as they are all of the very simplest description and construction. The cost of establishing a furnace is given by the Timmercottah authorities as below.

	Rs.	A.	P.
1 Pair of bellows.....	10	0	0
1 Do. of tubes weighing 30 seers.....	5	0	0
1 Anvil weighing 3 maunds.....	12	0	0
6 Hammers weighing 1½ maund.....	6	0	0
4 Pairs of tongs or pinchers of different sizes.....	15	12	0
1 Chukkachalum weighing 5 seers.....	0	12	0
1 Shovel weighing 5 seers.....	0	12	0
1 Poker weighing 5 seers.....	0	12	0
1 Crowbar weighing 20 seers.....	3	0	0
	54	0	0
Cost of sheds.....	17	0	0
	71	0	0

PREFACE.

If the seeming magnitude of this Report on the Iron ores of the Madras Presidency, be deemed by some beyond what the subject merits, I would fall back upon a conviction I have elsewhere expressed,* that "the vast Empire of British India will not receive justice until the examination of its various features be undertaken on a scale commensurate with their magnitude." But the Madras Government having bestowed £ 90,000 in fostering the enterprise of one Iron Company, and a second large Company having been recently formed and become busily engaged in smelting iron from the ores of this Presidency, seemed to me facts sufficient to justify my entering upon an examination of this branch of the manufactures of Southern India. That I was correct in this opinion will, I think, be shown by the details now furnished, imperfect as in many cases these necessarily are. I have, however, endeavoured to give all the information which the contributors, in presenting the Museum with specimens of the iron ores in the Madras Presidency, have communicated to me regarding them; and in most cases, have only so far altered the authors own words as to change their epistolary or tabular into a narrative form. I hope that the information now submitted will prove of benefit to the country; and as this seems to have been the chief motive that induced those, whose names are recorded in the body of this report, to collect the details it contains, in returning them my best thanks for their willing assistance, I trust that their benevolent aspirations may be realised. I am, however, far from considering that this inquiry is complete. I regard all that I have furnished, but as preliminary to a minutely careful investigation of the subject by the authorities and others residing in the several districts, which should be followed by another report furnishing the most accurate and most recent information. The present report will, to some extent I hope, facilitate such subsequent inquiries, as I have endeavoured to condense into it all available information and arranged it in a form to admit of the readiest reference.

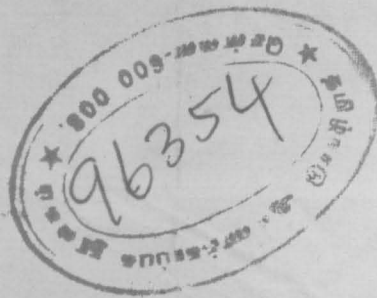
GOVERNMENT CENTRAL MUSEUM, }
MADRAS, 20th August, 1855. }

E. B.

* Barometrical Sections of India, with a description of the Physical features of the country. Madras; 1853.

96354 Aceno

* செப்பனிருவதற்காக எடுத்துக் *
* கொள்ளப்பட்ட *
* 1988 மாதம் 1988 வருடம் *
* செப்பனிரு முடித்த *
* 1988 மாதம் 1988 வருடம் *
* ஆராய்ச்சி உதவியாளன் *
* கையொப்பம். *



Cost of working a Furnace for a month. For making crude iron, Hire of 6 men employed in breaking the ore; supplying the Furnace; blowing the bellows; hammering &c. at 4 annas each per day.....	45	0	0
Hire of a blacksmith at 6 annas per diem.....	11	4	0
Hire of 6 coolies to assist in supplying furnace with ore and charcoal at 2 annas each a day.....	22	8	0
Hire of 2 men employed in digging out ore for 4 months at .. per day.....	30	0	0
Do. of 2 men employed in making charcoal for do. at do.	30	0	0
Hire of 6 buffaloes for conveying the ore and charcoal to the furnaces at 7 Rupees each.....	42	0	0
	102	0	0

This cost being for 3 month's work the proportionate charge for 1 month is.....	12	12	0
Cost of manufacturing crude into marketable iron for 1 month.....	9	8	0
add say 20 per cent. per annum for capital* employed gives for a month.....	1	2	11
	102	2	11

Mr. Purvis mentions that Mr. Rohde considers the above estimate pitched a good deal too high.† It is seen indeed that the highest rate of wages is entered. The estimates furnished from the Datchapully and Nursarowpet talook are much lower. Iron at Timmercottah is manufactured at the rate of 2 maunds per day, being 60 maunds per month, which require to be again melted and beaten, when 45 maunds of good iron is produced which at the rate of 2 Rupees per maund, would fetch 90 Rupees.

The quantity of iron believed to be annually made in the Ganjam district is

Timmercottah talook.....	108
Nursarowpet talook.....	50
Datchapully.....	25

* 71.

† Note by Mr. Rohde. The workmen must be satisfied with lower wages or each furnace would be actually worked at a loss.

But little of any is exported from this to other districts, the quantity made not being nearly sufficient for its own wants.

Steel is not made, and as much of country manufactured steel as is required for use is brought from the Mysore country and sold at from 5 to 6 Rupees per maund. English steel is brought by land or sea from Madras and sells at from 4 to 6 Rupees per maund.

Iron is imported from Mahadavoopeeram in the Cuddapah District, from Ramanakapetta, Juggiahpetta, and Yelchoor in the Masulipatam District. English iron is generally brought from Madras by sea to Masulipatam and thence finds its way into this province. The price of Rentachintala iron, as that from Timmercottah is called, in Guntur, is 2 Rupees a maund. Godlapully, Rupees 1-4-0; that from Juggiahpett, Rupees 1-8-0; Yelchoor, Rupees 1-6-0. The price of English iron varies according to the supply available at Masulipatam or elsewhere, from Rupees 1-8 to Rupees 2 per maund for bars; rod and sheet iron from Rupees 2-8 to Rupees 3.

The following are the names in the Telugu and English of the tools and implements made from the iron produced in this District.

గడ్డ పాచలు	Crowbars
శలగ పాచలు	Mometies
గడ్డ పుల్ల	Hatchets
పాగలంకరలు	Plough shares
గోమెకరలు	Teeth for harrows &c.
గుడ్డ పుల్ల	Pick axes
రొకటిపొన్నలు	Rings for pestles
దాగలి	Anvil
సంపెట	Hammer
పెద్ద కాళ్లు	Pair of tongs, large

The above are generally of a very ordinary description and are sold according to their weight from two to three Rupees per maund.

At the furnaces in the Datchapully talook charcoal is procurable at from 4 to 5 maunds for 10 annas. It is brought from low jungles near at hand. In Timmercottah the charcoal has to be brought to some of the furnaces from some little distance. About seven and a half candies are said to be required for making the 60 maunds of crude iron manufactured in a month. At Goudlapully the charcoal is brought from a jungle about 4 miles distance; the price is 4 annas for 5 maunds, 10 maunds are used at each furnace per day.

4 Men to bring charcoal at the rate of 6½ Rupees each	25	0	0
Hire of a person to bring ore from the Hill	7	0	0
Hire of a person to pound the Iron Stone	3	8	0
	68	0	0
For the <i>Dhavanamoo</i> forge	75	8	0
Hire of the smith	21	0	0
4 Hammer men and bellows men at 10½ Rupees each	42	0	0
2 Persons who bring charcoal at 6½	12	8	0
	75	8	0
Total for each time it is worked	144	0	0
Which being three times in the year, the annual expense is Rupees	432	0	0
Amount of loss by tear and wear for each Surthes of Iron made	27	6	0
Viz. four baskets for conveying charcoal	0	2	0
Six Cavady baskets for carrying charcoal	1	8	0
Expenses of plastering the fire place	3	8	0
Two Gunny bags for bringing ore	1	8	0
Shoeing Buffaloes &c.	2	8	0
Total loss in tear and wear each time of working	9	2	0
Annual loss in tear and wear	49	8	0
Viz. for 10 Saddles, 10 Pads and girths for 10 Buffaloes at 2½ Rupees each	25	0	0
A low wall built over the fire place of the Hombalum Furnace	0	4	0
8 Pot Stones (four for the Hombalum and four for the Davanum Forge, at 8 annas each)	4	0	0
For erecting 2 places for the two apartments	6	0	0
4 Bellows for both apartments at 3½ Rupees each	14	0	0
An earthen Pennum for fire place	0	4	0
	49	8	0
Total.....	508	14	0
Permanent stock belonging to the Hombalum Furnace Rupees	11	7	0

Viz. An Iron rod for ascertaining whether the ore has been smelted or not, by introducing it into the boiling fluid annas 4—A crowbar for removing the mud from the bellows pipes which hardens when the furnace is worked annas 4—A large pair of pincers for removing the mass of iron from the furnace, Rupees	2	0	8
Two large hammers for hammering the crude iron, Rupee	1	0	0
An iron ladle for removing ashes &c. from the furnace	1	0	0
An Iron rod used as a support over an opening in the furnace	0	1	0
Two Iron nozzle pipes for the bellows	1	0	0
A Crowbar for pounding ore	0	8	0
A Pick for extracting ore	0	8	0
A Spade for filling the baskets	0	6	0
Four Hatchets for cutting wood to make charcoal	4	0	0
	11	7	0
Belonging to <i>Dhavanamoo</i> forge	30	4	0
1 Iron anvil on a block of wood	17	8	0
2 Pincers of sorts used when hammering the crude Iron	1	0	0
2 Axes for Cutting the Iron	2	0	0
1 Crowbar used when hammering heated Iron	0	8	0
1 Iron Vessel for throwing charcoal into the furnace	0	8	0
1 Iron rod for clearing the bellows nozzles of charcoal &c.	0	8	0
4 Hammers used for making bar Iron	2	0	0
1 Pincer	0	8	0
1 Do.	0	8	0
2 Pincers used when welding	1	0	0
1 Pincer used when smoothing the Iron	0	8	0
1 Small hammer used in welding Iron	0	8	0
1 Iron ladle for removing ashes &c. from the forges	0	4	0
2 Bellows tubes	1	0	0
2 Hatchets for cutting wood	2	0	0
	30	4	0

There is a good deal of jungle in the vicinity of the villages where furnaces are established, and the demand for firewood and charcoal is not considered sufficiently great to cause any perceptible diminution in their extent: a man can make from 1 maund to 2 or 2½ maunds of charcoal a day.

The best iron in this district is called Rentachintala iron, which is that made in the Timmercottah talook and has been named Rentachintala iron, as many of those engaged in the trade reside in that village, but no iron is actually made at that place. This iron is preferred by the native blacksmiths to the English iron as harder and more durable but the latter works easier.

The wages given are 5 annas to a good, and 4 to an ordinary workman.

Mr. Rohde mentions that the ore from which the iron of Timmercottah is made, is dug out about 2 feet below the surface mixed with red earth and inferior iron stone; the miners suspect the presence of the ore from signs on the surface, the upper soil is mixed with quartz and the inferior, with ore or iron stone; the locality is about 3 miles west of Toomaragod, (Timmercottah of the map) whence the ore is exported extensively to the Doopaud, and the Nullagoonda District in the Nizam's Territories: the quantity thus exported has not been ascertained but it supplies 30 forges in the Doopaud in ordinary seasons; the carriers are chiefly Lumburries—the tools used in quarrying are spuds or iron spikes about a cubit long secured by staples to wooden handles, iron bars being inconveniently heavy for persons who work in a sitting posture, in which they find it convenient to undermine the surface stratum, when the ore is reached, and, allowing it to fall, they remove it and continue their work; and this custom which is generally prevalent in all quarrying operations of the natives is most inconvenient, the same soil having often to be moved repeatedly.

When a person determines on working the ore he collects a gang of 20 or 30 persons who jointly borrow say 100, 150 or 200 Rupees for their expenses; they commence by felling wood in the neighbourhood in the month *Kartika*, this and the preparation of the charcoal will occupy 2 months; the iron stone is then dug and broken small with hammers to the size of small gravel; a raised (pia) platform is also made, say 3 feet high; a smith is engaged, from the south, generally from Venkatagerry zemindary, and preparations are made for setting up so many forges as will employ the whole gang at the rate of 6 to each forge, each forge requiring two reliefs of 3 men in each who continue the work incessantly day and night. Each relief works out one charge which occupies 4 hours, so that each forge turns out 6 *Moodas* (lumps) in the 24 hours, each lump weighs say 1 maund of crude iron.

The feast of Seevaratry (March) is the time for commencing the manufacture which may last till Chetrum according as provision of stone and fuel has been made: after which the heat, in the Pulnaud would be intolerable till the rains set in which they do in June.

The furnace is constructed by forming a hollow in the edge of the (pia) platform before spoken of down to the ground which is also hollowed; a crucible formed of potter's clay, white quartz, sand and cotton refuse well worked is placed over the openings slightly projecting beyond the edge of the platform; a funnel of pottery surmounts this in the hollow formed in the platform and against it charcoal is heaped and coated with clay, the fire being lighted any cracks are repaired and this ascending is carried up around the crucible and funnel; the furnace is then charged with one large basket of charcoal which fills it to a level with the crucible; one *maricha* (about 1½ pucks scers is about 1/4 of a Madras measure) of iron sand, before spoken of, is then put in and the fire urged with bellows of buffalo skin each worked by one man; as the charge sinks, charcoal and iron stone, one basket of the former to one *maricha* of the latter are added at intervals and this is repeated thrice so that the full charge is four *marichas* of iron stone; no flux is used; at the end of 4 hours the iron is removed with tongs by breaking a hole in the wall of the furnace and being struck with wooden mallets or rammers is afterwards cut in sunder with an axe. In a subsequent operation it is heated in another but similar furnace and drawn out under the sledge hammer and frequently the two bars are again welded together in which state it is marketable and sells for 1½ Rupees the maund; from the slag of the refining furnace, if it may be so called, is prepared a superior iron (*Valepoo inoomoo*) used in manufacturing frying pans, measures and such articles as require to be drawn out considerably, it sells at 2 Rupees a maund: an indifferent steel is prepared from the slag of the first furnace and called *heet hookoo*.

The smiths who are engaged prepare from the iron the numerous agricultural implements; the Kond axe and matchlocks are also made, the latter at one place only, Kotapilly: 12 Rupees is the price of a matchlock; these are made in lengths of 8 inches which are afterwards welded together and bored with a drill: anvils weighing 3 maunds are charged 10 to 20 Rupees and not by weight; ordinary implements from 2 to 3 Rupees a maund.

The great consumption of iron is in the Doopaud and Pulnaud where from the stony nature of the soil the ploughs, &c. require daily repair. The price of iron has risen this year (1853-4) in consequence of the great demand from the Doopaud where the forges have been generally abandoned from the high price of grain, otherwise the price has not varied greatly.

The number of forges now at work are stated to be about 20 this year, these are at Kotapilly, Talapilly, Byrampana, Kullagoonda, Boodnaud.

sions thereon specified: when prepared for smelting A is placed on B and luted with an outer coating of clay so as to assume the form C; and this luting has usually to be renewed every smelting but the two shapes A and B. last for some time and improve by use. For smelting, about 4 winnows of charcoal, thickly sprinkled over with iron dust or finely pounded ore (the former produces the best) in seven alternate layers are placed up to almost the top of the furnace, in its form C.

The bellows D D are both introduced through the earthen pipe E, at the aperture a, and a continued blast kept up: as the fuel and smelted metal keep sinking in the furnace, fresh layers are put on until at last a body of smelted metal mixed with fuel is formed at the bottom of the furnace about the size and shape of half a 10 inch shell and weighing from 25 to 30 lbs. This is taken out when in a soft state and struck sharply with a heavy, flat, bludgeon, into a shape something like a flattened bullet: wedges (thus ) are then cut out with the axe G and forged into flat bars varying from 1 to 2 inches in width, about 1 1/2 foot long and from 1/2 to 3/4 an inch thick. The implements marked H and I are used for taking out the fused metal, dressing the furnace &c. J is a basket with a handle holding a winnow of charcoal, a smaller one is also used for sprinkling the iron sand or pounded ore thickly over the layers of charcoal.

Shortly after issuing my circulars regarding these ores, the Military Board instituted enquiries to ascertain the possibility of supplying, in our various districts, the iron implements which it had been usual to obtain from England and transmit through the Arsenals to the interior. Lieutenant King and Lieutenant Benson undertook these enquiries in the North Arcot district and from their reports, it is evident that the native manufacturers can sell their wares cheaper than we can import them. It is mentioned, in their reports, that the names of the principal villages from which the iron is procurable are, Arneapady, Valleyundroog, Seeramboor, distant from Arnee 7 or 10 miles and that iron can be procured at Arnee in large quantities after having passed through the smelting furnace at 1 Rupee and 4 annas for 10 viss.

The manufacture of steel in different variety of forms, is also carried on at, and near Arnee: it can be purchased in the bazar at 7 annas per viss of 40 pollums. The ore from which the steel is manufactured is stated to be of a darker or blacker color than the iron-ore and is found in greater abund-

- * 1. Undanoor.
2. Trenanamply.
3. Pellypett.
4. Poodoopalyam.
5. Keerookee &c.

ance in the Zillah of Cuddalore; at the villages as per margin* which are situated near the hills distant from Cuddalore 45 to 90 miles.

The merchants of Vellore brought three specimens of manufactured iron and steel which they stated they obtained from Arnee and of which they were ready to supply almost any amount (1000 lbs.) of iron a month and steel, 120 lbs., at the price expressed in the margin:*

No.	per lb.	A.	P.
1.		1	3
2.		0	8
3.		2	3

they calculated in working this up into tools, &c. the wastage of the 2d sort to be 75.

With reference to a statement shewing the price of tools made up, in the Vellore Arsenal, from Europe Iron, a comparative statement was drawn up of the probable price of tools manufactured from the country iron under similar circumstances, and from this it is shown that on account of the wastage double the amount of pounds of iron was used and proportionally increasing the extra charcoal, paddy husks and labor, required, thereby considerably enhancing the price of each article; the native merchants however undertook to supply each description of tool at 1/2 less than the price of the Vellore Arsenal manufactured tools.

In distributing the profits, after repaying the sowcar, the head man receives 2 shares, the smith with his tools 2, the rest share alike; a party of 24 men may thus divide 400 Rupees exclusive of the advance, but the work is considered hard.

Besides the above, which affords most excellent iron, a few men at Gotkoondoo prepare a very bad iron from an inferior ore found there; no smith is engaged, the furnace is less deep and is charged only twice in the 24 hours the iron being removed morning and evening when the charge is renewed. Of these furnaces I have no details and very little iron is there made.

One circumstance deserves attention both here and in other places where charcoal is made for reducing iron ores, namely that from idleness a very large proportion is prepared by burning the wood in open heaps and quenching it when half burned with water; the people know it occasions loss and also know the charcoal so prepared to be very indifferent in quality, yet if water is at hand they almost invariably resort to it. The result of this excessive waste of fuel is a greater difficulty in procuring it and the entire discontinuation of the manufacture in the more advanced villages.

The spot where the iron ore is found is in the immediate neighbourhood of the water-fall which according to Heyne is sixty feet in the fall. From his description and from what I can learn from others, I have no doubt that by forming a mill dam at no great expense or even without it, water power sufficient to work a small forge might easily be obtained, an overshot wheel of say 35 feet diameter would not require a very great expenditure of water and like all the Pulnaud streams the Chendra Vunda continually flows.

The adoption of any European method to the full extent, or the perfect fusion of the iron is not proposed, but a modification of the present system somewhat assimilated to that of Sweden or Elba, on an enlarged scale; the adoption of the European mode of making charcoal, economy in the expenditure of the forests; the erection of a tilt hammer and suitable refining furnace, steel works sufficient to expend the refuse charcoal, and perhaps, in the original manufacture, the use of a flux, but of this I speak hesitatingly as it appears to me that the quality of the iron might be somewhat injured by it. I have little doubt that such a work would amply repay any small capitalist who was himself competent to superintend it. Limestone is most abundant in all parts of the Pulnaud and quartz from which an artificial grit for hearths might be prepared also abounds, the people are generally docile and intelligent, water carriage by basket boats down the stream is afforded by the Kistnah about 4 miles distant from the water-fall, while there is every facility for working marble and slate quarries within a distance of 10 or 12 miles; should any addition-

al employment be described, there is probably no part of India where really good roads could be made so cheaply as the Pulnaud; at present the passes are hardly practicable for loaded carts.

Mr. Rohde supposes the ore of which he has spoken would yield at least 70 per cent. of fine iron, and that the waste of the present mode of working must be enormous when the slag is worth reduction and yields a still finer iron.

A list of the specimens of iron ore from the district of Guntur now in the Museum will shortly be published.

Mr. Rohde's observations on the ore and iron of Timmorocottah or Toomeragod are very interesting. He tells us that, on the River Chendravanka about 3½ miles west of Toomeragod and about 3 miles from its junction with the Kistnah, is a considerable water fall called by the natives *Pattipotta* described by Heyne and which he is informed is supplied with water during the whole year. The fall is considerable, Heyne says 60 feet; the river here intersects a range of low hills which furnish the ore: it is found interspersed with other stones and a small portion of a bright red soil throughout the hills to the East and West of the fall, whence it is quarried to within two miles of Toomeragod to the East; to the West the mining operations are for the most part limited to the immediate neighbourhood of the stream, thence it is conveyed to the several villages in the neighbourhood at which forges are established: of these there may be about 10 established which are for the most part in Kotapilly, Talapilly, Nagoolavaram, Kullagoonta, Bodlaveed and Jumoolamadika. The establishment of a forge is however so readily accomplished and its destruction by the periodical rains so certain, that the seat of the manufacture is shifted as the inhabitants of one or the other village are tempted to embark in the business, which is conducted by the villagers generally, a smith with tools being engaged and a share being assigned to each.

The period for working is ordinarily from January till the rains fall in June, the Sunkoeratri is nominally the day for the commencement of operations, though the charcoal and ore is prepared sometime previously.

The common mode of preparing the charcoal is to set fire to a stack of wood (the *Sundra Jana* and *Naralego* being used for this purpose) when thoroughly ignited the fire is quenched by heaping on earth. At Rentachintala a much better process was followed of burning the wood in close kilns, as in Europe, but the difficulty of procuring water to form clay for daubing the casing has induced the objectionable mode of burning now adopted. The charcoal preferred is that of the *Sundra* and *Naralego* (described as a large tree only used for fuel) *Boorzala* and *Kalya*, the *Jana* is used but is not well suited for the first process described.

Cattle, - - - - -	64 0 0
4 Head of cattle to bring ore from the mines, by turns, these are looked after by the ore gatherers and are purchased for 7 Rupees each, - - - - -	28 0 0
And the cost of conveying charcoal by these cattle is 6 Rupees each, - - - - -	36 0 0
	64 0 0
	105 11 0

NOTE.—The cattle last for about four years. If they die the skins of buffaloes are used as bellows, but those of the bullocks are sold to dealers.

Servants' wages for the year, viz. - - - - -	276 0 0
For the Hombalum furnace, - - - - -	64 8 0
Smelter, - - - - -	14 0 0
1 Bellows man, - - - - -	7 0 0
2 do. at 6 Rupees each - - - - -	12 0 0
3 Men to bring charcoal, at Rs. 10½ each, - - - - -	31 0 0
Total... - - - - -	64 8 0
For the Dhavanamoo forge, - - - - -	73 8 0
Iron Smith, - - - - -	21 0 0
4 Hammer men at 10½ Rupees each, - - - - -	42 0 0
1 Man to bring charcoal, - - - - -	10 8 0
	73 8 0

NOTE.—This expense of Rupees 138 is incurred each time the forge is worked being thus Rupees 276 for the two times it is worked in the year.

Amount of loss, in tear and wear for each sur- thee of iron made, - - - - -	11 4 0
Viz. 4 charcoal baskets, - - - - -	0 2 0
Shoeing 4 buffaloes, - - - - -	1 0 0
4 Cattle packs, - - - - -	1 0 0
Earth to make crucibles, - - - - -	3 8 0
	5 10 0

NOTE.—This being for one working makes Rs. 11-4-0 for the twice it is worked in the year.

Amount of Annual loss, - - - - -	34 8 0
Viz. for 4 saddles, 4 pads and 4 girths for 4 buffa- loes at 2½ Rupees a buffalo, - - - - -	10 0 0

Building a low wall over the fireplace of the Hom- balum furnace, - - - - -	0 4 0
8 Bulpom stones, (Pot stone) - - - - -	4 0 0
Erecting 2 places for the two departments, - - - - -	6 0 0
4 Bellows, - - - - -	14 0 0
An earthen Pennum for fire place, - - - - -	4 0 0
	34 8 0
Annual cash expenditure, - - - - -	72 0 0
Viz. paid at Thokaiahully for 8 baskets of pound- ed ore, - - - - -	10 0 0
Hire paid for bringing the above to the furnace at the rate of 7 Rupees per basket, - - - - -	56 0 0
To the inhabitants of Molkalmurroovoo for char- coal, - - - - -	6 0 0
	72 0 0
	393 12 0

Permanent articles of stock belonging to the Hombalum Furnace, - - - - -	9 1 0
Viz. 1 Iron rod - - - - -	0 4 0
1 Crowbar used for removing the lute from the bellows tubes - - - - -	0 4 0
1 Pair large Pincers - - - - -	2 8 0
2 Hammers - - - - -	1 0 0
1 Ladle - - - - -	1 0 0
1 Rod - - - - -	0 1 0
2 Iron Tubes - - - - -	1 0 0
3 Hatchets for cutting wood to make charcoal - - - - -	3 0 0
	9 1 0

Belonging to the Dhavanamoo Forge - - - - -	29 4 0
Viz. 1 Iron anvil - - - - -	17 8 0
2 Pincers - - - - -	1 0 0
2 Axes for cutting iron - - - - -	2 0 0
1 Crowbar - - - - -	0 8 0
1 Iron vessel for feeding the forge with charcoal - - - - -	0 8 0
1 Iron rod - - - - -	0 8 0
4 Hammers - - - - -	2 0 0
1 Pincer - - - - -	0 8 0

The furnace is formed by first constructing a circular platform of earth about 6 feet in diameter and $2\frac{1}{2}$ feet high; on one side of this an opening (*garu*) is made about 2 feet either way the whole depth of the platform, a hollow is also formed in the ground; this opening (*garu*) is then coated within with red earth mixed with sharp sand to a thickness of about $2\frac{1}{2}$ inches, the pit below is further protected by a layer of 4 inches of charcoal powder, (the body of the furnace being open in front is temporarily closed, before charging, by a slight wall of earth a few inches in height through which the blast fuel passes; on this three clay slabs are erected against the crucible *goomi* and all apertures are secured by daubing with mud). The crucible *goomi* is prepared of potter's clay well worked with cotton refuse and paddy husk, but it is also mentioned that suzza husk is worked up with the clay of which the platform is constructed: the crucible *goomi* is surmounted by a funnel, *Coompate* like the upper half of a chatty inverted. The upper rim of the funnel and the upper and middle part of the crucible are secured by iron hoops and a half circle of thicker iron is placed against the lower edge of the crucible above the *garu* on the front, the whole is well luted with clay, and when the tiles *Salapala*, (of unburned clay) above spoken of are placed in front of the opening and luted, the furnace is ready for charging. In front of the furnace is a second platform sloping towards it with an opening in the rear; this platform is for the bellows, formed of two tanned buffalo hides stripped off without ripping, each is worked by one man who rests with one foot on a peg or perch in the cavity described and one on a similar peg on the outside, the pipes of the bellows are of iron, the aperture for admission of air is in the same plan as in the common smith's bellows, a strip of wood being outside on either side, the opening having loops for the insertion of the thumb and fingers allowing of its being readily opened or held close as the working proceeds.

The ore being reduced to small pieces not exceeding say $\frac{1}{2}$ an inch across, the furnace is filled from the top with charcoal, fire being first put in, and a *manika* of ore having been placed on the top of the charcoal, the bellows are urged and as the charge sinks fuel and ore in the proportion of one basket of the former to one *manika* of the latter are added. This is repeated till 8 to 16 *manikas* of ore according to the size of the forge have been supplied; when this is reduced, the front of the furnace is broken down and the mass *mooda* of crude iron removed with tongs and beaten with heavy mallets on the ground: it is then set on end and cut in two with axes and the pieces laid aside till about 200 *moodas* have been prepared, when they are heated and reduced to a malleable state in a common smith's forge and by heavy hammering. Each charge occupies the furnace about 4 hours so that from 5 to 6 *moodas* are obtained in the 24 hours; ordinarily $\frac{1}{2}$ a maund to 1 maund of good iron is the outturn of each charge. The smiths from Koonkalagoonta

are said to turn out the heaviest pieces. The ordinary produce of a small furnace is said to be equal to 2 maunds of good iron a day, and after deducting for accidents and for days on which the furnace is not worked from want of repair &c. the ordinary outturn is for a small furnace $7\frac{1}{2}$ pooties of 500 lbs. each for the season. Iron thus produced is called *Palam*. A superior description, called *Valam*, is prepared from the cinder, which being broken the best pieces are selected and subjected to a process of refining (equal bulk of charcoal and cinder being supplied) and the fire urged with the large double bellows, in a circular open furnace about a foot high and 20 inches in diameter: the mass is thus heated during half an hour: when half reduced the slag is run off by making a small aperture in the plaster wherewith the hole left for this purpose in the rear of the furnace is stopped—the iron found in a hole below, excavated for the purpose in the hearth, is then reduced under the sledge hammers and the thus prepared sells for one-third more than the ordinary *Palam*. The produce of *Valapa* iron is in the ratio of the inferiority of the workman who prepares the *mooda*. On an average the cinder from 300 *moodas* will yield 5 to $7\frac{1}{2}$ maunds of *Valapa* iron.

In tending the furnace two bellows men and one to feed the furnace are constantly in attendance, being relieved on the charge being delivered—the furnace is worked day and night.

In sharing the proceeds two shares are given to the smith, (that is, according to custom, one to the smith and one to his tools,) the bellows are purchased of the chucklers from the common stock. His informant tells him it is necessary to slaughter the animal as the skins of buffaloes that die of disease are not suited to the purpose; 8 persons in addition to the smith are said to be sufficient for one furnace; each furnace is said to require a separate smith.

The party commence by taking an advance from some neighbouring sowcar, who receives $2\frac{1}{2}$ dubs in the Pagoda as his monthly interest and a present of 2 *Palaga* (about $\frac{1}{2}$ a maund in each) and as a return compliment they receive a sheep and a rupee, the sowcar probably trusting to a further profit in supplying grain, &c. The iron is chiefly purchased by traders from the Doopand.

The stone is brought by those of distant villages by contract with the Brinjarries who receive at the rate of 4 Rupees measured pooty for each *omada* (8 miles.) In the immediate neighbourhood of the ore the wood is small and not suited to the extended manufacture.

He also mentions that any stone reduced to powder is placed on either side at the bottom of the furnace when the charge is put in, as if placed on the top it would run to scoria in passing through the fire.

No. 201.

GOVERNMENT CENTRAL MUSEUM

MADRAS, 30th June 1854.

FROM SURGEON EDWARD BALFOUR,

In charge of the Government Central Museum.

TO SIR H. C. MONTGOMERY, BART.,

Chief Secretary to Government, Fort St. George.

SIR,

In this half-yearly Report I submit, for audit and the sanction of

	Rs.	A.	P.
In hand as per account dated 31st December 1853.	1	5	11
Received since	600	0	0
Total Receipts.....	601	5	11
Paid for Specimens, &c	184	5	10
Paid for Salaries.....	416	13	7
Total Paid.....	601	3	5
Balance in hand.....	0	2	6

The Right Honorable the Governor in Council, the accounts (Appendix B.) shewing an unexpended balance of annas two and pice six.

I have, also, the pleasure of submitting a list of the donors to the Institution and of their donations (Appendix A.) which have been less abundant than in former periods—the cause of the decline being that, in the space in the College allotted for the Museum, there is now no room to hold more, and, though fully aware of the great risk that is run in interrupting the current of gifts, I have had to abstain from asking contributions.* These have however, been still sufficient to testify to the interest which our countrymen throughout this Presidency, even in its remotest parts, continue to take in the success of the Institution, and to their great desire to aid in developing the resources of the country; the abstract of Appendix A. is given here for ready reference.

* Since the above was written, the Pantheon has been allotted for the Museum, its area is 10,000 superficial feet.

Gwalior

is an extensive principality in the Bengal Presidency lying between $20^{\circ} 37'$ and $26^{\circ} 48'$ N. Latitude and $73^{\circ} 25'$ and $79^{\circ} 16'$ E. Longitude, its greatest length 425 and greatest breadth 396 miles. Hill ranges, of more or less elevation, composed chiefly of sandstone, the best known amongst which is the Vindya range, occur throughout the country. The Chambal river traverses the northern part of the country, and in the south, where the Nerbudda crosses through about 40 miles of it, this river is navigable.

Though considerably to the north of most of the military posts held by the soldiers of the Madras Presidency, its iron ores are nevertheless of importance to be here made known because of their abundance, and because the iron or steel made from them seems to be indispensable to mix with the Hyderabad steel in the manufacture of the Damascus swords.

The ores of Gwalior are both argillaceous and the magnetic oxide and Dr. Malcolmson remarks (Royal Geological Society's Trans: No. XXXVIII for 1837) that Captain Herbert had long ago suggested that the superiority of the Gwalior iron ore to that principally worked in the Himalayas might depend on the former being a magnetic ore, like that of Sweden, but though this may be possible, this report will have shown the accuracy of remark
* Manual of Geology, 3d ed. of Sir H. De La Beche's statement, made on the authority of Dr. Royle that magnetic iron ore is extensively diffused in India.

The most recent information regarding the ores of this principality, however, will be found in a very important paper, by Major Drummond on the iron ores of India generally, and which I give as an appendix, for which it will be seen that the cost of raising one hundred maunds, of 80 lbs. (or nearly 4 tons) is from 1 R. to R. 1-13½ or 2½ to 3-8-0 when cleaned, reduced to 80. Specimens of the working ore both from the Gwalior and the Ketsari district, in Kemaon, were lately assayed by the chemical examiner Calcutta and found to contain from 65 to 66 per cent. of metallic iron, and Sir R. Shakspear mentions that 100 maunds of ore when raised to the surface or 80 maunds of cleaned ore yield 18½ maunds of malleable iron, and Mr. Becket says that one hundred parts of the Ketsari ore produce about 84-5 parts of marketable iron.

Gwalior iron is used in Mooradabad for making 12 inch nails; and nails of every description; chains, screws, clamps for boxes, phazals, kulharis, &c. &c. and all things requiring soft iron, such as horse shoes, horse shoe nails, &c.

The Bengal and Agra Guide and Gazetteer (1842 Rushton and Co. Calcutta Vol. 2 page 406) mentions that iron ores abound in these territories; both silicious and argillaceous: the latter only are smelted.

At Gwalior, magnetic iron ore, of an undescribed nature, is very plentiful; it is argillo-silicious, and is arranged in regular layers; the layers abound in the granular magnetic iron ore, or sand of Jameson to which they owe their property. The pieces near the surface are the most highly magnetic; each piece possesses north and south poles. The hills of Naogong and Raipoor, south of Gwalior, afford the best specimens. The ore also occurs at Girwai, Ujapoor and Bejapoor, south east of Gwalior. Metal is not extracted from these ores.

Red ochre is found in great quantity at the Nur-hills, where mines are worked.

HYDERABAD.

Hyderabad is not British Territory, but a native state to which we furnish a subsidy of 10,000 soldiers, Cavalry, horse and foot Artillery and infantry,—both European and native. These troops have been furnished from the Madras Army during the past fifty years, on which account this country can only be regarded as a Military portion of the Madras Presidency. One of its provinces, also, Berar, has lately been handed over to the British to rule, and this state being situated in the centre of the peninsula, bounded on the north by Nagpore; on the south by Bellary and Kurnool; on the west by the Southern Maharatta country, Ahmednuggur and Candeish, and on the east by the Northern Circars, all of these being British territory, a description of its products, in the form of iron and steel, is of much consequence. Such a description will, also, be highly interesting to those who take an interest in the history of the arts, because it is from a district in the Hyderabad dominions that the steel is exported, from which the long famed Damascus blades are manufactured.

The Hyderabad country lies between the sixteenth and nineteenth degrees of north latitude, and is about 280 miles long with 110 miles of average breadth, the whole area being about 95,337 square miles, containing 10,666,080 inhabitants. And in its physical aspect, the country may be described as a table land, elevated about 1,700 feet above the level of the sea. Its economic mineral products are abundance of the inferior gems, of the quartz family, bloodstone, amethyst, prase, chrysoprase, opals, onyx, agate, &c. with diamonds, copper, gold, and iron.

1 Pincer	0 8 0
2 Large Pincers	1 0 0
1 Pincer used when smoothing Iron	0 8 0
1 Small Hammer	0 8 0
1 Small Iron Ladle	0 4 0
2 Tubes for bellows	1 0 6
1 Hatchet for cutting wood for charcoal	1 0 0
	29 0 4
Cattle for bringing charcoal	28 0 0
3 Head of cattle for the Furnace at 7 Rupees each	21 0 0
1 For the Dhavanamoo Forge	7 0 0
	28 0 0
	66 5 0

In the *Muduckseerah talook* the large furnaces produce two masses of crude iron daily weighing $\frac{3}{4}$ of a maund each, which form one bar. Six such bars make a Vyloo, ten Vyloos make a Cundhayen and it takes a month to produce a Cundhayen of iron: the work in these furnaces is suspended for the 4 months of the wet season. Monthly wages of the workmen.

1 Iron Smith,	3 8 0
4 Persons for bringing charcoal,	7 0 0
4 Persons for bringing the gravel containing the iron ore,	4 0 0
1 Smelter who also works the bellows,	2 11 2
4 Hammer men,	8 0 0
2 Bellows men,	2 11 0
	27 14 4

At this rate, in the 8 months the furnace and Forge are worked, the expenses come to Rupees

Expenses incurred for the year as follows,	223 2 8
4 Bellows bags at 2½ each	46 8 0
4 Gunny bags in which gravel is brought,	10 0 0
Amount paid to Government as rent,	3 0 0
8 Cavady baskets for bringing charcoal,	11 0 0
Hire for 5 Buffaloes at 8 Annas each per month,	2 8 0
3 Buffaloes for fetching charcoal,	20 0 0
2 Do. for Do. Gravel,	12 0 0
	8 0 0
	20 0 0
	269 10 8

In the smaller furnaces a smaller number of work people being employed only one mass of crude iron is produced in a day, so that two months are required to produce a Cundhayen of iron, and the working expenses for 8 months in the year are exactly half of that in the large forges.

A set of new tools casts as follows, &c.

For the <i>Hombalum</i> furnace,	6 8 0
1 Pair of Pincers, large,	1 8 0
1 Rod for ascertaining the progress in the smelting,	1 0 0
2 Small hammers,	2 0 0
2 Axes for cutting iron,	2 0 0
	6 8 0
For the <i>Dhavanamoo</i> Forge,	10 10 0
1 Anvil,	3 0 0
1 Pair Pincers, —	0 12 0
1 Pair large Do.,	0 12 0
2 Pair Do.,	1 0 0
4 Hammers,	3 0 0
2 Pair small Pincers,	0 12 0
1 Small hammer of steel,	0 8 0
1 Do. Pair Pincers,	0 6 0
1 Iron ladle for removing charcoal,	0 4 0
1 Rod,	0 2 0
1 Iron Rake for cleaning furnace,	0 2 0
	10 10 0

Cost of erecting a shed,

The price of 5 Buffaloes at 6 Rupees each,

17 2 0
4 0 0
30 0 0
51 0 2

The quantity of iron stone and iron sand put into the furnace for one smelting varies according to the nature of the ore. In the *Koodleghee Talook* the quantity is 2½ maunds and 8 seers of the iron stone ore and 3½ maunds of the iron sand, and in the *Muduckseerah talook* 3 maunds of sand ore is the quantity put into the furnace.

The quantity of iron produced in the Bellary District in one year is as follows.

	Maunds.
In the <i>Kumpli Talook</i> ,.....	2,160
In the <i>Muduckseerah Talook</i> ,.....	9,360

The iron ores and the iron and steel of these territories have received the attention of two of the most eminent of the Geologists of Southern India, the late Drs. Voysey and Malcolmson; more recently, the Officers who have been employed to report statistically on the several districts of these territories have added greatly to the general knowledge regarding its productions, and there was likewise considerable information furnished by Major Davidson along with the specimens for the London Exhibition of 1851. In his report (Note Y Konasamboondrum steel p. 332 Proceedings of the Madras Central Committee) he mentions that steel is made at several villages in the Circar of Elgundel; at Ibrahimputnam and Konapure, in the Karcolla Purgunnah; and at Attacore and Chintulpet in the Vellooria Talooka, and that it formerly was prepared at several other places, but the steel furnaces in them are now abandoned: the *teepoor* as it is called, the raw material of the steel, is manufactured at Maytpilly, (a village twelve miles south of the Godavery, belonging to Balmookund) from a ferruginous sand procured from gneiss by roasting, pounding and washing. The whole process of the manufacture of this steel being detailed with accuracy and minuteness by Dr. Voysey in the first volume of the Asiatic Society's transactions, and also by Dr. Malcolmson in the Geological Society's transactions of 1839. Both these gentlemen visited the steel furnaces at Konasamboondrum in the adjoining district of Nermal which supply the material from which the Damascus blades are manufactured. The steel manufactured at these villages is very inferior to the Konasamboondrum steel, and does not fetch half its price. Yet the *teepoor* is used for both; and the same care is apparently bestowed, in the preparation, the only difference he could detect was that the pure iron, which, along with the *teepoor* and the bran, is placed in the crucible, is in the case of the Konasamboondrum steel, prepared from the yellow clay iron ore, found in the laterite at Taatpilly, while at Ibrahimputnam and the other villages any iron without reference to the ore from which it is smelted is used. The exact chemical condition of the metal under the form of steel has as yet evaded scientific investigation, which renders it probable that the inferiority of the Ibrahimputnam steel may be attributable to this one neglect. The Mogul who rents the Konasamboondrum furnaces would seem to be of this opinion as he holds a strict monopoly over the Taatpilly iron, inasmuch that he had some difficulty in procuring a specimen of the metal. In the steel furnaces five men are employed the principal workman who has the care of the crucibles, which he is continually moving about the furnace by means of a long iron rake, and four bellows men. The daily pay of the chief is two seers of rice, and two annas a day. The others receive half the rice and money. If the steel comes out of the crucible at all blistered or unequal on the surface, it is rejected as worthless. There

are two kinds of crucibles, the large and the small each of which contains a lump of steel of from one to two pounds in weight. The cost of the furnace varies from four to six annas for the smaller prices, and from eight to ten annas for the larger. The workmen complain that the Hyderabad market is now lost to them, their steel being undersold by steel from Europe which is there preferred for the manufacture of arms. The chief consumption is confined to the country about where it is used for hatchets, sickles, &c. At Lingampilly and another village both close to Aimulwarrah, barrels for pistols and matchlocks are prepared. All kinds of old iron, old meat buckets, agricultural instruments, &c. are collected and formed into rods of the thickness of a man's finger; these are then twisted by an instrument as is shown in figure I, of the drawing, three or four of these rods are joined together lengthways as in figure II, another band of iron of the same breadth and of the thickness of a third of an inch is taken and welded to this, both being formed into a band which is twisted as in figure III, and afterwards beaten into a solid cylinder which is bored by a hard steel chisel as shown in figure IV. Pistol barrels are made after this manner, but less trouble is bestowed in the manufacture of a coarser kind of matchlocks—the process commencing with simply twisting a band of metal as in figure III. Pistol barrels manufactured by the first process are sold for Rupees twenty and upwards and matchlock barrels so prepared for double that amount, the last made after the simpler manner are much cheaper. Swords, daggers, bullum and spear heads are manufactured at Elgundel from the country steel.

The lamented Voysey (Journal of the Asiatic Society Volume 1, Page 245) tells us that Konasamboondrum, (corner of the sea) situated about 1 mile south of the Godavery and 25 from Nirmul, is celebrated for its manufacture of steel the chief part of which goes to Persia. The following are the chief details of this manufacture, collected by repeated visits to the place, and personal inspection of the process.

The furnace is a temporary circular structure of clay, from four to five feet in height and five feet in diameter. It is sunk two feet below the surface of the ground. The fuel is charcoal, and the fire is kept up by a blast from four bullock skins, placed at right angles to each other, the muzzles resting on the upper edge of the furnace, so as to force the blast downwards. The granitic clay of the furnace is highly infusible; it is found in the neighbourhood, and is formed of the decomposition of granite rock with small pieces of quartz and felspar and is so valued for its refractory qualities, that it is exported for the manufacture of crucibles, &c. After some days, however if a considerable heat has been maintained, the furnace becomes semi-vitrified, and requires renewal; the cost of a furnace is from two to three Rupees.

Statement of Intranching Tools that can be made up at Vellore, shewing the quantity of Country Materials and labour expended in making each Tool with its price and also the of its m.

24

IRON ORES OF SOUTHERN INDIA.

Number.	Weight of each.	To make up each of the Tools.										Price of each Article.						Total of each Tool made with Europe Iron and Steel including bolvers.	Difference.			Remarks.				
		Iron.				Steel		Parrabs of Charcoal.		Paddy Husks.		Smith.		Hammerman.		Bellows Boy.										
		Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.									
1 Axes Pick.	11	0	22	0	0	8	14	24	14	14	2	0	5	0	2	7	3	2	3	4	15	11	0	3	1	The supposed price if made up in the Arsenal from country materials calculated by R. A. near Smiths.
Pick.	11	0	22	0	0	4	1	2	1	1	1	1	1	1	1	1	1	1	1	1	10	2	0	2	8	
77 Manoty. ...	10	0	20	0	0	0	2	3	2	2	2	2	2	2	2	2	2	2	2	2	3	5	0	0	7	

(Signed) R. BENSON.

S. A. C. General.

The bellows are plied incessantly day and night. During the operation, the men are relieved every four hours, each being engaged to work 12 out of the 24. They are partly protected by a screen of mud placed between them and the furnace, but the heat and exertion render their task sufficiently laborious.

The iron is converted into steel in pine-shaped crucibles, made of the same clay as the furnace, and of various sizes according to the purpose for which the steel is to be applied whether for the fabrication of swords, or knives, or other articles.

In making the crucibles, the granitic clay above described is ground to a fine powder along with the fragments of old furnaces and crucibles, and the whole kneaded together with the chaff of rice and oil. The vessels are defended by a luting of the same, they are covered with a similar top but a perforation is made in the latter. No charcoal is put into the crucible but small pieces of kanah, or the glass formed in the process, are put at the bottom of them along with the ore, and serve of course as a flux. The crucibles are arranged and stended in the furnace occasionally by the superintendent, with a long and stout rod of iron.

The materials used in the preparation of the steel are two different kinds of iron one from Mirpalli, the other from Kondapur in the proportion of three parts of the former to two of the latter. The Mirpalli iron is derived originally from the iron sand already noticed, and is sent in the state of large amorphous masses of a reddish gray color, and of an extremely porous texture. The internal fracture is often iridescent. The Kondapur iron is procured from an ore found amongst the iron clay, at a place about 20 miles distant. It is said to be of a dirty brown colour, and very frangible. The iron however, is moderately compact and of a brilliant white fracture, occasionally it contains some ingredient which spoils the steel, rendering it excessively brittle: the natives assert that the adulteration is copper, but it is more probably arsenic. The mixture being put into the crucible, the fire is excited and kept up for 24 hours. It is then allowed to subside, and the crucible is taken out and placed on the ground to cool, when quite cold it is opened, and a cake of steel of great hardness is found weighing on an average about a pound and a half. The cake is covered with clay, and annealed in the furnace for 12 or 16 hours: it is then taken out and cooled, and again annealed, and this may be repeated a third or fourth time until the metal is rendered sufficiently soft to be worked. The steel is known by the name of wootz in Telinga, and a kurs a cake of about 110 Rupees weight, is sold on the spot for 8 annas. The daily produce of a furnace is about 50 seers or in value 37 Rupees. The cost of this steel is much enhanced by the extortion of the Jaghirdar who not unfrequently appropriates the advance to himself and leaves the purchaser still to incur the whole expense.

The export of the metal to Persia must however be profitable as it is sufficient to bring dealers from that country and to defray the cost and risk of travelling. We found at the village, 1820, Haji Hosyu, from Ispahan engaged in the speculation and it must have answered his purpose, as he was here again in 1823, having returned in the interval to Persia and disposed of the venture. He informed us that the place and the process are both familiar to the Persians, and that they have attempted to imitate the latter without success. Besides residing at the village whilst making his purchases, he bore a personal part in the operation, weighing the proportions of the iron, and testing the toughness of the steel himself.

The following experiments may convey some notion of the degree of heat to which these furnaces can be raised, and which may be reckoned at 130° of Wedgwood. 25 Rupees weight of steel, which had not been submitted to the last operation, with the $\frac{1}{16}$ of a silver Rupee, was fused in three hours into a button of hard steel. A piece of shelly stratum from Jhirpa fused into a sort of porcelain. A piece of hornblende schist was fused into a glass, with many globules of iron and manganese floating on the surface. The granite from the bed of the Godavery yielded a green glass. Belkonda granite was partly run into a green glass with pieces of quartz little altered, floating on the mass. Sitabaldy basalt was melted into a yellowish green, and Jhirpa wacken into a very perfect opaque black glass.

Many years subsequent to Dr. Voysey's visit the late Dr. Malcolmson (Journal of the Asiatic Society of Bengal vol. 5 page 106) described the character of the ore and the process of smelting it. He tells us that 20 miles to the east of Nirmul, and a few miles south of the mountains, hornblende slate occurs on the granite and along with it the magnetic iron ore described by Voysey in the Journal of the Asiatic Society vol. 2. But that it is not a sand, as might be inferred from Dr. Voysey's description; but the grains of iron are either mixed with the hornblende or occur in a sandstone-looking gneiss, from which the hornblende has disappeared. Specimens of the rock, which he saw dug up, and of the sand formed by pounding it on protruding masses of granite, were forwarded. The softer pieces were at once reduced to powder, while the harder were first roasted, and the ore was then easily separated by washing in small shelving hollows dug in the clay. It was then melted, and its quality said to be improved by using teak branches: the iron was soft, but part was used in the mixture from which wootz steel is formed. The strata of the schists have been broken and elevated, but the dip and direction are in no two places the same. Here also, the granite was seen in the bed of a torrent, in concentric scales, not unlike the extremities of petrified trees, caused by the unequal waste of the component parts, the quartz projecting unaltered.

In the Harponhully Talook.....	2,970
In the Penagondah Talook.....	100
In the Koodleghee Talook.....	28,815
In the Kodcondah Talook.....	225
In the Hoovinhudgaly Talook.....	4,650
In the Dhurmasveram Talook.....	2,250
In the Raidevoo Talook.....	540

51,070

About 17,000 maunds of iron is imported into the Bellary Collectorate, of which 12,000 come from Mysore and 5,000 from Soodpore.

Iron is sold in the Koodleghee talook at the rate of from 1 to 1½ Rupees a maund and the rate at which it is sold in the *Muduckseerah* and other talooks is from 14 Annas to one Rupee. Annually about 22,000 maunds of iron is exported to the *Dharwar Zillah* and about 29,000 maunds to the Nizam's territory.

Steel is not manufactured in the Bellary district, but specimens of the iron produced from iron stone and of that produced from iron gravel in the Koodleghee talook have been received, also of that produced from iron sand in the *Muduckseerah* talook. The iron produced from the gravel ore is of ordinary quality,—not very malleable. In the process of making iron from the stone ore the stones are roasted, and pounded, and after the furnace is lit up the open part in front of the fireplace is shut with pot-stone and luted, a large lump of iron stone being placed against it to keep it firm.

The furnace is fed in the following manner. Two pukka seers of charcoal and which falls near the tube, are first put in after which thirty seers of charcoal are added, and then two seers of ore, broken into very small pieces, are put in together with 30 seers of charcoal.

The bellows are then worked and after the charcoal in the dish is consumed a fresh quantity of two seers of ore and four of charcoal is put in: as the heap diminishes they add four seers of ore and charcoal and when these have sunk down they call it the first smelting, and then put in other two seers of ore and thirty seers of charcoal, and as the heap diminishes they add six seers of ore and an equal quantity of charcoal when the ore smelts into a mass of iron weighing a maund.

In smelting the gravel iron ore twenty-one pukka seers (8 maunds and 10 seers) are thrown into a pit and water poured over it and after it is mixed, they put it into the furnace in handfuls in the following manner.

Two pukka seers of charcoal are first put in which fall near the tube. After that 30 seers of charcoal are put in; over which 5 seers of the ore mixed with water is put, with 30 seers of charcoal and 5 seers of the ore is again put in and mixed with the rod and covered over with 8 more seers of charcoal. The bellows are then worked and when the mixed mass sinks about two inches it is considered the first melting—after that 30 seers of charcoal and 5 seers of the ore are put in and stirred with a rod, and as it diminishes they add six seers of ore and an equal quantity of charcoal and stir it again with the rod when a mass of iron is formed.

In the *Muduckseerah talook* where iron is smelted from the iron sand they put three maunds of sand and sixty seers of charcoal in the bowl of the furnace and on working the bellows the ore smelts, the smelter then ascertains its consistency by thrusting an iron rod into the hole which is made for the tube of the bellows and when he finds it time to remove the mass he breaks open the luted part of the fireplace.

The lumps of crude iron thus formed are then taken to the Forge "Dhavanamoo" and by repeated heatings and hammerings is converted into bars and tools and sold. Persons requiring tools and implements used in cultivation purchase bars of iron and get iron smiths to make up what they require.

The prices of articles are as follows:

	Rs.	A.	P.
Spade - - - - -	0	8	0
Hammer - - - - -	1	4	0
Paloogoo or bar of Iron - - - - -	2	0	0
Polum or bar of Iron - - - - -	1	0	0
Pick - - - - -	0	10	0
Crowbar large - - - - -	1	0	0
Crowbar small - - - - -	0	8	0
Large Iron Vessel - - - - -	50	0	0

But the prices vary in proportion to the weight of the articles. Villages requiring agricultural implements purchase bars of iron and get them made up by the smiths of the village who are village servants and get their fees in grain from the cultivators: other blacksmiths enjoy ems.

From some slags of iron found near *Vitalahpoom* a hamlet of the village *Kolahully* in the *Harponhully talook*, people surmise that iron was formerly manufactured there, but it is not known when nor for what reason the trade ceased to be carried on.

Iron sand used to be found in the rivulet near the village of *Lookeeherrah*

Dr. Malcolmson however has furnished to the world a more extended report on this ore and its steel. He tells us (Royal Geological Society's Transaction No. XXXVIII for 1837 p. 546) that magnetic iron ore, employed for ages in the manufacture of the Damascus steel used by the Persians for sword blades, is obtained from the hornblende schist 20 miles to the east of Nirmul and a few miles to the south of the mountains called the Neermul range or the Siehel or Sheola hills. The mines examined are those of Deendoortoe; but the ore is extensively distributed. The minute grains or scales of iron are diffused in a sandstone-looking gneiss or micaceous schist, passing by insensible degrees into hornblende slate, and sometimes containing amorphous masses of quartz. The strata are much broken up and elevated, so that the dip and direction are in no two places the same, and bear no relation to the mountains to the north.

Manufacture, &c.—The mines are mere holes dug through the thin granitic soil, and the ore is detached without difficulty by small iron crow bars. It is then collected and broken on projecting masses of granite or quartz by means of a conical-shaped fragment of compact greenstone; but when too hard to yield to this simple instrument it is previously roasted. The sand thus procured is washed in shelving depressions dug near a tank, and the heavier parts, separated by this process, are exactly similar to Voysey's specimens, of the iron sand used in the manufacture of Damascus steel at Konasumondrum, in the same neighbourhood; but from his published papers, it does not appear that he had seen the rock from which they were derived. In other respects, all the information he could procure, accurately corresponded with that given in his interesting paper.* The ore is then smelted with charcoal in small furnaces, which have often been described; he did not see any flux used; but although he watched the whole process, from the digging of the ore till it was formed into bars, he could not assert that none was employed. The iron has the remarkable property of being obtained at once in a perfectly tough and malleable state, requiring none of the complicated process to which English iron must be subjected previous to its being brought into that state. Mr. Wilkinson, who has investigated the history of Indian steels with much scientific and practical skill, did Dr. M. the favour to submit to experiment a specimen of this iron as it came from the furnace. He found it to be extremely good and tough, and considered it superior to any English iron, and even to the best descriptions of Swedish. The Persian merchants, who frequent the iron-furnaces of Konasumondrum, are aware of the superiority of this iron, and informed Dr. Voysey, that in Persia they had in vain endeavoured to imitate the steel formed from it; a failure which could be ascribed only to the

* Journal of the Asiatic Society of Bengal, Vol. I. page 245.

difference of the materials used, as the whole process of the conversion into steel was conducted under their own superintendence. It is also probable, that there are few places in India where an ore of equal value is so easily procured; otherwise its distant inland situation, in a difficult and unsettled country, would not have retained a reputation for so many ages. In the manufacture of the best steel three-fifths of this iron is used; the other two-fifths being obtained from the Indoor district, where the ore appears to be a peroxide. It is evident, that if the beautiful water of the Damascus blades is derived from the crystallization of the steel, the use of two very different varieties of iron, one of which has been ascertained to be of such admirable quality must have an important influence on the appearance and quality of the manufacture. As these mines afford a boundless supply of ore easily wrought, and situated in the neighbourhood of vast forests, and near a river navigable for boats during part of the year, it is probable, that at no distant period, when the native government has undergone some amelioration, iron may become an important article of commerce. On this account, and because, although much has been written regarding Indian steel, nothing has yet been brought prominently forward regarding the finer kinds of iron ore with which that country abounds, Dr. Malcolmson makes a few additional observations regarding them.

Dr. Heyne has accurately described the manufacture of iron in the Carnatic, to the south of the Pennar river, and he states that it is, when first smelted, extremely brittle, requiring several operations to bring it into a malleable state. Dr. Malcolmson possessed specimens of two varieties of ore used in the district in which he observed the process, and where he had himself seen them carried on. The one, an iron sand, collected in the bed of rivers, consists of the protoxide; mixed with much of the peroxide; the other, a red schist, is almost entirely composed of red oxide, but in the centre of the mass it affects the magnet. Not far from where this rock occurs, Dr. Malcolmson collected specimens of hornblende schist, leaving little doubt as to the ores being of the same nature, the former having become altered in situ in the same manner as some of the superficial strata at Deendoortoe are seen to do. Dr. Malcolmson therefore concluded, that the superior quality of the Nirmul iron depends on the ore being a comparatively pure protoxide. And certainly is not dependent on the nature of the fuel, which is much the same in both places.* Captain Herbert, indeed, long ago suggested, that the su-

* Iron which has been ascertained to be superior, for many purposes, to the best German iron has been recently imported from the western coast of India; but the mines from which it was obtained have not been examined. Captain Jervis, of the Bombay Engineers, however, informed him, that ores, powerfully affecting the magnet, exist in great quantity at Taygoor, a village of the Koncan not far from the port from which the iron in question was procured.

in many cases, the ore is not in large quantities in situ but is disseminated in minute grains through the mass of rock and would never repay any labourers search for it, in the rock itself.

Magnetic iron exists similarly in the basalts of Ireland and England, but in particles so minute that they can be detected only by chemical tests, and in such cases nothing that could be collected would repay the toil. But man has a powerful assistant in the elements which act upon and disintegrate the mountains, and deposit, as in this case, in the beds of mountain streams, the heavy metallic ores ready prepared to his hand, for collection. This ore is extensively smelted; with implements powerless to excavate the more massive ores and furnaces and bellows too small to smelt them, wherever these iron sands are to be had, the people prefer them, as with simply washing they can procure an ore of great purity; for the magnetic oxides, and this sand is often magnetic, contain about 72 per cent. of iron and in Southern India they seem to be the most generally diffused.

The first enquirer into the iron ores of the Madras Presidency was Dr. Buchanan from whose work there is much to be learned regarding the ores of Canara, Malabar, Salem and Mysore of which last named country Captain Newbold and Dr. Clarke have given recently additional information.

Contemporaneous with Dr. Buchanan or it may be a little preceding him, was Dr. Heyne whose mind embraced many branches of science and who described the iron manufacture of Rajahmundry and of North Arcot:—then the lamented Dr. Voysey, to whom we are indebted for the first account of the Conasamoodrum steel which has long been exported for the manufacture of the famous Damascus scimeters and which was more recently described by the late Dr. Malcolmson. The only writers, however, who have attempted a scientific explanation of the process of iron making in this country are Mr. Heath and Captain Campbell, and as it would swell this report to a quite unwieldy size to enter at length into these two writers' views, it must suffice to mention that Mr. Heath considered the product of the native furnaces to be iron, which was subsequently converted into steel, while Captain Campbell believed the output to be steel, similar to the native steel of the Catalan and some German furnaces. And there seems every reason to believe that Captain Campbell is quite correct and that the product of many of the ores smelted in the native furnaces of Southern India is steel, perhaps very variable in quality, even the same, perhaps, containing portions of different quality, but still sufficiently characterized to be classed as a variety of steel. The writings of all those enquirers, however, had given us a considerable knowledge of Mysore; a little regarding the ores of Salem and a full account of the process at Sautghur in North Arcot;

of Lutehepoorum in Rajahmundry and of Conasamoodrum in Hyderabad; but all the rest here furnished is new.

It will be seen from the above, however, that the iron ores of several parts of the Madras Presidency and the products manufactured from them have engaged considerable attention during the past fifty years, and the Madras Government have amply showed how very important they considered this manufacture to be by their expending in principal and interest £90,000, (Rupees 8,22,240, see Sir V. Stothhouse letter dated 23d August 1849) to promote the enterprise of the late Mr. Heath and the former Porto Novo Company who, for the past 25 years, had been endeavouring to turn the ores of South Arcot, Canara, Coimbatore, Malabar, and Salem, to profitable account. These efforts of Mr. Heath and the former Porto Novo Company were, however, wholly commercial; and except from the earlier papers of Mr. Heath and those of a more recent date by Captain Campbell, little was known; for the recent voluminous Parliamentary return (20th June 1853) contains not much of scientific interest, and little information even of that definite nature regarding the localities of the ores which it is, at all times of importance to possess.

The circular letters which I dispatched were drawn up in accordance with these views, my objects being as stated below.* And a very cursory examina-

* 1. To ascertain the name of each site in each division of the Madras Presidency where iron ore, whether mined or not, exists; with information as to its abundance and with specimens of the ore from each site.

2. To obtain the name of each site where iron ore is mined or extracted; the quantity of ore which can be collected by one man in one day, and the process of collecting it, with information as to whether it is smelted on the spot, or sent to any other, and what place to be smelted.

3. To learn the name of each site where a furnace exists, with drawings or plans of the furnaces and of the apparatus employed in smelting the ore and working the iron; to obtain an estimate of the expense of erecting a furnace, and of the cost per month of working it; with the quantity by weight of ore that one furnace contains.

4. To ascertain the names of the Talooks and Villages where iron is produced in most quantity; the quantity and kinds of iron produced yearly in each collectorate and their selling price; also the quantity of iron exported from each collectorate and places to which it is sent.

5. To find out the descriptions of iron and steel now manufactured; with information as to the process by which the ore is converted into metallic iron and this into the commodity sent to the market, and to collect specimens of the iron and steel from each furnace and forge.

6. To obtain a return of the quantity of iron imported into each collectorate, the places it is brought from, its selling price, and the purposes it is applied to.

7. To learn the names of, and samples of all the tools, implements, &c. manufactured in each District, from the iron of the District, with the selling price of each implement.

8. Where iron is not now manufactured in any District, to discover whether it was so in former times, and, if so, why the smelting has ceased to be practised.

9. Where the charcoal which is employed in smelting the ore is brought from, at what price it is sold, at the furnaces, and what quantity of it is expended for one smelting.

in the *Koodleghee talook*. It was washed by the rains into the rivulet from off a piece of high ground near it, and after the rivulet ceased to flow was gathered and washed and iron produced therefrom, but the iron sand became exhausted and the people abandoned the place about 5 years ago and took to manufacturing iron from ore gathered on the hills of Sundoor.

There were formerly two furnaces in the village of Koylargootty in the Hoovenhugaly talook, and the iron ore was brought to them from the hill of the village of *Iyannahally* of the same talook, which however from want of charcoal,—fell out of blast about 15 years ago.

A person from the Mysore country took up his residence at Rampoor in the Gooty talook, established furnaces and carried on a trade there, but he lost by it and went away. Iron has not been manufactured there for the last 20 years.

About 40 years ago when there was much wood in the jungle of the village of *Hoossainpoorum* in the *Kodecondah* talook, some of the inhabitants of the Mysore Territory residing in the neighbouring villages erected furnaces there but from want of wood in the jungle these have since ceased to be worked.

Furnaces were constructed also near the villages of *Koornhoolapully*, *Deesharapully*, *Mudakalipully*, *Ramaghirry* and *Moasherkovila* in the *DURMAVEN* talook, and experiments continued for a year, but as the iron sand and charcoal were scarce they did not prosper and were given up.

Wood is generally cut in the jungles nearest the furnace and reduced to charcoal on the spot, this work being performed by hired labourers, the fire is extinguished by covering the burning wood with earth; the process takes 4 days and about 100 pukka seers is made in a day by one man.

The names of the trees from which charcoal is made are *Vellanasutta*, *Guddadhardhee*, *Chendradhy*, *Corundbathie*, *Junapadhee*, *Janacutay*, *Chogaraoutty*, *Patcharry*, *Thedajunadhy*, *Narapadhy*, *Curracey*, *Nemusecuttay* *Poosoomareddy*. And it is said that the charcoal from other wood than the above does not answer so well.

Iron smiths and others consider English iron to be more malleable and better adapted for some work, but for making tools and implements they prefer country iron: they say that if the former be once heated it becomes very brittle while the country iron stands repeated heatings, and all work people, therefore, prefer tools and implements of country iron.

The hire of a Smith varies from 2 to 6 annas a day according to the custom of the different villages.

The furnaces are erected only where there are extensive forests or rather low jungles of small trees. The woods diminish as the felling goes on, but as they make charcoal only in one part for a time, the trees grow up on the parts they have quitted.

The following points deserve consideration. In the *Koodleghee talook* the hill in Sundoor whence ore is brought is very high and the road to the mines bad, and much difficulty and inconvenience therefore is experienced in bringing the ore to the furnaces—this road ought to be made fit to drive carts on it.

The mine also from long use has become a den, so that the people work with difficulty as well from the depth of the ore as in passing it from hand to hand: there is also a fear of the hill above falling in on them; this indeed has occurred in some instances—and some remedy should be provided.

There is a small tank near the village of *Adharagunny Murdy* in the *Koodleghee talook* which has fallen into disrepair and the people and cattle have now to go a distance of a coss for water: its repair will benefit the trade and be the means of realizing a larger revenue.

In the *Hurponhully* and *Hudgaly* talooks, the roads to the sites of the iron ore and charcoal are so bad that the people are obliged to bring these in on cattle: if the roads were made fit for carts, much benefit would result.

In the furnaces for smelting the stone ore 465 maunds of iron is produced in each in a year.

In the furnaces where the gravel ore is smelted 305 maunds, and in the furnaces where sand ore is smelted in the large 360 maunds, and in the small 180 maunds in each in a year. Nineteen pounds of iron is produced from 100 pounds weight of iron stone; nine pounds from 100 pounds weight of gravel ore, and 25 pounds from 100 pounds of sand.

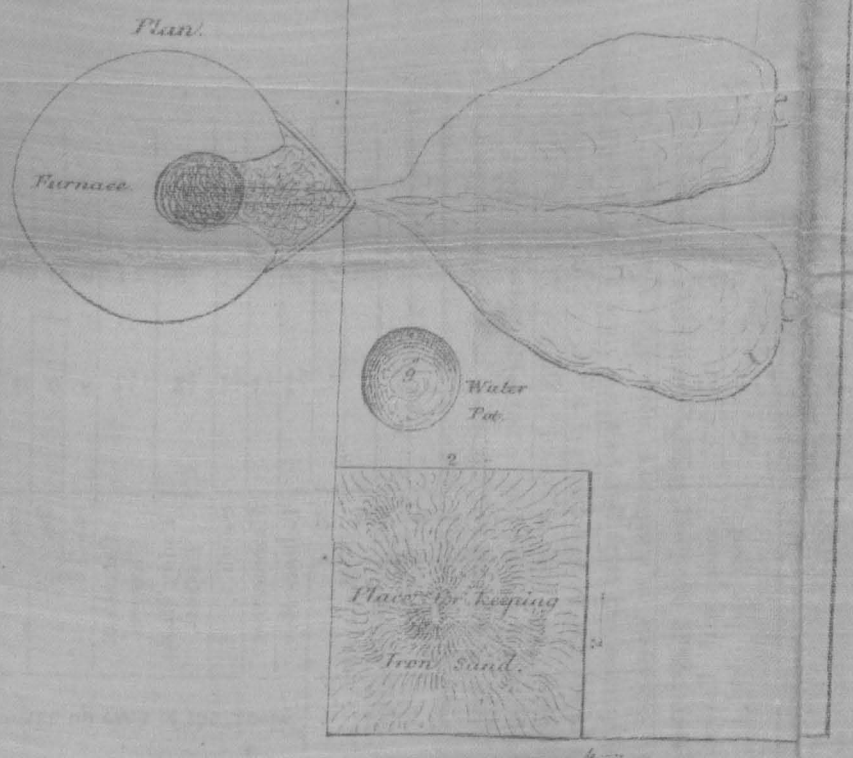
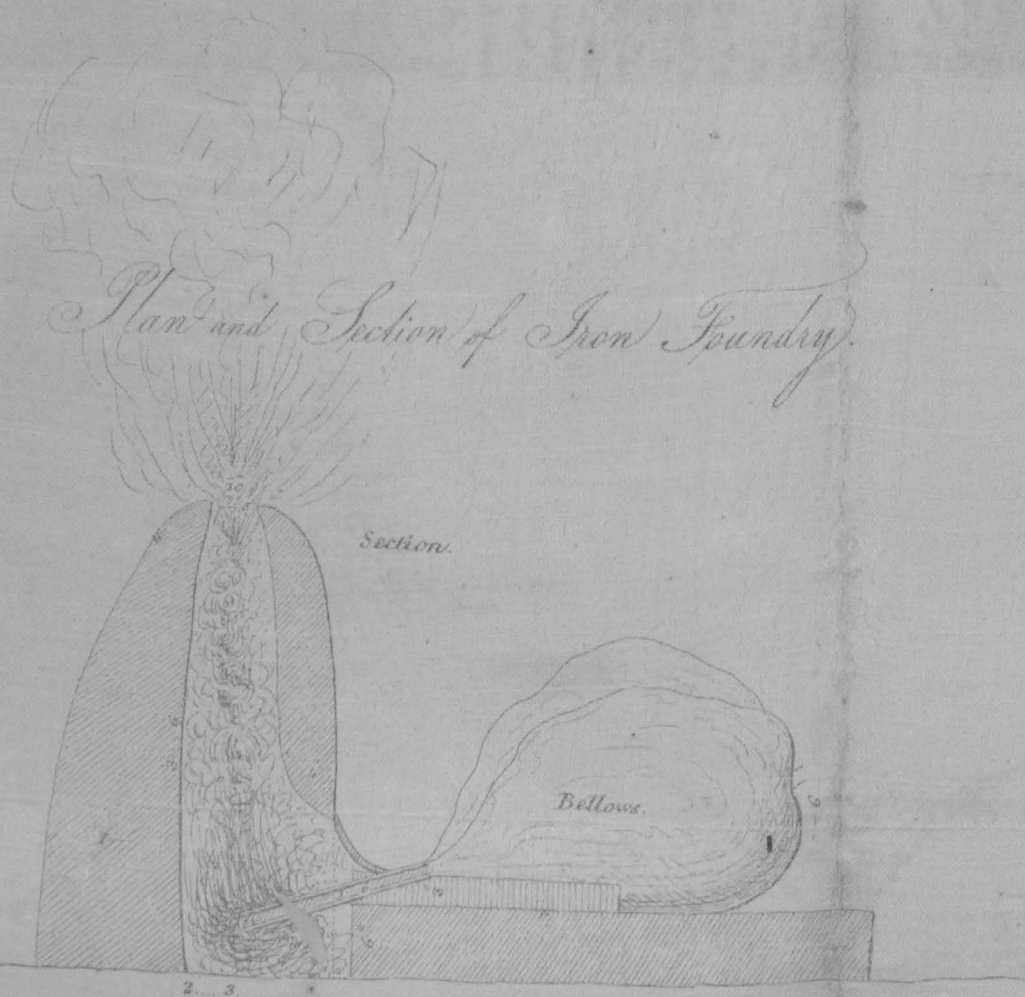
A half of the crude iron is lost in preparing bar iron, but sometimes when the first iron happens to be good only a quarter is lost.*

BOMBAY.

Although the cantonments in the southern and central portions of the Presidency of Bombay have all, from time to time, been held by the Madras army, and indeed, the Southern Mahratta country may be said to be more frequently in the occupation of Madras troops than in those of the western

* Note.—Since the above was sent to the Press a valuable report has reached me from Brigadier Yaldwyn.

Plan and Section of Iron Foundry.



(Signed) J. J. Bourdillon,
Collector.

Army, notice is here taken of the latter Presidency only to mention that iron ore does not appear to have been discovered in any of its districts on the Madras frontier, and these are probably supplied with iron from Canara, Malabar and Mysore. Colonel Sykes mentions the existence of ore and furnaces at Mahabuleshwur, in the Dekhan, and Dr. Castello has favored me with specimens from there. Colonel Sykes mentions (*Madras Journal of Literature and Science* Volume 6 Page 364) that no other ore than that of iron is found in the Dukhna and it was only worked to his knowledge, at Mahabuleshwur, at the source of the Krishna river. It occurs there as a nodular hematite, associated with laterite.* This ore, adds Colonel Sykes, produces the celebrated wootz Steel.

A list of the specimens of iron ore from the Bombay district now in the Museum will shortly be prepared.

CANARA

is the most northern of the Madras Collectories on the western side of India and has Goa and the Bombay Presidency as its northern boundary, Malabar to the south, Mysore on the east, and on the west the sea extends along the coast. It has an area of 7,720 square miles and 995,656 inhabitants and for revenue purposes is arranged into twelve talooks.

Ankola,	Buntwal,	Oodipy,
Barcoor,	Cundapoor,	Pootoor,
Bekul,	Honore,	Soopah,
Bilghi,	Mangalore,	Sondah.

In general aspect the country is rocky and uneven, for the western ghats covered with dense forests in some places approach near to the sea, and in others spurs of rocky hills stretch from the ghats towards the sea.

It has been stated that the bisulphuret of iron or iron pyrites exists in abundance both in Travancore and Canara (*vide Proceedings of Madras Central Committee* p. 225) and Mr. Heath seems to have become early acquainted with the existence of valuable ore in Buswarajdroog, a fortified island three miles north of Honore, for Canara is one of the districts which the monopoly of the Port Novo Company includes. Dr. Leslie informs me that it exists in large quantities and that one man can procure about 1,120 lbs. a day, (his daily wages is 3 annas) and it can be easily shipped on board vessel anchored near, except when a heavy swell is running, as there is no harbour or other shelter; but he thinks that a pier could be easily thrown out. This ore is not smelted in Canara but is chiefly sent to Calicut.

Charcoal can be made in abundance in the neighbouring jungles.

Mr. F. N. Maltby reports that iron ore is abundant on the surface of the

ground in South Canara and the supply of wood unlimited. The site is a high plateau in the Soopah talook at an elevation of 2,000 feet, and will be within 25 miles of water carriage to the coast as soon as a new Ghât, now tracing is completed. Limestone also is found in proximity to the iron.

Mr. Hall has favored me with a valuable collection of specimens of the iron ore found in North Canara, as well as of the metal manufactured from it and the following interesting report.

In North Canara the practice of making iron, is confined to a class of people called "Koolhurs," who are a poor race of Hindoos living in the Forests, and their method of manufacture is as follows.

They first break the iron stone up into small pieces, and then throw them, well mixed up with a quantity of charcoal made of particular kinds of wood, (in the proportion of about four of the latter to one of the former,) into a hole or cavity in the ground, which they previously prepare as a smelting furnace. When the hole is filled, they set the charcoal on fire and keep it briskly burning by powerful bellows, replenishing the quantity first thrown in with more stone and charcoal, as the heap subsides in the course of burning after this process has been continued for some time, the metal becomes cleared of the earth and stone, and is then gradually beaten out with hammers into bars of pure iron, in which state it is brought to market. They employ no flux for smelting, and their tools are of the rudest kind.

The average price at which they sell their iron, may be set down at two rupees a maund (28 lbs) but as its manufacture involves no actual outlay of money but only the labor of the parties engaged in the work, he is unable to say what the real cost of production is.

The iron ore is found very near the surface of the earth, and it is rarely necessary for the people to excavate more than 5 or 6 feet deep. They carry the stone from the mines to the smelting places in baskets and there break it up.

Iron ore is to be found in a great many places throughout this District, but there has not, as yet, been any systematic attempt made to collect or work it, excepting on the island of Buswaraj Droog, off Honore, in the Honore Talook, from whence a good deal of ore has, at different times, been taken to Bepoor to be smelted.

It is not easy to say how much ore can be collected by one man in a day, as the natives work in such a desultory manner. They dig away the earth with a common mamoty, and then raise up or break off by means of crow bars, and pickaxes such portions of the stone as they can easily get at.

Since the abolition of the transit duties, there is no means of knowing

tion of these desiderata will suffice to make it evident that a much greater interval than five or six months would have been required to ascertain all the points indicated, but the copious stores of information which have been sent me, will show how much has been now done, and will help others in their future labours.

The time for this enquiry was also favorable; the great rise in the price of iron, from Rupees 14 in 1851 to Rupees 33 per candy in 1854, and the still greater price which the prospect of a general European war seemed to point to was an inducement to ascertain what the people of this country are doing and could do with its ores of Iron. And I think that the various reports will show that, for all the smaller implements used in manufacturing and agricultural pursuits, the Native furnaces are producing a steel iron infinitely superior to any thing obtainable in England and which will stand a comparison with the best Swedish and Russian irons, and that its price at the furnaces is lower than that of iron worked on the European plans. The following table will show what iron has been selling at here and in Europe.

10. Whether the forests in the neighbourhood be extensive; whether they be diminishing in extent or otherwise, and what amount of charcoal can be made by one man in one day.

11. Whether the blacksmiths, in the District prefer Indian or English iron; and what reasons they give for their preference of either.

12. What the daily wage is of a blacksmith in each District.

13. To obtain suggestions for any simple improvement on the methods now adopted by the native manufacturers with a view to cheapen the cost of production;—either,

(a.) by facilitating the excavation of the ore from the mine; or

(b.) bringing the ore from the mine to the furnace; or

(c.) facilitating the preparation of the charcoal, with less waste; or

(d.) in bringing it to the furnace; or

(e.) in the structure of the bellows, hammer, or other simple implements; or

(f.) in producing from a given quantity of ore, a larger quantity of metallic iron; or

(g.) in the construction of roads to the mines or to the forests where the charcoal is prepared.

14. To ascertain the quantity of metallic iron produced from one smelting, so as with the information asked for in the last part of question 3, to show how many pounds weight of metallic iron is produced from 100 pounds weight of the ore.

15. The quantity of metallic iron lost in the process of preparing bar-iron from it.

Statement of value of Iron, Bar, Square and Bolt, suitably assorted for the Madras Market, from January 1851, to June 1854.

Article.	Year and Month.	Price per candy in Madras.		Price of Europe Market per ton.	
	1851.	Rs.	Rs.	£. s. d.	£. s.
Iron Bar.	January	14	to 15		
do.	February	14	to 15		
do.	March	14	to 15		
do.	April	14	to 15	5-5	to 5-10
do.	May	14	to 15-4	5-5	to 5-10*
do.	June	14	to 15-4		
do.	July	14	to 15-4		
do.	August	14	to 15-4		
do.	September	14	to 15-4	5-2-6	to 5-10
do.	October	14	to 15-4	5-2-6	to 5-10
do.	November	14	to 15-4	5-2-6	to 5-10
do.	December	14	to 15-4	5-2-6	to 5-10
	2				
	1852.	Rs.	Rs.	£. s.	£. s.
do.	January	14	to 15-4	5	to 5-5
do.	February	14	to 15-4	5	to 5-5
do.	March	14	to 15-4	4-17	to 5-2
do.	April	14	to 15-4	4-17	to 5-2
do.	May	14	to 15-4	4-17	to 5-2
do.	June	14	to 15-4	4-17	to 5-2
do.	July	15-8	to 15-4	5-7	to 5-15
do.	August	15	to 16	5-10	to 5-15
do.	September	15	to 16-8	5-17	to 6
do.	October	16	to 16-8	7-15	
do.	November	18	to 19	8	
do.	December	19-8	to 20-8	8	
	1853.	Rs.	Rs.	£. s.	
do.	January	19-8	to 20-8	9-10	
do.	February	19-8	to 20-8	9-15	
do.	March	22	to 22-8	9-5	
do.	April	22	to 22-8	9	
do.	May	22	to 22-8	8-15	
do.	June	22	to 22-8	8-10	
do.	July	22	to 22-8	8-10	
do.	August	23	to 24	8-10	
do.	September	23	to 24	9	
do.	October	23	to 24	9	
do.	November	23	to 24	9	
do.	December	26	to 27	9	
	1854.	Rs.	Rs.	£. s.	
do.	January	26	to 27	9-10	
do.	February	26	to 27	9-10	
do.	March	26	to 27	9-10	
do.	April	26	to 27	9-10	
do.	May	33	to 33-4		
do.	June	33	to 33-4		

In the Europe market the pig iron has risen in three years from £5-5 to £9-10 and in the Madras market bar iron per candy from Rs. 14 to Rs. 33.

Besides this, Government are, themselves, considerable importers, as well of iron and steel as of implements made of them. These, on importation, are dispatched at a great expense to the out station Arsenals and on all the articles sent 5 per cent. is charged, on account of carriage, if within 100 miles and 10 per cent. if above that distance; this was the case until these enquiries were commenced though there can be no doubt that, in all the districts where our Arsenals are situated, their steel-irons and steel, would furnish implements and tools greatly superior to any thing brought from England: as the proof of which I may point to the reports which shew that Native furnaces are in active operation on the sea-board and even near the Porto Novo Company's works and that the people almost invariably prefer Native iron to that from Europe. The quantities of iron and steel imported by Government have, for the past 5 years been as follows.

The quantity of English iron imported or purchased for the public service for the following years, has been.

English Iron.				
	T.	C.	Qr.	Lb.
1848-49	419	1	0	9
1849-50	17	17	3	16
1850-51	45	18	0	11
1851-52	68	14	0	10
1852-53	4	5	2	16

Received
from Europe.

English Steel.				
	T.	C.	Qr.	Lb.
1848-49	5	0	3	10
1849-50	2	9	2	1
1850-51	0	3	0	4
1851-52	4	17	2	21
1852-53	none	0	0	0

Received
from Europe.

T. C. Qr.

The cost per ton for iron has been 112 ... 2 ... 7 per ton.

Do. do. for steel has been 471 ... 10 ... 4 do.

Besides the above 18 tons 4 cwt. 3 qrs. $\frac{1}{2}$ lb. of iron, and 6 cwt. 18 lbs. of steel were received from the Commissary General during the five years the former at an average cost of Rupees 153-11-2 and the latter at Rupees 392-6-2 per ton.

Besides exhibiting the superior quality and the great extent to which steel iron is produced throughout this presidency there is one fact shown, connected with the best interests of this manufacture which merits the early consideration of Government. It is the slow but general diminution of the forests or wood tracts from which the smelters procure their charcoal. It is to be supposed that, with the increase of population, the forests in their vicinity would be cut away, but, this Government and the Honorable Court are so fully alive to the necessity of foliage in a tropical country that it is only necessary for me to draw attention to the diminution going on to have measures taken, to secure for the country, and the people themselves, therefore, that trees cut down for fuel should be as little wasted as possible:—So far as can be gathered from the reports which have reached me, there is great waste from the defective mode of making charcoal, and I append a very recent article from Mr. Tomlinson's dictionary explaining the modes adopted in Europe in the manufacture of this material.

In addition to those papers on the influence of trees on climate by myself, by General Cullen, and Dr. Smith, which Government published in 1848, and 1849, there has been much correspondence on the subject of the forests of Southern India, (See Parliamentary paper Porto Novo Works, pages 103, 150, 154, 155, 162, 250, 263, 268, 277, 299, 312, 313, 314, 315, 316, 317, 311, 313, 4, and 6, 314, 5-6 and 317 to 321, 323, 4, 5, 6: 338, 9, 40, 61, 2, 3, 4, 346; 369, 370, 371, and 374) with reference to their uses as fuel;—but, for both objects, it is necessary that some general measures should be introduced to preserve them from useless waste. Colonel Cotton, in one of his reports on the Porto Novo Company, considered that the forests from which their supplies of charcoal were obtained, were inexhaustible, and Mr. Dalryell, who has sent me a valuable report on the iron ores of Salem, has mentioned that the forests, there, have sustained no diminution. But it may be safely asserted that, if mining and smelting operations ever be carried on with activity the best of the trees and even the most extensive forests in India would diminish and disappear as they have done in other countries; and their diminution would be hastened by the wasteful processes of the charcoal burners;—this country's productiveness of iron can be limited only by the amount of charcoal and every care should be taken, by introducing a regular system of cutting and planting, to preserve the woods from which it is made. The need of this care is proved by the fact that the great obstacle which the former Porto Novo Iron Company had to encounter was the want of a regular supply of charcoal—and that obstacle has not, as yet, been overcome. In Sweden, where is produced the best iron for making steel, the Government permit only a certain number of tons of it to be manufactured annually. This

ARCOT, SOUTHERN DIVISION.

This collectorate lies between Latitude $12^{\circ}16'$ and $11^{\circ}20'$ south, and Longitude $79^{\circ}50'$ and $79^{\circ}8'$ east, with the collectorates of Chingleput and the northern division of Arcot on its north; those of Trichinopoly and Tanjore on its south, the Coleroon river running between them,—on the west Salem, and on the east the sea. South Arcot has an area of 7,610 square miles, and contains 873,925 inhabitants. It is arranged for revenue purposes into thirteen talooks.

Chaitput,	Morcanium,	Trenomallie,
Chellumbrum,	Munnargoody,	Trevandy,
Cuddalore,	Tindevanam,	Verdachelum,
Cullacoorchy,	Trecullore,	Villapoorum.
Ellavanasoor,		

This collectorate forms the southern division of the Carnatic, and lies low. The parts nearer the sea are flat and sandy with solitary hills of igneous and volcanic origin projecting from the surface: but further inland it is more hilly with some large tracts of jungle. Amongst its principal rivers, are the Coleroon, which is the name given to the north branch of the river Cauvery, the Pennar, the Vellar and the Yerrady. In the vicinity of Pondicherry and westwards towards Trichinopoly the prevailing rocks are of the supra cretaceous group containing numerous fossils imbedded in limestone.

The attention of the European community has long been attracted to the iron ores and the iron of this district and more so in later times from the circumstance of Mr. Heath having formed his first manufactory at Porto Novo, one of its towns. This town is thirty-two miles south of Pondicherry, on the sea coast, has a harbour susceptible of improvement and the river Vellar discharging itself into the sea, below the town.

South Arcot is one of the districts included in the Porto Novo iron company's monopoly, but, there is nothing in the ore, which is an argillaceous iron stone, nor in the position which has been chosen, to explain why Mr. Heath selected this district and the following returns which Mr. E. Maltby has kindly favored me with will shew that many small native furnaces are still in blast, and of course, working profitably,—there being still seventy villages throughout the collectorate where its ore and ores from North Arcot are smelted. This will be found to be the case, also, in Malabar, in which collectorate there are still a number of native furnaces in active operation, and this seems to show that, were the native manufacturers taught to make some improvements of easy introduction,—improved form of bellows; improved form of hammers and smaller implements; were some arrangements made for pro-

iron sells at £ 40 a ton, and is monopolised by the Messrs. Sykes of Liverpool and unless for some very grave reason the Swedish Government would not restrict the quantity produced. Their reason is the want of wood for charcoal and as, in that cold country, 20 years are required for a new plantation to grow into timber, only a certain portion of the forest is allowed to be cut down annually and the spot replanted. The present processes of the charcoal burners of Southern India, are most wasteful. The only check upon those engaged in iron smelting is their own preference to certain kinds of wood; but those who cut wood for fuel and for making charcoal for other purposes than that of iron smelting, in many of the forests have no restraint and in others are only prohibited cutting down timber trees,—but there do not seem to be sufficiently stringent measures adopted to secure effect being given to this prohibition. As I am to be reporting in December next, on this country's forests and woods, I will, by that time, have sufficient information to enable me to offer some suggestions on this important point, but, now, it appears advisable to have efficient native conservators of forests and stringent rules for guidance in cutting and replanting. There is another point on which it is necessary to say a few words. While I have been enquiring on the subject of the iron ores of Southern India, questions have been put to me as to the probability of discovering coal. "Coal occurs extensively in many provinces of the Indian empire, Tonasserim, Cuttack, Bengal, Arracan, Burdwan, Sylhet, Assam, Rajmouhal, Behar, and Nerbuddah and on the Godavery." In every instance, iron ores, either the common clay iron stone, or a red or yellow iron stone, containing from 30 to 50 per cent. of iron, occurs with the coal, or extensively in the same district—but the fossil remains which have, as yet, been received from south of the Godavery do not afford the least prospect of finding coal in any Collectorate of this presidency. But, even if coal were discovered, to-morrow, and in the greatest abundance, it is necessary to express clearly that, so far as regards the iron trade, it would not do much good to this country which will be long before it can compete with the common iron of England and that every pound of coal used in smelting the rich ores which every where cover the surface of this country would, by so much, deteriorate the value of the product: for iron made by coal is always inferior to that made by charcoal from the coal being more or less contaminated by the presence of sulphur. As iron smelted with charcoal undoubtedly works the most kindly, so it is certainly the best when the same description of fuel can be used during the working of it, and the native black-smith always prefers his own ill smelted iron, to the English, from the greater facility with which he can work it up: even if coal, therefore, existed on the spot, it would not be proper to use it so long as charcoal can be had, as it would make what might be a good iron only an inferior one. At present, from all furnaces of Southern India, the pro-

duct is either a kind of steel, or an iron well suited for making steel, for which coal-smelted iron is wholly unsuited. I do not know what amount of iron is smelted in the Madras Presidency, but Captain Campbell in one of his letters speaks of iron to the value of three-quarters of a lakh of rupees leaving one district on the west coast and Mr. Gleig says that, in Salem alone, between two and three lakhs worth of iron is made at the native furnaces.

If these statements be in anything like the truth, there must be, at the very lowest calculation, iron of the value of half a million sterling annually produced in the districts which I have here attempted to report upon and a manufacture of this extent is not undeserving the fostering care of Government.

Far superior to the ores of England, which contain on the average only 33 per cent. of iron, and equal to the best ores in the world, all that is wanting to the people is the knowledge of working them on a larger scale and working them economically. For the natives of the country already produce iron and steel reported to be equal to the best products from Dannemora, and the immense number of furnaces all over the country, from which, from their very numbers, a vast amount of iron must be produced, is a sure indication that, with all the waste the people of this country are still preparing an article which the European furnaces cannot compete with.

This being the case, it may be asked what more is required of the country. What is required is that it shall be able to export to England and other countries the steel iron, which is now chiefly obtained from Sweden and from Russia.

This is perhaps to be effected only by introducing greater economy into the processes of smelting; a less wasteful mode of manufacturing charcoal;—improving the roads to the forests and the mines; using rails and wagons on the slopes of the mountains;—more powerful bellows; larger furnaces:—and teaching the workers how to smelt the massive ores, with a flux. The mere process of smelting must ever be the same—everywhere—and it is only in the more economic use of the materials that the hope of this country must be held in. The extent of loss from wasteful processes is very great, and so much was this formerly the case that even in England old workings have been gone over again, and a profitable result obtained from the rubbish of the ancient bloomeries, from the ore of which much of the metal had not been extracted. That this imperfect smelting equally prevails here is clear, because from oxide of iron containing 72 per cent. of metal the native smelters, as will be observed from the subsequent reports, are only obtaining 33 per cent. of metallic iron.

teaching the forests, teaching them to make their charcoal cheaper and better; showing them how to shore up the roofs of their galleries and explaining to them the advantages of a tramway—on the slopes of the hills where ore is mined, as even now, the people hold their own, at least make all their own implements of husbandry, they could compete with any company or any foreign country.

Ores are found in the villages of Talacoonum and Moodayoor in North Arcot extensively and are smelted for local consumption at Vylamoor and Kurasampoodi. The ores from the two villages are found differently situated. In the Talacoonum village they are excavated at a depth of five feet, on the top and at the base of a hill, and are powdered before smelting. The wood employed is that termed Caringal, and about 3 or $3\frac{1}{2}$ viss of pig iron is produced at one smelting from which about $\frac{1}{2}$ or $\frac{1}{4}$ th of a viss of malleable iron is obtained by subsequent heating and hammering.

In the Cullacoorchy talook the following return exhibits the sites of the ores and the villages it is smelted in with the other data.

<i>Villages where ore is to be found.</i>	<i>Villages where ore is smelted.</i>
Manamalay	Manamalay,
	Namasevayapoorum,
	Tottum.
Kosappady	Kosappady,
Peckonum	Peckonum,
	Solumputtoo,
	Pottai.
Kantoovunnypeathoor	Kedungoodayanbuttoo,
	Shrotrium Coluttoo,
	Selluckoy Coopum.

These ores are excavated at about 2 yards deep at the foot of hillocks, each man being able to dig up eight Madras measures per day. When pounded, which is done with an iron bar, three-fourths of the ore is left serviceable. Crude iron lumps are sold from 2 to 4 annas according to their weight: and steel at 4 annas the piece. The crude iron lumps are worked into thick masses of malleable iron, but not like those prepared in the western and northern provinces. During the process of converting the crude into malleable iron half the quantity is lost. The lumps are not sold by weight but by sorts and quantities.

The village of Vanamputtoo is the only place where ore is smelted in the Ellavanasoor talook; the ore being brought to it from Callamadoo, Coolocoor-

chy and Arunthum. In each of these three villages there are from ten to twenty pits from which the ore is taken and it is of the same kind in each. The iron stone is found near the surface, at a depth of about 3 feet in the villages of Arunthum and Callacoorchy; but, in the village Callamadoo at a depth of 50 feet. The men who smelt the ore generally buy 40 viss of this ore at 2 annas a parah. Twenty-two and a quarter viss of cleaned ore on being smelted gives 9 $\frac{1}{2}$ viss or 47 per cent of crude iron, and 5 viss or 19 per cent of malleable iron, which is sold at 1 anna 8 pie the viss. Except in one village, where a tract of twenty cawnies yields this ore, it is found only on small patches of ground not exceeding a quarter of a cawnie in extent. The ore is exported to the Verdachellum talook in certain villages of which it is smelted.

There appears not to be any iron ore in the Trevandy talook, but iron is manufactured at the villages of Cattoocoodalore and Veerasom Coopum from ore brought from the Ellavanasoor talook. The ore costing $4\frac{1}{2}$ annas the parah.

The stones are roasted in a furnace built of earth and stone, for 18 hours, and then are pounded with granite stones. After sifting the powder to separate the ore, this is put into another furnace with charcoal (5 to 1,) and a blast with two bellows, one on each side, kept up for eight hours, when the ore melts and runs into the pit beneath the furnace; this mass is taken out by pulling down the front of the furnace and is sold at 13 viss per Rupee; it is put into the iron smith's forge and being then well hammered gives one part of malleable iron and 2 parts of refuse.

In the Trinomalay talook, the manufacture of iron is the most extensively carried on—as will be seen from the following return.

The massive ores too remain wholly unworked; or the larger pieces are thrown aside and only the smaller or such as are easily pounded are made use of. The native smelters, also, do not use any flux, which may be one cause why so much of the metallic ore remains unreduced: sufficient indeed that workers, on the economical processes of Europe, would, I am inclined to believe, find the slags and scoræ of this country's furnaces richer in metal than the average of the English ores.

Another improvement to be shewn them is a cheaper and less wasteful process of preparing a better charcoal. At present the timber which they cut is sometimes prepared in the open air, by which a very great portion of the carbon is burned off and sometimes in pits and a common mode of extinguishing the smouldering mass is by throwing water on it. In this way much of the timber is lost in the burning, and the charcoal which remains is injured by the water. Even in this country, therefore, it is by improvements in mechanical preparation that economy can be introduced, rather than by any of the metallurgical processes which have long since been carried to perfection.

The announcement of superiority of the ores and iron of Southern India, to any ore produced or iron manufactured in England, may be new to many minds here, and officers in charge of our arsenals may be deceived by their smiths telling them that they prefer English to Indian iron. To the smiths of our arsenals, who do not care for the quality, the English iron and steel is infinitely preferable. To these men, and all who wish work rapidly turned out, English iron is more useful from its being purchaseable in the form of bars, rods, sheets, wires, &c. while a rough and shapeless mass is turned out of the Indian forge. But this has nothing to do with the quality of the material, and the natives of this country, whose implements can neither be easily nor rapidly replaced, must use materials which will last. In this they act similarly to the woodsman of America who will pay double or treble the price for an axe which he can trust to in the remote backwoods than for an article of English manufacture the edge of which may turn over on the first blow.

Another point is the better smelting of the ores, in order to get more out of the materials employed than the 30 per cent. now obtained. The necessity of this may be shewn by mentioning the greater yield in Britain where the powerful blast enables ores to be employed which in India would be regarded as too poor to work. Every ferruginous ore indeed is regarded as an iron ore when it contains more than 20 per cent. of metal, and the richer ores, such as the red hematite of Cumberland and the magnetic of Sweden, yield from 50 to 70 per cent. In Britain, the clay iron stone from which the great mass of iron is produced, yields, on an average, from 30 to 33 per cent.; in the principal mining district, South Wales, poor ore yields 31 and rich ore 42 per cent.

though the South Wales coal field extends over 800 miles and is the most important of the British coal fields. Wales ores, on the average, contain about 33 per cent. of metal and the average price is 8s. per ton. In Staffordshire 17s. per ton. The Gubben or Duddley ore fetches so high a price as 16s. and 17s. a ton and contains about 40 per cent. of metallic iron. At Merthyr Tydvil South Wales about 3 tons, 7 cwt. of its clay iron stone, are required to produce one ton of cast iron. Of all the iron produced however the Swedish is most suited for the manufacture of steel. The iron ores of Scandinavia consist of magnetic iron ores mingled accidentally with specular ore and their average yield is as much as 46 per cent. and the most celebrated of them are Dannemora, Uto near Taberg, Mora and Phillipstad. The total production of the country is 133,500 tons. Even in America there is an immense abundance of magnetic iron ore and oligist and spathic iron and immense forests. The annual make of iron in the United States is estimated at 400,000 tons, the produce of about 298 furnaces of which 230 are charcoal furnaces. With all that, however, the gross annual production of iron in Great Britain is now upwards of 2,250,000 tons, of which quantity South Wales furnishes 700,000 tons; South Staffordshire (including Worcester) 700,000 tons; Scotland 600,000 tons, and the remainder is divided amongst the various smaller districts. To produce this quantity of iron, there are 450 British iron furnaces consuming annually 10,000,000 tons, of coal and 7,000,000 iron stone, at an average cost of 48s. or 50s. per ton.

With these few and brief prefatory remarks on iron ores generally, I would introduce the following reports on the ores and iron and steel of the various Civil and Military districts of the Madras Presidency which for facility of reference I have arranged alphabetically.

AMHERST.

See Tenasserim Provinces and Eastern Settlements.

ARCOT, NORTHERN DIVISION.

The Collectorate of North Arcot has never had any of that attention paid to it which others of the districts of the Madras Presidency have received from the geologists of Southern India and which might have been expected for it considering its proximity to this city. It came into our possession in 1801, with the Civil and Military jurisdiction of the other districts of the Carnatic. On the North it has the Collectorate of Nellore and part of Cuddapah, on the West Cuddapah and Mysore. On the South Salem and the Southern Division of Arcot, and on the East, the Jaghire of Chingleput and the sea. Surrounded with rich and populous districts and with the sea on its Eastern border it is

Villages where ore is found.	Villages where ore is smelted.		
	Oochimalay, &c. 5 Villages.		
	Agarum,	Malepoonjai,	Peemanundul,
	Asoovanaachasoorkar,	Malepullyputtoo,	Pennattoor,
	Aurangr,	Malevunnakumbady,	Peramanundul,
	Auroor,	Maththoor,	Peeroomanum,
	Carooppoor,	Meyyoor,	Peroombakum,
	Chinnakongayanoor,	Molechungum,	Pinchoor,
	Chinnacoluppaudy,	Moodeyanoor,	Poolloothyoor,
	Gheggumpattoo,	Moothanoor,	Putty Ackeracaram,
	Govindumpattoo,	Mullynundul,	Sathanoor,
	Iyempollem,	Mullapahnaikenpoliem,	Savelpoondy,
	Karryunthul,	Munnattyputty,	Thavanundul,
	Keelavunnakumbaady,	Narasinganulloor,	Thurdapputto,
	Keernoor,	Nedoongavaudy,	Unthanoor,
	Konnilloor,	Nesampalypettan,	Vagghykul,
	Koorulpandy,	Nuttavaudy,	Vengoya Valore,
	Koekarapandy,	Oochimalay Cooppuna,	Varyvynoor,
	Kottacoolum,	Parayempattoo,	Voothapoondy,
	Kuttamadoovoo,	Paracacoluppaudy,	Voyvedanthongul,
	Malanachipattoo,	Pauchel,	Wooltharumpoondy,
	Malepandoor,	Paulippattoo,	Yaryoor.

Manner of smelting ore or converting it into Iron and Steel.—There are two descriptions of furnaces, the smaller of which is five feet high and two and half in circumference tapering to one foot at the top, into this the ore and charcoal are put together and a blast kept up on which the ore is smelted and the metal deposited at the bottom; it is then taken out and hammered. The furnace for crude iron is larger than the above; the ore used in it must first be well pounded and cleaned with water 3 times, and then put into the furnace, with charcoal, where it is smelted, and is taken out through one side of the furnace in the form of a lump of crude iron. Four and a half lumps of this material with two and a half of iron is put into a crucible and being melted is formed into a lump of steel, weighing six pollums, which is used for making iron smiths' chisels, &c.; in the process of converting crude iron into steel the quantity subjected to operation is reduced to one half:—

Eight Madras measures of ore put into the large furnace produce No. 1 valued 4 annas; this melted and hammered gives $1\frac{1}{2}$ viss of iron. Six measures of ore put into the small furnace give No. 2 valued $2\frac{1}{2}$ annas, which again when melted and hammered yields No. 3 weighing about $1\frac{1}{2}$ viss of iron. Steel is not producible at once from the ore which must be crushed in a mortar and well cleaned before it is put into the furnace for melting; four Madras measures of ore thus prepared and melted gives (No. 4) $2\frac{1}{2}$ viss of pig iron: $4\frac{1}{2}$ pollums of this product with $2\frac{1}{2}$ of iron being again melted gives No. 5 weighing 6 pollums of steel for iron smiths' tools, &c. sold at $\frac{1}{2}$ anna: the crude iron when put into the small furnace with a wastage of half the quantity produces steel No. 6 priced at 9 pice: the above specimens together with 2 measures of uncleaned and one of cleaned ore have been received. Ore is to be had to any required extent, at the foot of hills in the villages specified.

Verdachelum Talook.—In the Vardachellum Talook, iron is smelted at the villages of Poothanay and Catacherry from ore brought from Seangoorichy. This ore is found in that village in a tract of 20 cawnies of land at a depth of $\frac{1}{2}$ yard and is purchased by villagers in the Talook at $\frac{1}{2}$ Rupee per basket consisting of 5 pootters and carried to their furnace to be worked into iron.

Port Novo.—Dr. Malcolmson, (Royal Geolog. Soc. Trans. P. 548, No. 37) mentions that magnetic iron ore occurs in quartz rock near the iron works of Port Novo—but ores of this kind have not reached the Museum. In reply to my circular letter, Captain Benson furnished the Commissary General with the following additional remarks regarding the iron ores and iron of South Arcot.

1st. Mines containing the ore are situated at Callacoorchee, Ellavanasoor, Pallacolly. The mines are 25 feet deep and two men can dig 750 pounds of ore in one day, which is considered a good day's work: the ore thus collected, in its raw state, sells at 1,000 lbs. per Rupee. The miners appear to have no fixed daily pay but a certain percentage upon the amount sold.

2d. The tools and other implements manufactured in the vicinity of Cuddalore are ploughshares, mamoties, bolts, hinges, chains, locks, pickaxes, &c. &c. and the iron used for the aforesaid implements sells at 2 annas 6 pie per viss. Charcoal sells at six annas per candy. Two candies of charcoal are consumed in smelting one candy (500 lbs.) of ore—wastages of ore is calculated at $\frac{1}{2}$ of the lb.

3d. The smelting furnace is rude but simple. A cubical hole of 1 foot 6 inches is dug in the ground with a small aperture leading from the surface to the floor, answering the purpose of a tube for the bellows. The charcoal is first laid on the ground at the bottom or floor of this hole or furnace, and

favorably situated for trade, and for the export of any of its common products.

The districts which form the Collectorate were formerly known as Sati-vaid, Pulicat, Cow-cowdy in the Baramahal, part of the Balaghaut, and of the Western Pollums, but the Divisions into which it is now arranged, like those of other Collectorates, called Talooks, are as follows :

Arcot,	Chittoor,	Sautghur,	Trivitoor,
Cauverypauk,	Palamanair	Sholinghur,	Trevellum,
Chendragherry, Poloor,	Sutwaid,	Vellore,	
and			
Wandewash.			

The area of the North Arcot Collectorate is 5,790 square miles and it contains a population of 623,717 souls. Its physical aspect is very various, but it is in many places mountainous. Mr. Bourdillon, Captain Collyer and Mr. Sullivan, have sent to the museum numerous specimens to illustrate its geological features, but though these amount to 228 in number they are still insufficient to admit of any description of the country being given further than to mention, generally, that they consist of hypogene schists upraised by plutonic and volcanic rocks, and that no fossils have, as yet, been sent to me. From the specimens which have been received hitherto and the appearance of the country, through which I have four times passed, I think that many articles of use in the arts will subsequently be discovered in it, and one of these, its ores of iron and its products, is the subject of the following observations.

The earliest intimation that was given of the existence of ores of iron in the Collectorate of North Arcot was by Dr. Buchanan* who reported the rocks in the neighbourhood of Vencatagherry to consist, chiefly, of white granite, with large masses of quartz impregnated with iron, and mentioned that iron was smelted from the black sand found in the beds of the stream, near that village. He likewise ascertained that, about two miles from Naickan Eray, in the dry season of the year, iron was smelted by Teling pariahs from an ore in the form of black sand which was brought down from the hills of the neighbourhood by a torrent; and that each forge, in those days, paid a certain quantity of iron for permission to carry on the work.

Some years subsequently Dr. Heyne in his tracts (page 189 to 197,) described the method of smelting iron at Yeragutty near Satghur, and the people of the country are so slow to change, that his description may still be applicable to the smelters there. He stated that "the works or furnaces are under

a banyan tree, near a village called Yeragutty, about 4 miles south from Satghur. The workmen are exposed to the inclemency of the weather, without any other shelter than the shade of a tree, they can only smelt iron in the driest season of the year, from the beginning of January to the end of March. In the wet season or immediately after the rains, they collected the ore, which is a fine black sand found in small rivulets that derive their source from the neighbouring mountains. This ore is covered by a fine silicious sand, and when this sand is removed the ore may be procured in any quantity. Furnaces are made of red loam mixed with sand, and consist of two parts. The lower and larger is about three spans high and a foot in diameter, quite cylindrical, and erected over a hole in the ground, about 4 inches deep; its sides were every where about two inches thick. The upper part was conical, with the higher portion of the cone reversed, it was about eighteen inches high, and at the opening not quite a foot in diameter. The bellows were of the kind used by the iron smiths, and made of sheep skin, a hole being left near the bottom of the cylindrical part of the furnace to receive their nozzle.

"In order to smelt iron they cemented the two parts of the furnace with some loam and filled the bottom part of it with charcoal: this being ignited, they put upon them, with a flat plate made of basket work, one *sir* of iron sand, which they covered with four plates of charcoal. After blowing with the bellows for a quarter of an hour, they added another *sir* of iron sand, and four plates of charcoal. The third time they added 2½ *sir* of ore, and five plates of charcoal; the fourth time one *sir* of sand and four plates of charcoal, and the fifth and last time, one *sir* of sand and four plates of charcoal. During the interval between each of these additions, which is nearly a quarter of an hour, the bellows are constantly plied. This produces sufficient heat, if not to melt the iron, at least to soften it, and conglutinate it with the dross, and at the end of the operation it was found in a solid mass at the bottom of the furnace: water was then thrown upon it, and while yet hot it is cut in pieces, which however were not entirely separated from one another. In this state it was sometimes sent to the market, but more commonly it was put a second time into the fire and subjected to the action of the hammer. By this process it lost two-sevenths of its weight which is usually seven *sir*, and in that state a piece of one *sir* weight sold at a quarter of a rupee.

"As they usually smelted three times a day, they could make about three hundred and sixty pieces, selling at forty rupees. This is all that they got for their labour and skill, and all that they had for the support of their families during the course of a year.

"As the quantity of sand used amounted to nine *sir* and produced seven *sir*, or, when freed from dross, five *sir*, we must allow this to be one of the richest

* Buchanan's Mysore, vol. I, page 29 and 30.

then a layer of ore, and so on alternately:—specimen No. 1 is smelted by this process. The impurities of iron at this, the first stage, are got rid of, by subjecting it, repeatedly, to the forge and blacksmith's hammer.

The iron (specimen marked 3) sells at 4 annas per viss. A blacksmith's wages average 6 annas a day. Manufactured articles are procurable by weight, mamoties, pickaxes, crowbars, scythes, &c. being sold generally at the rate of 8 annas per lb.

BELLARY.

This collectorate is the western portion of the districts which were ceded in 1801 by the Nizam whose dominions, with Kurnool, bound it on the north, its southern and western boundaries being the Mysore, while Mysore and the Cuddapah collectorate bound it on the east. Bellary has an area of 13,056 square miles, and contains 1,200,000 inhabitants. It is the largest of all the collectorates of the Madras Presidency.

It is elevated about 1,200 feet above the level of the sea, and may be characterised as a plain with a small range of mountains and many solitary hills rising from the surface. Its rocks consist of hornblende and mica slate upraised by granite rocks—and its known minerals are copper, gold, iron, saltpetre and marble.

It is 280 miles long and 264 broad, and is subdivided into the following seventeen talooks.

1 Adwanie,	7 Hoovenhugally,	13 Pengondah,
2 Anantpoor,	8 Hurpunhully,	14 Punchapolem,
3 Bellary,	9 Hoodleghee,	15 Raidroog,
4 Durmavar,	10 Kodecondah,	16 Taudputry,
5 Goolem,	11 Kumply,	and
6 Ghooty,	12 Mudugserah,	17 Yadakee.

The only precise information published regarding the geological structure of the Bellary collectorate is to be found in the writings of General Cullen and Captain Newbold, but much and various information has reached me since the establishment of the Central Museum; and regarding its iron ores, I have been principally indebted to the communications of the Local Committee for the Exhibition of 1851;—to Brigadier Yaldwyn from whom I have received specimens; and to a valuable report from Mr. Pelly. The Bellary Local Committee detailed the process of manufacturing iron in the district, and Mr. Pelly has since favored me with a list of all the sites where the ore exists and is smelted: to the former therefore I give the precedence and it is as follows; (P. 103. M. C. C. Proceedings.)

"The manufacture of iron is a process carried on all throughout India, and must be well known to many, but as some little difference may exist in the plan followed in various parts of the country, the Committee will endeavour to give a short sketch of the process in this district.

The smelting furnace is about 4 feet high, $1\frac{1}{2}$ feet in diameter at bottom, and 9 inches at top, and terminating in a flat earthenware pan about 6 inches deep and 2 feet 6 inches across, having a hole in the centre corresponding to the top of the furnace; this is fixed on the top as a sort of funnel, and to prevent the fuel falling over when heaped up. The bottom of the furnace is sunk about 6 inches below the surface of the ground. The first $1\frac{1}{2}$ feet of the furnace is built very solid, and forming a platform some two or three feet broad, but the round, that is the ground plan, is only completed to about two-thirds of a circle, the remaining segment being left open. This lower part is surmounted by an earthenware cylindrical chimney, about 2 feet high, strongly hooped with iron and plastered inside and out with fire clay. The uncompleted part of the circle in the lower part of the furnace is the place where the blast is introduced, and where the metal is withdrawn, and is closed in a temporary manner when the furnace is in use.

To prepare the furnace for work the open segment in front is built up about 6 inches with clay, and an earthenware pipe, about 9 inches to a foot long, is rested upon this, inclining downwards at an angle of about 30° with the horizon, so that the mouth of the pipe is within about 8 inches of the bottom of the hearth, and nearly in the centre of the furnace. The remainder of the front segment is then built strongly up with clay; a quantity of charcoal introduced from above, and fire applied. The bellows consist of two bullocks' skins sewn up so as to form bags; a nozzle pipe is introduced into the neck, the other end of the bag being drawn round two pieces of wood and sewn down to them, so that when the pieces of wood are held close together, the bag is pretty well closed, and when opened the air is admitted. The nozzles of these two bags are introduced into the pipe in the front of the furnace, and well luted round with clay, leaving a small hole just over and between the two nozzles through which the interior of the hearth can be seen. We should have mentioned that the pipe is a double one inside,—about 2 inches diameter on the outside, tapering to one inch at about two thirds of its length, and then opening out again inside the furnace to about $1\frac{1}{2}$ inches. The bellows are worked by 2 men who alternately close the bags and press upon them to force out the air, one drawing them out again while the other is pressing down, so as to keep up a pretty continuous blast. The furnace is three-fourths filled with charcoal, and about 6 lbs. of the ore broken into

of iron ores, for in the careless manner in which the process is conducted, and the small degree of heat applied, we may safely conclude that part of the iron remained in a state of oxide in the dross, and that another part was lost among the charcoal. The iron thus produced by the first operation is of very inferior quality being porous, full of dross and charcoal, and so brittle, that parts of it may be easily knocked off by a few strokes of the hammer: it is in fact what is called cold short iron. This is doubtless produced, in part at least, by the small degree of cohesion of its integrant particles, though it may likewise be owing in part to the presence of charcoal by repeated heating and hammering it becomes perfectly malleable and fit for all purposes. He imagined the great fusibility of this ore to be owing to the presence of manganese, though he was not able to determine the point by a few imperfect experiments which he attempted: the want of the proper re-agents would have prevented him from undertaking a regular analysis, even if he had possessed the requisite skill; but from the analysis of Dr. Thomson it appears, that this ore contains only oxide of iron.*

"To account for the place of nativity of this rich ore, as well as for the great quantity in which it is found we have only to examine the nearest mountains. These mountains, in this part of the Carnatic, from Vellore to the Ghauts, consist of sienite composed of quartz, felspar and hornblende: the hornblende contains a great proportion of particles, he conceived, of the iron sand. The sienitic hills have a more rugged aspect than the granitic mountains, and it has a kind of appearance of being composed of very thick horizontal strata: this is most perceptible in the highest and most naked rocks; as for example on Kailasghur, the highest hill about Vellore, from which it lies in a south westerly direction; even at a considerable distance its strata are discernible, we find them six feet broad and upwards. They are apt to split into smaller masses, and even to undergo disintegration.

The disintegration takes place chiefly on the surface of the large masses which we find every where scaling off: the smaller stones are frequently af-

* NOTE BY DR. HEYNE.—The ore from which it is made is the iron sand of mineralogists, a sub-species of micaceous iron ore. It is attracted powerfully by the magnet like iron filings, except a few particles which occur in small blunt grains, and which are probably iserine, as that species of ore of titanium was found by Dr. Thomson mixed with the iron sand of the river Don in Scotland. The colour of the iron sand is deep iron black; some grains of it are particularly shining with a lustre almost metallic, and these break with a conchoidal fracture: with acids it does not effervesce, and consists in fact of the black oxide of iron probably united to some titanium. The specific gravity lies between 3 and 3.5, the same kind of sand occurs likewise in some places along the shore. From some of these places the specimen, mentioned by Kirwan, as coming from the East Indies, was probably taken.

The iron sand mentioned by Senz is probably of the same kind, or differs only in its cohesion; but he affirms that it yields ninety per cent. of pure iron, which I conceive to be a mistake. If his account were to turn out true, it is obvious that his iron oxide would be the protoxide of iron, for which chemists have been hitherto searching in vain.

fectured throughout their whole mass. This property I ascribe to the great quantity of iron, nearly in the metallic state, which exists in the hornblende. When this iron is exposed to the air it attracts oxygen, and loosens, in consequence, the firmness of the whole mass: it is to the complete disintegration of this rock, that the fertile valleys of the Carnatic or Palliam owe their soil.

These hills with a very few exceptions indeed, run north and south, and they may be considered as having once been more intimately connected with the Ghauts, which intersect the Peninsula of Hindoostan: they make their first appearance a few miles on the east side of Arcot. There are indeed some hills near Madras, but I rather consider them as unconnected with those of which we are speaking, as they have a fourth ingredient, garnets, which I have not observed near the Ghauts: they contain likewise hornblende slate.

The third ingredient is a species of hornblende, which I conceive to contain an unusual quantity of iron and on that account would be disposed to distinguish it by the name of ferrilite. It occurs chiefly mixed in small quantities with the other ingredients which forms the sienite. Its fracture is uneven or undulating, lamellar, and often resembling mica, from which it is distinguished by its superior hardness, by its streak, and by its fracture. It is very much given to disintegration and this is probably the reason why the sienite in the Carnatic is so apt to decay. In large masses it traverses the rock in veins, or occurs in it massive, from the size of a hazel nut to that of a tun or more.

I do not suppose that our ore is derived from the large masses of the rock, but rather from the disintegrated hornblende, in which I suppose these minute grains of iron sand are mixed in abundance. By the heavy falls of rain, we may suppose that many half disintegrated stones of sienite are broken in pieces by being forced along by the torrents driven with violence against each other. Thus its particles are gradually reduced to sand and deposited according to their specific gravity. The iron sand, being the heaviest, sinks lowest, and the comminuted quartz and felspar cover it. Those portions of the iron, that are mixed with the hornblende in the state of peroxide, are probably washed away with the water in a state of fine mud and are either carried to the sea or deposited on the fields, to which they communicate the red colour so common in those countries where this kind of sienite prevails.

To see whether the smaller particles of the well-mixed sienite contained iron sand, I reduced a portion of it to powder, and had the satisfaction to find that it was attracted by the magnet, though for obvious reasons not so powerfully as the iron sand itself. The only mineral mixed with the sienite, or passing through it in veins are hornblende slate, garnets, shorlous beryl, pyrites."

Such then was Dr. Heynes' description of the method of smelting iron in the beginning of this century from the black iron sands of North Arcot and

during the forty years that have elapsed since then till now, I do not find that any additional observations have been made. The subject indeed seems to have been considered exhausted and the black iron sand came to be regarded as the peculiar ore of the district, but the following very important report and return, which Mr. Bourdillon has favored me with, will show that ores of iron are mined in every Talook and in one hundred villages of this Collectorate and that no less than 86 villages smelt the ore, the average number of furnaces being about 200.

"The iron ore found in various parts of the district, is worked to some extent. But the processes are of the rudest description and the people engaged in the business are extremely poor and ignorant. The ore is found in two forms sand and stone. The sand ore is the material most generally made use of. It is found on the surface of the beds of running streams near to the hills, after there has been a good fall of rain and a consequent flow of water. After the stream has run down, the people engaged in collecting the ore, most of whom are pariahs or persons of low caste, set to work and gather as much of the black sand left on the surface as they can. Sometimes they get very little, and when there is much, perhaps there are not enough of hands to collect the whole. The quantity collected therefore cannot be stated with any certainty.

The stone ore is found in larger quantities and below the surface of the ground. In the village of Surumbaid in the Calastry Zemindary, there is a hill and on digging into this hill to the depth of a few feet large quantities of the stone ore are found; each stone being the size of a lemon or orange. The Zemindar rents out the right of working this bed to certain chief inhabitants of the village for 60 or 70 Rupees a year. The renters sell the ore excavated to people engaged in making iron. Stone ore is also found in some parts of Trivettor and Trivellum Talooks and in the Arnee Jaghire.

In general the stone is pounded and reduced to sand before it is put into the furnace; but in the village of Cantrapully it is only broken into pieces of the size of gram. The original sand or the stone thus reduced to sand or broken small, as above stated, is in the first instance beaten in a mortar and washed several times with water till the ore is freed from all admixture of other material. The washing is so managed, that the ore being the heaviest sinks to the bottom, while the other lighter sand remains at the top, and may be easily removed. The ore thus cleaned is then fit for the furnace. The furnace is most commonly of the form and dimensions shown in the accompanying plan; viz. about 3½ feet in height and 2½ feet in its largest external diameter. It is made of clay and lasts only one year. The charcoal for smelting is prepared in the adjoining jungles. The cost of the furnace and charcoal

cannot be ascertained because the persons who gather the ore, also construct the furnace and prepare the charcoal and do not lay out any money for them.

In the process of smelting, four persons are employed, viz. two at the bellows, one in the general superintendence, and one in sundry work. A quantity of charcoal is first put into the furnace and made to ignite. A quantity of the ore is then thrown in upon that burning charcoal, and is covered with a second layer of charcoal and this operation is repeated till there are seven layers of the ore; the bellows are worked for about two hours, when the whole ore fuses, and the metal runs together into one mass. The quantity of ore put into the furnace each time is about 5½ or 6 viss; and the quantity of charcoal used is from twelve to twenty times as much as the ore, according to its quality. The lump of iron produced from the above quantity of ore weighs generally between 1 and 1½ viss; and when freed from foreign matter and made pure iron, it is reduced to about ¾ viss, which sells for three annas. In the course of a month about 40 lumps or about 30 viss of iron can be made at each furnace, and the work does not continue on an average above four months. Thus the entire quantity of iron made in one furnace in a year comes to about 120 viss, worth 30 Rupees. This gives 7½ to each of the four men for about five months' work, including the time occupied in collecting the ore or Rupee 1, annas 8, a month. Poor as this business is, and miserable and destitute as the people are who follow it, it has not escaped the Moturfah. A tax is levied on every furnace, ranging from about a quarter of a rupee to the exorbitant sum of Rupees 3 annas 8 a year, and averaging about 1½ Rupee. In this instance as in very many others, the Moturfah is simply and directly a tax on labour. The total number of furnaces in use in a year throughout the district, excluding the Zemindaries of Calastry and Cavetnuggur of which there are no accounts, is a little more than 200, fluctuating somewhat from year to year. There has been a gradual increase in the number taxed during the last fifteen years; but I am unable to say whether there is a corresponding increase in the number worked. The whole quantity of iron made is very small; the whole of it I believe to be consumed in fabricating the ordinary agricultural instruments and for other local purposes. I am not aware that any is exported. I am unable to say what quantity of country iron is brought into the district for consumption in addition to its own produce but a good deal of English iron is imported. Though not liked by the blacksmiths for general purposes, it is very convenient in the form of bars for handy wheel tires, for which it is almost exclusively used.

In the village of Cantrapully in the Calastry Zemindary there is a furnace on a somewhat larger scale, than those described above. The quantity

of metal produced at each firing weighs 6 viss, and sixty firings are stated to be made in a month or 720 in a year. This furnace pays a Moturfah tax of 10½ Rupees a year to the Zemindar.

There are jungles in this district where sufficient material for making charcoal can be obtained. The parts of the district where there is most jungle are noted in the margin. The jungles may be said to be diminishing as portions are annually brought under cultivation; but this diminution proceeds at a very slow rate. The

people who make iron prepare charcoal for themselves; but there is a class of men who trade in that article and sell it to burners of chunam stones, &c. It is prepared in the jungles and sold at 4½ annas retail and 3½ annas wholesale per parah of five mericals. In some places it is sold as low as 2½ or 2½ annas the parah.

One of the questions is whether the blacksmiths prefer Indian or English Iron? They decidedly prepare the former, as being less brittle and more easily worked. The daily wages of a blacksmith are as follows.

	As.	P.
A Maistry Smith.....	7	6
A good smith with tools.....	6	0
A common Do. with do.....	5	0

List of specimens of Iron Ore and Iron collected in the district of North Arcot.

Name of the Talook.	Name of the village in which the iron ore was found.	No. of the bag which contains the ore and the iron made from it.	Remarks.
Chittoor.....	Chittapora.....	1 & 2	No. 1. These ores have not been worked for the last two or three years.
	Eachanairy.....	3	
	Papasamoodrum.....	4	
	Toombapoliem.....	5	
Chendragherry...	Thegavamoorthuvary pullay.	6	No. 2. These ores are smelted in the villages in which they are found.
	Thettoopully.....	7	
	Muddeenayam pullay.....	8	
	Chinnipaupiahvaru pullay...	9	
	Chinnasawmy reddy pullay...	10	

List of specimens of Iron Ore, &c. (continued.)

Name of the Talook.	Name of the village in which the iron ore was found.	No. of the bag which contains the ore and the iron made from it.	Remarks.
	Audeenapullay.....	11	No. 2. These ores are smelted in the villages in which they are found.
	Camachinnapullay.....	12	
	Bothuvunkah.....	13	
	Gollapullay.....	14	
	Vocoppaulopullay.....	15	
	Jekkeedonah.....	16	
	Nuchoccoroo.....	17	
	Moongeloppullay.....	18	
	Moongelputtoo Cothapullay...	19	
	Amasavarupullay.....	20	
Vellore.....	Paukum.....	21	
	Pulliputt.....	22	
	Auchenamput.....	23	
	Vunnanthongul.....	24	
	Vomrenbutt.....	25	
	Catharer cooppum.....	26	No. 3. Vide Remark No. 2.
	Vamrenbady.....	27	
Sautgher.....	Ramalo.....	28	
	Cullapandee.....	29	
	Vardareddy pullay.....	30	
	Valadoonpolum.....	31	
	Cothapullay.....	32	
	I naneabundah.....	33	
	M recooppum.....	34	
	Pa alcooppum.....	35	
	Thoitteeshoroy.....	36	
	Rungumpetta.....	37	
	Goondlapullay.....	38	
	Kistunupullay.....	39	
	Paukum.....	40	No. 3. Vide Remark No. 2.
	Alangooppum.....	41	
	Chintaconamah.....	42	
	Caracooroo.....	43	
Trivellum.....	Cangooppum.....	44	
	Culleanaperangooppum.....	45	
	Thoonersucooppum.....	46	
	Nangul.....	47	
	Mauliaputtoo.....	48	
	Malemayel.....	49	
	Soorungoopum.....	50	
	Calamput.....	51	

List of specimens of Iron Ore, &c. (continued.)

Name of the Talook.	Name of the village in which the iron ore was found.	No. of the bag which contains the ore and the iron made from it.	Remarks.
	Chenje.....	52	No. 4. The ore found in this village is smelted in the village of Callanput.
	Gungemayanucopum.....	53	No. 5. Smelted in Maleyaputtoor.
	Maracalooocopum.....	54	No. 6. Smelted in Posmuntha in Goo- dupouty Poliem
	Thimudiah pullay.....	55	
Trivatoor.....	Nellum.....	56	No. 1. Not worked for the last 15 years.
Poloor.....	Modayooroo.....	57	No. 8. Vide Re- mark No. 2.
	Chungoonum.....	58	
	Padgum.....	59	
	Pothara.....	60	
	Sottookinnee.....	61	
Tirtany Division.	Vencutranz Coopum.....	62	No. 10. Smelted at Teroomubraz pettah.
	Ereengairy.....	63	
	Ramaliagapoorum.....	64	
	Chumalipollem.....	65	
	Vencutroz Coopum.....	66	
	Mahadunapoorum.....	67	No. 11. Vide Re- mark No. 2.
	Condum.....	68	
	Vanadoorgapoorum.....	69	
	Rungarauze Condegoy.....	70	
	Amedayala.....	71	
	Theoncondum.....	72	No. 12. Not worked for several years past in the village of Coor- injahum where was once a furnace for working this ore. It is however smelted in another village Cautra- pullay, specimens of iron therein made will be found in bag No. 76.
	Theroovengadanadaraja po- rum.....	73	
	Mudloooroo.....	74	
Maderpauk.....	Sadsombadoo.....	75	

List of specimens of Iron Ore, &c. (continued.)

Name of the Talook.	Name of the village in which the iron ore was found.	No. of the bag which contains the ore and the iron made from it.	Remarks.
	Do.....	76	
Congoondy.....	Soyanamalaeondah.....	77	No. 13. Not worked for sometime past.
	Kristnapoorum.....	78	No. 14. Smelted at Servarampoorum.
	Peddagoondlapullay.....	79	No. 15. Their vil- lages are in the Mysore country but ores are brought from them and smelted in the villages of Ajaculthedy and Pau- kumpulley in this dis- trict.
	Chinnagoondlapullay at- tached to Mysore.....		
	Nimma rapullay Santooroo...	80	No. 16. Smelted at Jerdunakoolapullay.
	Nayanooroo.....	81	No. 17. Do. at Cudarcepoorum.
Caslastry.....	Seerasumbadoo.....	82	No. 18. Vide Re- mark No. 2.
Arnee.....	Seerooinoyaloo.....	83	No. 19. Smelted at Poodoopolieum.
	Sengoonum.....	84	No. 20. This place is situated in Pooloor Talook but the ore is brought from thence and worked at Cutti-vander.
Narainawarum..	Chevuttergoontah.....	85	No. 21. Vide remark No. 2.
	Chintalogoontah.....	86	
	Aggrahorum.....	87	
	Agguchanupully.....	88	
Palmanair.....	Thatumocoolapully.....	89	
	Cothacotah.....	90	
	Gooroovermakoolapullay.....	91	
	Chakala coopum.....	92	
	Nalecgaree.....	93	

I am indebted for the specimens received from this Collectorate, to Mr. Bourdillon, Mr. Sullivan, Lieutenant King and Captain Brooke. A list of these will be found appended, and it is sufficient to mention that they all

consist of oxydulous iron, Iron sand, magnetic iron ore imbedded in quartz, and oligist or specular iron ore.

On writing to Captain Brooke at Arnee, he sent me a report, by A. Ramanjooloo, on the ores of that neighbourhood, and the mode of smelting them, from which I have made the following extracts. In the Talook of Arnee near the village of Seeromboor,* is a mountain called "Sunnamalay" which contains much iron ore. In the hot weather, iron stones are excavated and in the rainy weather the people collect iron sand, specimens of both of which marked A. and B respectively, were received. In the neighbouring Talook of Poloor also, iron is smelted in the villages of Attambady, Chengoomum, Poondy, Potturay, and Modavoor, the ore being obtained in very great quantities from a hill in their vicinity. Steel is also said to be manufactured there, though of a quality very inferior to that of Europe. Sunnamalay, the mountain above alluded to, near Arnee, slopes east and west, and runs from north to south, for about a mile. It is situated within the village limits of Seeromboor, and on the southwest has Vettyantholoonum and Seeromboor; on the north east it stands on an elevated plain, the soil of which is very hard. The average breadth of the westerly slope is 180 yards including the peak. This part of the west slope is from 150 to 200 feet in breadth, and is said to contain mines of iron ore to an immense extent, much of it being magnetic. The iron ore is of two kinds. On each heavy fall of rain, iron sand is washed into the hollows and inequalities on the western slope and at the foot of the mountain on its western side; so soon as the rain is over a great quantity of iron dust is seen every where on the west slope of the mountain. The women, (mostly of the pariah caste) of the adjacent villages of Seeromboor, Vettyantholoonum, Arreyapady, and Poodeopalyum, all in the Jaghire Talook of Arnee, commence collecting it. One woman with her broom, her basket and winnowing trough will collect in one day about $7\frac{1}{2}$ measures (standard) of the iron sand, working up to one o'clock P. M. from early in the morning. The ore collected is taken by a man, to the brink of a running water to an earth work in the form of a gently sloping trough, (as per rough sketch No. 1), its lower end being close to the water for convenience in cleaning the ore. He puts the sand into this trough and throws water from the stream with one hand, supporting the trough with the other and shaking it repeatedly until all the earthy particles are removed, the iron dust remaining in the trough: the trough will hold $7\frac{1}{2}$ measures of iron sand, and about an hour is required to wash that quantity: when cleaned so far it is exposed to the sun, and before it is fully dried, the washer kneads it with his feet for about an hour and

* Distance from Arnee to Seeromboor is 4 miles.

afterwards replaces it in the trough to be again washed and cleaned as before for half a hour, and after a day's exposure to the air it is ready for smelting. This iron ore produces a very superior metallic iron; and the bar iron manufactured from it is considered to be superior to the iron manufactured from iron stone-ore, the process with which is as follows. In the hot weather the ryots of the above village (chiefly Pariahs,) when at leisure from agricultural pursuits, mine on the west slope of the mountain by means of crowbars, mamoties, and pickaxes, excavating the iron stone. Two men drive a shaft with a semicircular opening from 4 to 6 feet long, removing all the stones and earth as they advance, and one of them sorting out the iron ore. Should they fail in the first shaft they drive another near it, but a shaft containing iron-stone will supply 4 or 5 large baskets full of ore: the stones are rounded and from 2 to 12 inches long and, where successful, two men employed will perhaps collect in one day 10 or 15 baskets of ore.

First process of preparation for smelting and pulverizing the iron stone-ore.—One man can pulverize from 10 to 15 baskets of iron-stone, by placing them upon a large stone and hammering them, a man will complete the whole process of pulverizing, collect the dust, winnowing it and removing the earthy matters in one day. The dust from these iron stones requires to be cleaned in the same manner as the iron sand to prepare it for smelting. This ore produces metallic iron inferior to that of the iron sand and the bar-iron manufactured from it is also supposed to be inferior to the sand ore. The iron ores thus obtained are smelted by the miners in their own villages where smelting furnaces are established. The miners occasionally barter the iron dust for grain or money to the people of their own or the neighbouring Talooks of Arcot, Wandiwash and Trivatoor.

Smelting furnaces are at work in the villages of Seeromboor, Vellyantholoonum, Arreyapady and Poodeopalyum in the Talook of Arnee, and the rough sketch No. 2 attached will explain their height, &c. The only implement for withdrawing the metallic iron from the furnace is an iron hook with a wooden handle. The blacksmith's forge and the implements he employs in working the metallic iron into bar-iron are similar to those of the smiths in the Arsenals. In all the above villages, there are one, two or three blacksmiths' shops. An estimate of the expense for erecting a smelting furnace is also annexed in the sketch No. 2.

Smelting process.—In the process of smelting, two men will undertake the smelting for 4 annas each per day provided they be supplied with a furnace, a pair of bellows, ore and charcoal: they smelt, in six smeltings, 18 standard measures of ore (or dust,) in one day with 18 standard measures of charcoal. For each smelting they employ 3 measures of ore and 8 measures

of charcoal. One of the men takes 2 measures of charcoal and spreads it at the bottom of the furnace which is already lit, while the other works the bellows as long as necessary. The former divides the 3 measures of ore and the remaining 6 measures of charcoal into 12 portions, and puts them into the furnace in the following manner. The first portion of the ore mixed with the charcoal, is placed into the furnace and the bellows worked. In 7 minutes more, the second instalment of the ingredients is put in and so on. It requires $1\frac{1}{2}$ hour to complete the first smelting, when they withdraw the bellows by removing the mud covering the circular grate of the furnace, and the mass of metallic iron is removed through the opening. They immediately reclose the gate by fresh mud, attaching their bellows to it, and continue smelting the second portion of the ore, obtaining another mass of metallic iron (sample marked C. is sent herewith,) and so on from the third to the sixth portions. Thus they get six masses of metallic iron, each measuring about 8 inches long, $5\frac{1}{2}$ inches in breadth and $2\frac{1}{2}$ inches thick, and weighing from 3 to $3\frac{1}{2}$ viss (of 40 pollums.) The ryots of this talook and of the talooks of Arcot, Wandiwash and Trivattoor, are in the habit of purchasing these masses for their implements of husbandry for which they are very suitable. One mass of this metallic iron will give, when worked up, in the smith's forge, from 1 to $1\frac{1}{2}$ viss of bar-iron.

In the talook of Poloor superior iron and a smaller quantity of inferior steel are produced, and it is reported that the iron manufactured in that talook is better than that of Arnee, Poloor having extensive forests from which abundance of charcoal can be had, whereas those in the vicinity of Arnee have been very greatly diminished. Only one kind of iron from the iron stone is now manufactured, in Arnee, (sample marked D. is herewith sent) iron ore in the form of sand can only be obtained in rainy weather or immediately after rain. The miners are in the habit of selling the iron either at their own villages, or at those adjacent and to send it also to the talooks of Arcot, Wandiwash and Trivattoor; in general 6 lumps of metallic iron weighing 18 viss, which are the produce from the furnace of one day's smelting, sell for one Rupee; and the bar-iron manufactured from it is sold at $8\frac{1}{2}$ viss for Rupees 3-8-0. The quantity of bar iron produced yearly is estimated to be 2,555 viss all of it manufactured in the villages of Seeromboor, Vettiantholcovum, Arreyapady and Poodeopalayum (which are in the vicinity of the "Sunnamalai hill;" the daily produce of one furnace is 6 masses of metallic iron, which gives 6 or 7 visses of bar iron. Some supplies of iron in the form of flat bars, &c. are now and then brought to this talook from the Salem district, 30 viss of metallic iron will yield 14 or 15 viss of the bar-iron, used for crow bars or other heavy articles such as smiths' or other tools and implements. Supplies of bar-iron are also

brought to this talook for sale from the villages of Chengamavoo, Pullepputt, and Adanoor, all in the Collectorate of South Arcot, to be used for mamoties, smiths' and carpenters' tools and implements.

The bar iron manufactured in Arnee from the iron sand is considered to be best fitted for all the finer work. It is used chiefly for thin plates to form circular buckets, pots, measures, locks and keys, hooks and hinges, &c. nails of every description and mamoties. The bar-iron manufactured from the iron stone-ore is reckoned inferior to the former but is used for plough shares, crowbars, pick axes, and other heavy work.

The quantity of iron now manufactured in this Jaghire talook is greatly less than it was in former times.

They had formerly large supplies of charcoal from the neighbouring forests of Seeromboor, Coopum and Cumbasamoodrum, the first in this and the two last in the Arcot talook, which have now entirely disappeared; and a number of the miners of this talook left it and settled in that of Poloor where they have extensive forests. In Arnee talook, charcoal is now obtainable in very small quantities, and the miners are themselves obliged to go to the neighbouring hills and other places, where wild trees grow: at the furnace 90 measures or $2\frac{1}{2}$ parabs of charcoal are sold for 4 annas.

One man will cut a bandy load of branches in a day: he will be employed all the next day cutting them up, exposing them to the sun and reducing them to charcoal; and on the third day he will be able to bring in the charcoal, which will measure 7 parabs or thereabouts, and sell it for 12 annas; a man can thus make 4 annas worth of charcoal in a day. The forest of Pudwet in the talook of Poloor is extensive, (it is situated about 15 miles from the Sunnamalai, by a common road fit for bandies): charcoal made of any wood is considered suitable for smelting purposes, with the exception of that of the tamarind tree, which spoils the iron. Charcoal made from (கறிங்காவிமரம்) Karingalee tree (சகமரம்) Namay tree, (கோரம்மரம்) Koram tree (காசாமரம்) Kasa tree (ஒட்டமரம்) Oodda tree (தேத்தம்மரம்) Tayttan tree, are recommended as superior, for smelting purposes.

The blacksmiths in this talook prefer Indian to English iron, as the latter is brittle, but European iron is used for fires of wheels, crow bars, &c. because it is very cheap. It is deemed, however, unsuitable for nice workmanship.

The daily wages of a blacksmith are for a 1st rate workman Rs. 5½
2d do. " 4½
100 lbs. of ore cleaned will give 33½ lbs. of metallic iron the loss being two