REPORT

ON

THE GOLD MINES

OF THE

SOUTH-EASTERN PORTION OF THE WYNAAD

AND

THE CARCOOR GHÁT.

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OOTACAMUND,
30th October 1879.

From

R. BROUGH SMYTH, Esq.,
Mining Engineer,

To

J. H. GARSTIN, Esq., C.S.I.,
Acting Secretary to Government,
Revenue Department.

SIR,—I have the honor to submit the following report for the consideration of His Grace the Governor in Council.

I have the honor to be,
Sir,
Your most obedient Servant,

(Signed) R. BROUGH SMYTH.

has permitted ... in that direction are innumerable ...

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GOLD MINES OF THE SOUTH-EASTERN PORTION OF THE WYNAAD AND THE CARCOOR GHÁT.

Areas examined.

The areas which have been examined are as follow :—

(*a*) The country drained by the western tributaries of the Pandi river, east of the dividing range, from the sources of the Keilakahpoya to Marpanmadi North Peak.

(*b*) That drained by the southern tributaries of an affluent of the Noogoo river, from Hadiahbetta to Marpanmadi North Peak.

(*c*) The country between Cherambádi and Vellirymulla.

(*d*) The basin of the Keilakahpoya from Devála to a point below Eddakurra.

(*e*) Nanjanad, Avalanche and Sispara.

Physical character of the Nilgiris.

The most elevated portion of the Nilgiris has a mean height of 7,400 feet and an area of 420 square miles. On the south-east the descent to the low country is very rapid, there being in a distance of nine miles a fall of 4,500 feet.

On the margin of the plateau the heights of the peaks vary from 5,600 feet to 8,500 feet; and near the centre of the tract, Dodabetta the culminating point, attains an altitude of 8,642 feet. On the north the descent to the country drained by the Moyaar river (which for some distance has a course nearly parallel to, and at a distance of five or seven miles from, the edge of the plateau) is rapid; and on the south the precipitous declivities seem almost to approach the banks of the Bhováni river. On the west the physical character of the country is different; there is a gradual decrease of elevation towards the Pykara river and onwards to Neddivattum, and thence a sudden drop of 2,700 feet to a plateau which has a mean height of 3,000 feet. The rugged rocky margin of this lower plateau trends from south-east to north-west, and the fall to the area drained by the Beypore river is in some parts for hundreds of feet almost perpendicular, and even where tracks have been made, the difference of level is, in a distance of no more than five miles, as much as 2,800 feet.

The upper as well as the lower plateau presents a series of rounded well-grassed hills with masses of rock protruding in places. In the sheltered hollows and narrow valleys there is usually a growth of shrubs with a few moderately straight but rarely large trees. On the main ranges and on the margins of the plateau extending into the low country, the forests are dense and much of the timber is excellent.

The country between Devála and northwards for some distance, and that between Devála and Moopenaad, is generally rather lightly timbered, and there are numerous bare grassy hills and well-grassed swamps. In various places there are good forests to be seen in travelling westward, and near Vellirymulla there are magnificent trees in the jungles; and wood suitable for fuel is everywhere abundant.

Near Ootacamund exotics, represented mainly by *Eucalyptus globulus*, *Acacia melanoxylon*, *Acacia dealbata*, *Acacia decurrens*, *Acacia pycnantha*, some species of Cinchona, and willows and pines grow generally luxuriantly. On the lower plateau neither Acacias nor Eucalypts are common, and it is at least doubtful whether they would live in a situation where the rainfall is so great.

The character of the vegetation of the Wynaad, as far as has been observed, gives no help to the gold seeker. In Australia the several geological formations

are marked by forms of vegetation of distinct types; the dry Silurian ranges which are intersected by quartz veins are clothed with forests in which the iron bark (*E. Siderorylon*) is often a feature; the granitic areas carry sparsely she-oaks (*Casuarina*); the tertiaries near the coast support the honeysuckle (*Banksia*) and the she-oak; the areas occupied by carbonaceous sandstones, and porphyries in most places are covered with dense forests of various species of gum; a thick scrub composed of *Eucalyptus dumosa* and *Eucalyptus oleosa* with some species of *Fremla* covers the tertiaries bordering on the river Murray; and the wide basaltic plains are treeless. The miner accordingly, in a country with a vegetation so well marked and so closely corresponding to the areas differing geologically, had some rough guides in his explorations: in Southern India there are none of the like kind, because the soils derived from the rocks intersected by quartz veins are throughout very similar in composition, and situation and climate alone are the influences at work in promoting or retarding vegetation.

Features of the country in the southern parts of the Nambalakod and Munanad Amshoms.

The chief physical feature in that portion of South-East Wynaad, which has been examined, is the dividing range extending from Hadiahbetta on the south-west to Marpanmadi North Peak on the north-east. This range separates the waters of the Pandi river from those flowing to an affluent of the Noogoo river, and for a portion of its length forms the boundary between the Nambalakod and Munanad Amshoms.

The ridge from the edge of the Carcoor ghât to a rocky eminence near Needle Rock is covered with thick jungle. The lower slopes have been cleared and are now planted with coffee.

The culminating points of this part of the range are Hadiahbetta about 4,000 feet, Needle Rock 4,600 feet, and Marpanmadi North Peak 4,650 feet.* The lowest "saddle" in that part of the range near Devâla is approximately 300 feet below the general level of the summit.

On the east and west side of the range there are lower ranges—the boundaries of distinct small drainage areas—but they are not continuous, well-defined even ridges; they consist of rounded hills having smooth contours and connected with each other by low saddles, thus reminding one rather of those areas in which granitoid rocks prevail than of those in which, in other auriferous regions, the even symmetrical, almost rectangular, ranges of the lower Silurian rocks offer so many facilities for sketching the country with accuracy and comprehending rapidly its systems of drainage.

At the foot of the hills and at levels varying but slightly, there are numerous swamps and flats (usually intersected by small water-courses) which are in part cultivated by natives.

The summits of the hills forming the subordinate ranges are from 100 feet to 400 feet and more above the level of these swampy flats. The swamps are natural water-reservoirs, the water being stored in the strata overlying the bed-rock. They are generally well grassed, but some are mere bogs or, where well sheltered, densely covered with screw-pines or, where partially drained, supporting a thick growth of thorny plants and scrub.

The streams, having their sources in the hills, after the burst of the south-west monsoon and generally during the months of June, July, August and September, are torrents rushing over rocky beds, which on reaching the low flat lands unite to form perennial streams. In October there are often heavy showers sufficient to swell the brooks; but in November, December, January, and February many of the sources are almost dried up, the waters of the main streams decrease in volume; and in March, April and May, the hot season, when dry harsh winds are not infrequent, and when the grass in the earlier part of the season is on fire on the hills, the tributaries of all the rivers exhibit a marked difference of character.

The smaller tributaries, the sources of the streams, have cut rather deep channels in the sides of the main range and the hills; the descent is rapid and the direction of each nearly straight; it is only when they unite and flow through the low level lands that they have a tortuous course.

* The figures here given are approximate only.

he soils on the slopes are, where protected, moderately good and deep. In hey are light reddish brown, brown, dark brown, and nearly black, the latter ; a fair proportion of decomposing vegetable matter. Elsewhere they are very sting on hard rock or on strong tenacious clays derived from the decomposition country rock *in situ*. These clays are but little affected by the heavy rains: rface of them becomes glazed, and running water does not cut into them as it do if they were arenaceous. Where cuttings are made the clays stand for ght of fifteen feet or more perpendicularly, and, in some parts, even for a al height of fifty feet, the rains scarcely affecting the surfaces at all.

Clays however that have been moved, carried down by the rains, and redeposited n comparison, rather easily disintegrated and washed away.

On the lower parts of many of the steep slopes the soil and stones carried n during the monsoons form distinct but irregular layers and (though rarely) a somewhat resembling alluvial deposits. Heaps of gravel and partially water- n stones accumulate in the beds of the torrents, where there is a sudden change vel, caused by a hard bar of rock or a fall of rock, and the torrents, as their are deepened and the courses are changed, have these loosely-formed beds as s on one side or other, rarely at the same spot on both.

It is observable that on the lower slopes of the ranges the plants in the coffee lens are usually more luxuriant and exhibit finer forms and better foliage than he higher parts of the ranges. This may be accounted for by the larger accu- lation of soil and the greater moisture in such situations. Where, however, the s are low and there is no such accumulation of soil, the plants are generally akly.

The numerous roads in the Wynaad at various heights and in many cases nearly rallel to each other, whether made by the Government for the purposes of neral traffic or by the planters for convenient access to various parts of their ates, are invariably well made and the traces are good. They are sideling roads: e bank on one side of the hill is cut away and the excavated earth and rock are ide to form a part of the road.

They are necessarily, in a hilly country like that of the Wynaad, contour lines, nd the maps which accompany this report show in what directions they run; and, the absence of a correct orographic map, give some hints as to the general features the country.

In cutting these roads very many fair sections of the rocks and some quartz eins have been exposed; and the mineralogist and geologist find at numerous points s they travel along them much that instructs both as regards the character of the ountry rock, its modes of decomposition and its conservation, as well as the rather eculiar character of the "leaders," "strings," and small veins which are, as it were, hrown off from the main reefs of quartz.

Climate.

Though the climate of the Wynaad has been represented as unhealthy, it is not uncommon for Europeans employed in connection with coffee gardens to remain in the district with their families through- out the whole year. Fever is prevalent in March, April and May, and some of the residents become seriously ill. But it must be borne in mind that a coffee planter who attends carefully to his business is subjected to exposure to the sun during the hot months and to the heavy rains during the monsoon. He has to walk or ride for many hours each day when the solar radiation is at its maximum, and during the monsoon his clothes are rarely dry.

From August to the end of September the moisture is excessive, and the tem- perature in the room of a bungalow is often above 70°; yet, during this season, fires are lighted at night, and, notwithstanding the high temperature, the warmth is enjoyable. The moisture and heat injuriously affect everything that is manufac- tured. Boots, portmanteaus covered with leather, and books are quickly and plen- tifully covered with down-like fungi, and instruments of all kinds are irretrievably ruined unless they are well protected, and constantly cleaned. Clothes suffer

in like manner; and the cost of a visit to the Wynaad during the monsoon is not to be measured by the charges for living, horses, servants or the like. Slight neglect or ignorance of the effects of the weather may result in heavy losses if the visitant has provided himself with instruments for scientific observations. During the monsoon the very early morning may perhaps be clear and give promise of fine weather, and a stranger is easily tempted under such favorable aspects to prepare for a day's work and to proceed for three or four miles in the hope that work may be done; but by eight or nine o'clock the clouds come up the ghâts, the south-west monsoon moves in its great strength athwart the hills, the rain descends in torrents, the mists or fogs are dense, features not fifty yards away become invisible, and the day's work, if surveying or geological investigations are the pursuits, is finished.

The rainfall at Devála during the years 1869 to 1875 varied from 158·10 inches to 208 inches per annum; at Cherainbádi during the years 1871-72, 1873-74, and 1875 from 109·10 inches to 117·97 inches; and at Vellirymulla during four years from 109·04 inches to 139·47 inches. As much as nine inches of rain sometimes falls in one day, and a fall of one inch of rain in one hour is not uncommon. Still, as already remarked, these heavy rains have comparatively little denuding power, the rocks even where decomposed, resisting the action of the water to a degree that to one accustomed to view other formations is at first almost inexplicable. Such rains would wash away and carry to the sea mountains composed of other more perishable rocks.

The rains are yet not without destructive effects. In many places there have been extensive landslips. The sides of lofty hills have slidden down to the valleys beneath, and Nature nowhere has rapidly hidden the evidences of great changes of this description.

The granitoid schists or gneissoid rocks of South-East Wynaad are, it is probable, as will be shown hereafter, only completely metamorphosed sedimentary strata. The minerals observable are felspar, quartz, hornblende, mica, talc, chlorite, pholerite, and magnetic iron. The ordinary foliated rock is usually massive or composed of thin compact layers of quartz and felspar, or of quartz and hornblende. Magnetic iron takes the place of one or other of these constituents, or accompanies them in some places; and at and in the neighbourhood of Marpanmadi North Peak magnetic iron is largely present in the rock, the decomposed surface stone exhibiting layers and reniform and nodular masses of sesquioxide of iron. Some specimens are composed almost entirely of quartz and magnetic iron, and in others the iron occurs with quartz and felspar; and again there is a variety composed of translucent quartz, magnetic iron, and an asbestiform mineral resembling iron amphibole.

Bands also have been observed in which the proportion of iron pyrites in disseminated crystals is very large.

Massive hornblende rock is found on the south-east and garnetiferous foliated gneissoid rock is common towards the north and east.

In many places the country rock, besides being intersected by large persistent reefs of quartz, is seamed and veined throughout with threads and strings of quartz, not in any way conformable to the lines of foliation; and where a section of the rock decomposed *in situ* is laid bare these threads and strings are clearly traceable through the red, reddish brown, and dark brown of the kaolin-like clays resulting from the decomposition of the stone. These veins vary from one-eighth of an inch or less to six inches or more in thickness, and they consist either of white opaque or blue opaline quartz, the latter not unlike that which forms thin layers in the foliated country rock.

In more than one locality near Devála the harder rocks consisting of dense quartzite or quartz with magnetic iron and a little felspar appear as large rhombohedral blocks or as symmetrical hexagonal or square prisms; and the faces of the planes are not seldom covered with thin layers of rather dark blue opaline quartz. Many of the forms are of singular interest, and a stranger might without examination suppose that some of the masses were of igneous origin. It is perhaps needless to say that the shape of these blocks is due to the direction of the several systems of divisional planes or joints.

The modes of decomposition of the several varieties of gneissoid rocks in th Wynaad give hints as to the degree of metamorphism to which they have bee subjected. For instance, where not intensely metamorphosed they do not weathe into spheroids nor exhibit concentric layers around a hard core of rock, such as on sees in tracts occupied by granitic, trappean, and the older igneous rocks. Where however, there is a greater development of the crystalline structure, as in some parts of the country west of Devála, this well-marked feature presents itself.

East of Needle Rock and east of Harewood thin micaceous shales occur which remind one of the typical micaceous lower Silurian rocks; and the lines of lamination in the former might well seem to correspond with the cleavage planes of the latter. The strike of these thinly-laminated micaceous shales east of Needle Rock is N. 55° W. being nearly at right angles to the general direction of the folia of the gneissoid rocks. It is perhaps correct to say that observation has shown that the most productive auriferous belts in the Wynaad are those in which these micaceous and chloritic rocks occur; and that as a rule where the hard dense massive quartzo-hornblendic strata are found, and where the foliation is indistinct, the veins are either absent, or, where present, consist of saccharoid quartz with large and small plates of mica.

The foliation of the rocks in that part of South-East Wynaad already described preserves throughout a nearly uniform strike, namely, N. 54° E.—S. 54° W. There are curves however where the direction varies from N. 40° E. to nearly east and west. The dip is southerly and south-easterly from 60° to vertical.

Only an extended examination of the country, such as would be made in the course of a minute geological survey, would enable the observer to offer suggestions as to the probable origin of these metamorphic and metamorphosed rocks. It is apparent wherever they are well exposed that there is one system of planes very like strike-joints which, but for the direction of the dip, might be supposed to represent planes of original deposition. The direction of these in some degree accords with the general direction of the main quartz veins, and it might be surmised on a first view that the formation of the latter was due to the same forces which operated in altering the strata they intersect; that, in other words, the quartz in the veins was segregated during the enormous period which elapsed from the time of the first slight alteration of the original sedimentary rocks until they were metamorphosed as we see them now.

In the *Manual of the Geology of India* it is stated that "this Nilgiri strike is noted as distinctly that of the lamination and bedding of the gneiss as well as of the foliation," * and therefore it is the more difficult to conjecture to what forces the direction of the quartz veins is due, coinciding as it does, not with the foliation, but rather with the system of joints above referred to.

While the strike of the rocks over a large part of Australia is nearly meridional the reefs also have generally a north and south direction.

The stronger and more persistent veins as they appear at present may represent what were once lines of least resistance, and some speculations of a strictly geological character might follow this suggestion if this report were not confined to questions of a practical character.

Much valuable information is to be obtained respecting these rocks from the reports and map prepared by Mr. King. A sketch of a Geological Map of South-East Wynaad on the scale of four miles to one inch, published with the records of the Geological Survey of India (May 1875), and which I had not the opportunity of seeing until after much of this report was written, shows alternating bands of felspathic gneiss and chloritic gneiss running north-easterly and south-westerly, as well as a large area occupied by quartzo-hornblendic gneiss (Nilgiris) and the smaller areas of granitoid gneiss at Yeddakilmullay and Munnaymulla.

There is an absence of intrusive rocks in South-East Wynaad. There are no dykes or masses of porphyry, no basalts or recent volcanic rocks; and it is only at one point, as far as is known, where greenstone occurs, namely, on the Hamsluck estate. The rock consists mainly of hornblende with a small proportion of felspar (oligoclase).

* *A Manual of the Geology of India*, by H. B. Medlicott and W. T. Blanford, 2 Vols., 1879.

Near the spot where this rock is exposed there are [illegible] of granite or perhaps, to speak more correctly, veins of quartz with [illegible] In several places, more particularly at Gidicair, Cherambádi, M[illegible] and Vellirymulla there are masses of quartz with [illegible] The mineralisation of the quartz is observed most frequently [illegible] re the veins are very thick; and from the observations which have been [illegible] the present time it might be inferred that gold, in such proportion [illegible] and in veins which are free from mica, is rarely present in the same rock.

It is not yet certain that the [illegible] less salubrious in those places where the quartz veins are [illegible] as to be noted in the neighbourhood of Devála.

The quartz veins of the Wynaad [illegible] those intersecting [illegible] the almost [illegible] of Australia, but [illegible] are [illegible] to the present [illegible] as persistent. [illegible] and by [illegible] which up [illegible] often [illegible] have [illegible] than veinstone from the [illegible] to become [illegible] smaller masses [illegible] Some of the rocks with which it is associated. [illegible] but it may be conjectured that the [illegible] would be structures, which have resulted in the [illegible] would not be without influence on purely [illegible] these places.

From the larger (true) veins "leaders" are thrown off, most commonly to the westward. The leaders usually dip at a low angle, but [illegible] large and of such a form as almost to give the character of "saddle" reefs to the masses of quartz.

The ordinary "casing" of the reefs is a [illegible] separable into thin laminæ with oxyd of iron and the minerals ordinarily [illegible] associated; and gold in small flat particles, visible to the eye, is not rare in the casing. The casing of many of the larger auriferous reefs is quartzose and ferruginous rudely laminated and with scales of ripidolite and talc scattered through the mass.

The average thickness of the true quartz veins is about five feet. Some are less than two feet in thickness and others again exceed [illegible] feet. The greater number, however, vary from four to seven feet. The direction of the veins is usually N. 30 W.—S. 30 E., and some are nearly due north and south; and the dip, though nearly always easterly, is irregular. On the summits of the [illegible] hills the veins are commonly almost flat or with a very [illegible] at a little depth from the surface the dip is, as might be expected, very different. It is not seldom as much as 30°, 40°, and 60°.

These sudden variations may be due partly to the changes produced on the surface by the heavy rains which fall yearly. Much decomposed and almost solid rock is moved in masses, and "the action of gravitation on substances loosened by weathering, or the 'weight of the hill' as it has been called," would account for the difference of dip as measured near the surface and at some depth from the surface.

The direction or strike of the quartz veins is, in a district like the Wynaad, broken up, as it is, into rounded hills of varying height not easy to trace, unless regard be had to the elevation of each point where an outcrop of quartz is seen.

* *Manual of Geology*—Blyth, Jukes and Geikie, 1872, p. 224.

An outcrop on a hill is thrown to the westward and the same reef outcropping in a valley is necessarily eastward of the line which would appear if the ground were of the mean level.

It is not yet possible to say what number of separate veins of quartz there are in the area which has been examined, but there are at least two hundred outcrops—not necessarily distinct reefs.

From Moopenaad to Cherambádi, a distance of eleven miles and-a-half by the road, twenty-three outcrops were observed, many of them indicating reefs of great thickness; from Cherambádi to near Nadukani in a straight line south-easterly, twelve miles, there are at least eighteen separate veins; and east and south-easterly of Devála the reefs are from 5, 5½, 7, 10, 16 and 23 chains apart.

Between Moopenaad and Cherambádi the rocks are in places arenaceous.

As will be seen from the detailed reports which follow, gold is almost universally distributed throughout the soils and quartz veins of the Wynaad. It occurs also in the sands and soils both on the east, west, north and south.

In South-East Wynaad, on washing a few dishes of the surface-soil anywhere, a few specks of very fine gold will be found; in the vicinity of the reefs rather heavy gold is often got by sluicing; and if a suitable spot be selected the native miners will obtain, even by their methods, sufficient gold to remunerate them for their labor.

The character of the rocks, the nature of the climate, and the formation of the country have all contributed to prevent the accumulation of drifts such as are found in California and Australia. There are here no gullies having in their beds shallow deposits with a well-defined auriferous stratum, no "deep *leads*" covered and protected by layers of volcanic rock: there are only, as a rule, in the district now under consideration "surfacing" and "quartz-mining."

On the Seeputtee river there is an accumulation of well-rounded boulders of quartz and gneissoid rock imbedded in hard clay and sandy soil which may be regarded almost as a "cement." It is no more than the old bed of the river which owing to the "cutting back" action of the water has lowered its level and left this drift on its banks. It is probable that, as in other similar cases, the "cement" will be found in patches on both sides of the river, in places which were formerly beds of the old stream. The bed-rock on which the gravel, clay, and boulders lie is at no great height above the level of the existing water-course; and the part of the drift which has been worked is about thirty feet in thickness.

This drift and those which are to be found in the beds of the swamps may be said to represent the alluvial deposits of the Wynaad. Some of these are probably rich in gold, but it is only under favorable conditions that they could remunerate the miner.

It would be extremely difficult and costly, and in many cases almost impracticable, to drain the swamps by artificial channels, and the expense of pumping the water from a shaft would be very great. Still, if the lowest stratum should prove to be highly auriferous, it might be found remunerative to resort even to pumping, care being taken to carry off the surface water from the swamps by constructing races.

Below the Wynaad plateau and bordering on the tertiaries there are in the beds of the streams rather deep deposits of drift. At Karambaut the water-wor[illegible] gravels and rounded blocks of country rock and quartz are of considerabl[illegible] thickness.

Below Eddacurra the bed-rock is covered with quite recent deposits and tertiary strata (laterite). It is not known whether the stratum immediately overlying the bed-rock is generally auriferous; but wherever the latter is intersected by quartz veins more or less gold will be found in the disintegrated rocks.

Mining for Gold in Malabar in former times.

From the appearance of the mines and the soils on the slopes of the hills it is almost certain, as stated elsewhere, that gold was worked in Malabar at a very early period. This, however, is only conjecture. The industry has no history. The wealth of the native rulers in former times, the buildings erected by them, and the records relating to their wars all point however to the conclusion that gold was derived in large quantities either from the Peninsula or perhaps from some neighbouring country.

It is stated that "in the year 1293, A.D., Alláhu'd-din, afterwards Emperor of Delhi, took the city of Deogarh, but the citadel still held out. Subsequently, Allah raised the siege on receiving a ransom, the amount of which may well appear incredible; 15,000 lbs. of pure gold, 175 lbs. of pearls, 50 lbs. of diamonds, and 25,000 lbs. of silver being enumerated among the items. So much, at least, appears certain that Alláhu'd-din levied an enormous sum upon Deogarh, and that consequently it must at that time have been a very great city and a rich emporium."*

In a letter to the *Times* (London) of January 2nd, 1879, signed Edward B. Eastwick, there is the following interesting statement:—After calling attention to the probable occurrence in the south of India of gold fields far richer than those recently discovered, the writer says—"The learned Dr. Burnell, in his 'Note on the great Temple of Shiva at Tanjore' tells us that 'in the eleventh century, A.D., nearly all the great temples to Shiva in Southern India were built, and in the twelfth and thirteenth centuries the great temples to Vishnu were erected;' and it has always been a puzzle whence the great wealth came which enabled the Rajahs of Southern India to construct such enormous works, which, collectively, must have cost millions. The marvel is increased by the fact that, so far from these Indian princes having been impoverished by this expenditure, they were still possessed of vast treasures which fell into the hands of the Moslems in the fourteenth century and were carried away to Delhi. But the famous inscription on the Tanjore Temple, the deciphering of which (an astonishing feat) has been effected by the same authority, sheds some light on the matter." Dr. Burnell writes:—

"The full importance in Indian History of Vira Cola's reign is only to be gathered from this inscription; but it contains other information also of great value. It proves, *e.g.*, that in the eleventh century gold was the most common precious metal in India, and stupendous quantities of it are mentioned here. Silver on the other hand is little mentioned, and it thus appears that the present state of things, which is exactly the reverse, was only brought about by the Portuguese in the 16th century.

"I submit that the great abundance of gold spoken of in the inscription can have arisen only from mines, and that in the terrible convulsions caused by the irruption of Moslem invaders from the north and Europeans from the west, the position of these gold fields was lost sight of * * * * *."

The full significance of this statement as affecting Southern India can be understood only when taken in connection with the large areas which are now known to have been worked by the natives. It seems to leave little room for doubt that the reefs and soils when first opened up were extremely rich, and that the soils as we find them now have been impoverished by repeated washings.

Mr. Sheffield, Principal Collector of Malabar, stated in a letter referred to by the Committee which reported to the Government on the character and prospects of the gold fields of Malabar in 1833 that the collecting of gold had been farmed out in Wynaad and the Nilambúr Valley for fifty years previously.

Tippoo Sultan procured large quantities of gold from some source and was possessed of great wealth.† It is stated in *Maxwell's Life of Wellington* that amongst other conditions exacted from Tippoo by Lord Cornwallis, he was to pay three crores and thirty lakhs of rupees in gold mohurs, pagodas, and bullion:

* *A Hand Book for India, Madras.*—John Murray, 1859, Page 94.

† The Committee who reported on the gold mines of Malabar in 1833 state that "it is pretty certain Tippoo attempted to make them a source of revenue during his possession of the country." He no doubt employed slaves, and these would have to be fed. What was the cost during the period of Tippoo's rule of maintaining a slave? The Committee mention that at the time they reported a cooly could be hired for a pagoda a-month (say Rs. 3-11-8, or 2 annas 6 pie per diem nearly) and food was cheap. When Lieutenant Nicolson was in the Wynaad twenty seers of rice could be bought at Nadagani for one rupee, and thirty seers of rice for one rupee at Sultan's Battery; and the cost of a sheep at Ootacamund varied from eight to twelve annas. Rice at Devala at the present time is sold at the rate of eight seers for one rupee and the price of a sheep is from three to four rupees. When food was to be obtained at such low rates as those which were current some fifty years ago, the washing of very poor auriferous soils would have given a profit to the proprietor of the slaves.

equal to nearly, £3,300,000. On one occasion Tippoo sent thirty-eight camel-loads of money to Scindiah with the hope of securing him as an ally; and from the estimate of treasure and property taken at Seringapatam in 1799 there appear two items that clearly show to what extent the Sultan, in a comparatively short space of time and notwithstanding very heavy demands on his treasury, had been able to accumulate wealth. Of specie there was 16,740,350 Star Pagodas, and of jewels, gold, and silver bullion 25,000,000 Star Pagodas. His throne was sold unbroken for about £2,500, the gold not included in the purchase producing nearly £25,000. These facts and the knowledge we have of the enormous costs incurred by this Prince in supporting armies, constructing forts, and in procuring munitions of war and stores, sufficiently support the conclusion that he must have had ready means of procuring gold; but whether to any large extent from the mines of Southern India can only be conjectured.

In the reports of a joint Commission from Bengal and Bombay appointed to inspect into the state and condition of the Province of Malabar in the years 1792 and 1793, the Commissioners refer very briefly to the occurrence of gold. In treating the subject of the royalties claimed by the Rajahs mention is made of "all gold ore" and also of "compositions of gold * * * * *, of which last article some is found in the Nilambúr District."

About the same time the gold mines had attracted the attention of the Government. In 1793, the Honorable Mr. Duncan, Governor of Bombay, took some steps to ascertain the value and extent of them.

In 1802-3 the auriferous rocks of the Nilambúr valley are again mentioned; and in a work by Dr. Whitelow Ainslie, published in 1813, an account is given of the localities where gold is found in India. The Committee of 1833 quote from his work as follows:—

"Gold dust has been found in the bed of the Godávari, and in Malabar in the bed of the river which passes Nilambúr in the Irnadi District. It has moreover been procured in very small quantities in Wynaad, in the Arcot District, and in the sand of the Beypore river near Calicut. Though the sources are evidently numerous from which this valuable metal can be obtained in the Indian Peninsula, it would seem from the little interest they have hitherto excited that none of them promised to be very productive."

Prior to the year 1831, Mr. W. Sheffield, the Principal Collector of Malabar, had been purchasing gold for the Government, and on the 10th January 1831 he furnished a very interesting report on the several localities where gold was known to occur and on the methods of mining employed by the natives.

On the 15th February 1831, Lieutenant W. Nicolson was appointed by the Government to search for gold "in the mountains on the Malabar Coast," and with him was associated Mr. Henry Louis Hugenin. The latter, in his agreement with the Government, stipulated that he should receive one-half of the gold he might assist in finding and raising during a period of twelve months and the same proportion of all gold he might collect from the mountain streams, &c., by washing; the Government having the right to take such share of the produce at the market price of gold.

The party was formed apparently for the twofold purpose of "prospecting" for gold fields and for procuring gold for the Government. Lieutenant Nicolson had under his directions a Havildar's party of pioneers, and he employed natives to teach the pioneers to wash for gold and to assist him in his explorations. In his first report, dated 18th April 1831, Lieutenant Nicolson states that he met Mr. Hugenin at Devalacottah on the 16th April, and that they forthwith commenced their explorations.

The localities visited by this exploring party are shown approximately on a tracing accompanying this report, which is a copy of a map drawn and furnished to the Government by Lieutenant Nicolson on the 15th July 1832.*

Lieutenant Nicolson and the members of his party suffered much from fever; and in the letters and reports detailing their proceedings at various places there are numerous complaints of the misconduct of servants, the want of a sufficient number of assistants, bad tools, and an irregular supply of necessaries for the men. The petty Rajahs too, Lieutenant Nicolson states, incited the natives over whom

* See map facing, p. 83.

they had control to obstruct their proceedings. They felled trees to stop paths; they filled in shafts and also misled the party by mistating facts as to the value of the mines.

After the Government received the report of the Committee appointed to examine the gold mines of Malabar (25th May 1833), the Right Honorable the Governor in Council, being convinced of the inexpediency of working the mines on account of Government, the services of Lieutenant Nicolson were replaced at the disposal of His Excellency the Commander-in-Chief.

It seems from the absence of any records relating to the mines of the Wynaad that the search for gold, and indeed even any interest in the questions which had engaged the attention of the Government in 1831—33 had completely ceased.

In October 1857, the Acting Collector of Malabar drew attention to the arrears of taxes payable by the Rajahs for the right to mine, and in his letters there is some information given respecting the gold workings. He says, in a report dated 4th December 1858, that "it is difficult to define the exact locality in which the gold is quarried and washed; for it is obtained in very many places interspersed through a tract of country extending for some thirty or forty miles along the western face of the ghâts and in parts along their summits. * * * * *. Along the whole of this extensive tract gold-diggings and washings have been, and are, I dare say, now being carried on in many parts. But circumstances have altered so much within the last ten years that the trade has gone down very much, and many of those who understood the art have betaken themselves to other employments and have carried away with them the knowledge of the localities richest in ore. The only persons who seemed to have any acknowledged right to the gold are the parties against whom the present balances are outstanding. They collected the ore entirely through the agency of their Chermars and Panniars, or slaves;* and I am given to understand that whole families of these have betaken themselves to Western Wynaad, where good wages and fair treatment are to be had at the hands of the various Coffee Planters."

Many persons, besides those who became planters, were attracted to the Wynaad as soon as the country was opened up anew, and amongst them were a few persons from Australia. Two whose names are now well known in the district were miners or acquainted with mining. In July 1865, Mr. H. L. Sterne, who had had six years' experience as a gold-digger, made application to the Government for leave to search for gold and other metals on Government land in the Madras Presidency; and on permission being granted he prospected in various places, but with what results is not accurately known. Mr. G. E. Withers commenced to prospect about the same time, or subsequently, and in pursuing his labors became convinced that the reefs were auriferous and deserving of attention. It seems that it was owing partly to his labors, but mainly to the enterprise of Mr. J. W. Minchin of Hamslade near Devála, that machinery was erected for reducing the quartz found in the veins at the Skull Reef and the reefs within the Wynaad Prospecting Company's area. Mr. W. E. Schmidt and Mr. J. W. Ryan were applicants for the right to mine on their estates in April 1866, and they were also active in promoting the new industry. The results of the operations of the Companies who commenced quartz crushing in 1875 and 1876 are referred to in another place in this report.

Other applications for land for gold-mining purposes were made in 1876, and it seemed at that time that the gold fields would be reopened and worked with suitable machinery, but the trials made were unsatisfactory and the works were brought to a standstill.

Gold-washing as practised by the Natives.

The methods employed by the natives in washing the auriferous earths, whether by "ground-sluicing" or by *pautties* (puddling troughs), their system of mining in quartz veins, if mining it can be called, their plan of grinding the quartz as well as their final operation of "washing off"

* Lieutenant Nicolson makes mention of the mines being worked by slaves. He says the people were "most inhumanly and barbarously treated." See appendix to this Report.

in the wooden dish (*Murriya*) are of the highest interest, representing as they do operations that were carried on in all probability exactly in the same manner some thousands of years ago. The old gold fields of the Western World were certainly worked more than five-hundred years before the Christian era in the same manner and with the same appliances as those used now by the Korumbars and Moplahs.

Their various methods are tedious, they involve the expenditure of much labor, and the results are no fair criteria of the value of the earths or rocks which they treat. By any system of "ground-sluicing" some gold is lost, but, working as the Korumbars do, it is questionable whether they collect more than a small proportion of the fine gold contained in the soil. By using the puddling trough they may have saved a little more gold, but not much more. The *murriya*, however, in the hands of an experienced native is nearly as perfect for "washing off" as the tin dish of the Californian and Australian miner.

The tribes which are mentioned as supplying men commonly employed in gold-mining are the Korumbars, Moplahs, Panniars, Nairs and Tiers. The Korumbars and Moplahs are said to have worked the quartz veins, and there is reason to believe that their systems of excavating the reefs were different, though their treatment of the stone was in all likelihood the same.

Ground-sluicing.

In getting gold by "ground-sluicing" the Korumbars display much ingenuity. One old miner usually directs the operations. Having fixed on a spot where he thinks there is a probability of finding gold he "prospects" the area, using the *murriya* for washing the earth.

On a site being chosen, if it is not actually in the bed of a stream, a supply of water is directed to the spot by a race, and work is commenced. The men excavate the earth with their mamooties, the water all the while flowing over the space in which they are working. One man stands behind the other at such a distance as to permit of his using his mamooty, and in a short time three or four men are laboring knee-deep in water: the large stones are put aside so that finally a wall is formed. The men are usually careful in washing the stones, and they exhibit no little skill in turning every slight advantage to account. The soil is stripped to the bed rock, every crevice is scraped with the mamooties, and at length the resulting heavy material having been concentrated by being raked up against the stream, the old miner steps into the channel with his *murriya* in his hand and fills it with the sand, &c., piling the stuff as high as he can on the dish. A little pool meanwhile having been made he places the wooden vessel with its weight of sand in that and "puddles" the sand, always scrupulously washing and examining the small stones before he throws them away. By tilting the dish and adroitly moving the stuff with one hand as the water flows over it he finally obtains a black, heavy, iron sand and on this being sufficiently concentrated the vessel is filled with water, a swinging motion is given to it so as to throw the gold into or a little above the hollow in the centre, and then again tilting the *murriya*, he takes water in one hand and allows it to fall through his fingers on to the sand in the lower part of the dish, and thus in a little time clears the dish of the refuse and at length is able to show the gold almost completely separated from the black sand.

The washing is continued dish after dish until all the material concentrated in the sluice has been treated. The Korumbar's skill in manipulation is very great and he is also patient and painstaking.

When the gold is got together it is put into a leaf, and any black sand in it is washed off.

The operation of washing a dish of stuff usually occupies half-an-hour or more.

The Murriya is made of hard, heavy wood. It is from eighteen to twenty-two inches in length, sixteen inches in breadth, and from two to three inches or more in depth. There is a projecting pin at one end and a knob at the other. It becomes smooth and black by use and shows the smallest particle of gold quite clearly.

In many parts of the Wynaad District the remains of the walls built by the miners when ground-sluicing, the lines of their races, now almost obliterated, and heaps of rubble extending in some places over many acres, are to be seen; and in the jungles on cutting into the earth on a hill side one finds that the soil has been disturbed. Indeed the evidences of the patient labors of the native miners are so numerous and are found in so many localities that one pauses to consider the length of time which must have elapsed since gold-washing first became an established industry in this part of India. The soil and rubble made to yield its gold in times long past is now again consolidated, covered with herbage, and supporting large jungle trees.

Washing with the Pautty.

The box used by the natives for washing auriferous earth more resembles a puddling trough than a sluice. The *pautty* is a trough made of wood. It is from six to seven feet in length and one foot or more in breadth. On discovering a spot where there was a sufficient quantity of auriferous earth these boxes were employed; and it would seem from the report of a Committee appointed, under date 14th December 1832, to examine the gold mines in the Zillah of Malabar, that when they visited the mines near Mambat (Beypore river) there were fifty or sixty Moplahs at work.

The Committee state that the *pautties* were placed over a running stream, or water was conveyed to them in races. The boxes were placed in a sloping position. At the lower end small pieces of bamboo were laid across which acted as "riffles." Two men, the Committee state, were required to work one *pautty*. One day they collected the earth and the next day they washed it. The earth was carried to the *pautty* in the *murriya* and the men stirred the earth with their hands, removing the stones, &c., until only heavy sand remained. This residium was washed in the ordinary way in the *murriya*, and quicksilver was used to collect the gold, the amalgam being afterwards wrapped in a rag and placed between two pieces of burning charcoal until the heat volatilised the mercury and left the gold clean.

The *pautties* were used during the wet season on the higher lands, and in the dry season in the beds of the streams.

Working Veins.

Throughout South-East Wynaad and at several places in the low country of Malabar the quartz veins have been worked by the natives. The appearance of the workings indicate the following methods of getting out stone:—

(1) Quarrying on the outcrop of the veins (surface workings).
(2) Vertical shafts.
(3) Adits.
(4) Vertical shafts with adits therefrom.
(5) Shafts on the underlie.

Quarrying on the outcrop of the veins was undoubtedly followed in the first instance. Gold was seen in the stone, and blocks were broken in order to procure fragments with gold visible. It is believed that no stone was crushed which did not show gold.

Subsequently vertical shafts were sunk, but by what tribe is not known. Many of them are well formed, always round, and as deep as seventy feet or more. Some are in solid quartz, others in country rock intersected by "leaders" and thin veins of quartz. How the miners could possibly have sunk such shafts in hard dense quartz with the tools they had is hard to guess. They are plumb and the sides are quite smooth. It is not uncommon to find a number of shafts very close together, not more than a few feet apart. The adits in most cases were evidently constructed long subsequent to the sinking of the vertical shafts; where the latter are found on the summit of a hill they are undercut by adits; and in some places care has been taken to block up the shafts so as to prevent stones and earth falling in on the miners below. It is unreasonable to suppose that several vertical shafts would have been sunk close together after the adit was driven. They could not have served any useful purpose. And the miners who constructed the adits did not generally sink vertical shafts in following the reefs downwards from their

adits; they sunk shafts on the underlie or footwall, and these are to be seen in various places.

Towards the north-west another system was employed. In mining on the steep slope of a hill a vertical shaft was sunk to the depth of six or eight feet so as to cut the reef, and an adit was driven therefrom. With what object this method was adopted is not known; but it may be supposed that in some situations difficulties were found in protecting an open cutting from the rains. The cutting necessary to get a "face" in the solid rock would present surfaces which would be to some extent affected by the rains; whereas by sinking a shaft (at all times easily protected) the miners were able to penetrate the hill with safety, though the additional labor involved in getting out stone would be great. There are, as already stated, not a few shafts sunk on the underlie in several localities near Devála. The reefs were mined in this manner, it is almost certain, by the same class of miners as made the adits.

It was not unusual for them to penetrate to the depth of sixty or seventy feet, but where the reefs were flat or had a low dip these underlie shafts were only inclined adits, rising where they worked at the casing of the hanging wall and falling again as they followed the footwall.

In what manner soever the auriferous quartz was procured the after-treatment was in all cases nearly the same. The quartz broken into small pieces was given to the women to grind. Each woman was provided with a muller or hand-stone, and the fragments of quartz were either ground on a suitable piece of stone *in situ* or on a large flat stone procured for the purpose. The pounded stone was subsequently washed in the Murriya and the gold got by amalgamation with mercury.

The auriferous stone was sometimes roasted. Whether merely to effect its disintegration more easily and rapidly, or whether from a knowledge that the pyrites in it were auriferous, has not been quite satisfactorily ascertained.

It is probable, however, that some of the miners knew that the pyrites contained gold though it was not visible to the eye, and that by roasting the mineral they would get it. In one locality it was usual for the miners to procure blocks of pyrites, divide them, and take the pieces to their homes for treatment.

In breaking up blocks of quartz too on the outcrops of the reefs, it is said that they used fire. In one place, according to information given to me, the trees of the jungle were felled, the timber piled in heaps on the quartz and there burnt, and on the outcrop of one reef an excavation in the solid rock was found which appeared to have been constructed for and used as a kiln.

Where the quartz miners have labored there are to be seen usually large heaps of broken quartz, the pieces rejected, because they did not show gold; and on the outcrops of the reefs are found the smooth hollows in the rocks worn by long hand-grinding, while in the jungles the flat stones and mullers, covered with moss, are occasionally met with.

It may be interesting to remark that these flat stones and mullers are very similar in form to those used by the Australian natives for grinding seeds, &c.

The miners who worked in the adits seem to have had more knowledge of mining and of the modes of occurrence of gold than those who formerly got out quartz by sinking vertical shafts. The former followed the run of gold wherever they were able to do so, sometimes taking out the footwall and "casing" and sometimes the hanging wall.

The Korumbars, skilful as they are, have no knowledge of the manner in which the gold has been distributed. They are acquainted with the "run" of the reefs and show great intelligence in selecting spots likely to yield gold, but they do not believe that the gold in the soils has been derived from the disintegration of the reefs. They say that it is found in some places in the reefs, in other places in the soils, but that its occurrence in the latter is in no manner connected with the former.

There is no record of any large pieces of gold having been found in the Wynaad. In the pamphlet entitled *Gold Prospecting in the Wynaad* it is mentioned that one fragment was got within the last few years which weighed over seven pennyweights, but some quartz was mixed with it. Other pieces, weighing respectively 11 grains and 21·9 grains, are named as having been washed out of the soil near Devála and Glenrock. The natives have made many statements and have some curious traditions respecting the finding of nuggets of gold in former times.*

Number of Native miners employed.

Even in those gold-mining countries where there is a very complete system of registration of "claims," and efficient machinery for collecting statistics relating to the number of miners employed, the mechanical appliances in use, and the yield of gold, few returns are regarded as more than approximations.

If extensive mining operations were carried on by the natives in Southern India it would be impossible to arrive at any results, except by making rough calculations of the probable average yield per men per diem based on such information as might be afforded by the miners and the purchasers of the gold in any given area; and it is not surprising therefore that the Committee appointed to make investigations in the Province of Malabar in 1832 write with much caution when dealing with the statistics afforded by the shroffs, cultivators, and others examined by them.

The Committee state that the best informed persons who gave evidence before them estimated that not more than 1,000 persons were engaged in gold-mining in the whole province of Malabar. Most of these, it was added, were married, and it was assumed that probably between 4,000 and 5,000 people derived a portion of their means of subsistence from the produce of the mines.

The miners were not employed during the whole year in searching for gold: they followed this pursuit only during those periods when the weather interfered with the carrying on of agricultural operations; and it is said that there was no instance known of any persons giving up other occupations for the purpose of devoting their time exclusively to gold-mining.

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* When at Devála I was told that a lump of gold weighing about 9 lbs. had been unearthed a long time ago in a valley not far from the bazaar. Again, when at Sullumilai, "Kooty" Maistry informed me that a piece of gold as large as his head had been found in the Pandi river on the way to Peria Shola, and that the largest piece he, "Kooty," had ever washed out was worth Rs. 25. He added that on the slope of the Needle Rock range towards Devála a nugget of gold was found in his grandfather's time which was as large as two hands could compass, and that it was taken away by the Adagherry of Nelliallum. At the same time when talking with Kooty Maistry it was stated by some of the men that one "Koolamby," a Pannier who was employed in cutting the district road near the Monarch Reef, found a piece of gold of some weight. Mr. Minchin corroborated the statement of Kooty Maistry, when he said that it proved of sufficient value to support Koolamby for three years. Kooty Maistry was inclined to be communicative. He told me that the old workings about Devála were made by people called Bordah, very small people who alone could have made the small adits and holes we see. Kooty said he had found their implements, small things between mamooties and pickaxes, so small as to show that only small men could have used them. On the other hand, Korumbar Carlah declared that the miners in ancient times were very large men, and he inquired how the large stones could have been moved if the miners themselves had not been large? Kooty rejoined how could large men enter the small holes we see? This discussion was not without interest.

Subsequently I received an account of mining operations on the Pandi river below the Peria Shola crossing. There they say, a party of forty or more natives sank down to the bed rock through the overlying strata (on or nigh the bed of the stream) making coffer-dams, using, in constructing them, fascines filled with clay, and on penetrating to some depth, after working for four or six months, finally reached a layer of gold one inch in thickness! It appears, however, that they seldom touched this layer. Floods, too, often carried away their dams. Their statements may perhaps be more reliable than their traditions. All the natives in the neighbourhood of Devála firmly believe in the following story and it is given as nearly as a translation of their words can convey their meaning:—

"Two hundred years ago there was a larger population in this country. The Veddah Rajah lived in this place. He had a fortress at the Manera Kotta and one at the Tum Tum Hill; the Devála Kotta is the sacred place. This Rajah collected much gold; all the holes and caves in the country were dug by his people in getting gold.

"The Kurumbranád Rajah, who lived in the low country, wanted his gold and came up the Ghâts with all his soldiers to take it away. The Veddah people were not soldiers; they dug in the ground. When the Veddah Rajah heard that the Kurumbranád Rajah was coming up he put all his gold into large copper pots and threw it into the tanks below his forts. There is much gold buried in these tanks both at Manera Kotta and at the Shuli Kolam.

"The Kurumbranád Rajah killed all the Veddah people. A few ran away and are still in Mysore and in the Nilambúr Forests. The Kurumbranád Rajah gave the country to the Numboly Kotta Vanavaar and his descendants. About eighty years ago the Vanavaar tried to get the gold from the Shuli Kolum; he made great Poojah; all the people were feasted three days; a great tamasha was made.

"Then the Rajah got elephants and chains, and the chains were fastened to the great copper pot at the bottom of the tank. The elephants were beaten, all the people screamed and cried, the priests prayed, and the top of the great pot appeared above the water. Then suddenly two chains slipped, the great pot rolled back into the water, and nothing was left, but the copper cover. A fearful storm of wind and rain commenced, the people fled to their homes, and on that night the Vanavaar's son and most of the people engaged in this business died.

"The copper cover was for a long time kept at the Devála Kotta and was afterwards removed to the Numboly Kotta Temple, where it has been seen by many of us. But no one will now go near this Shuli Kolum, and whoever attempts to recover this gold will surely be killed."

The above legend may or may not have some solid foundation, but it is certain that one of the most acute and farsighted men in the Wynaad believes in it so far as to have made such an offer to the Nilambúr Rajah for the right to search for the hidden gold as to prove that he was thoroughly in earnest. The offer was refused. I have seen the so-called tank. It is a deep water-hole in a swamp, covered thickly with screw-pines.

It is impossible now to ascertain whether any large number of persons contied to employ themselves in mining in Malabar between the years 1832 and 1842. the year last named the planting of coffee was commenced in the Nílgiris;—and cultivation subsequently was rapidly extended. In 1854 a large extent of land as cleared in South-East Wynaad for plantations, and it may be assumed that the miners as well as others were attracted to the plantations by the wages offered by e planters. Labor was in some way withdrawn from the miners. In 1857, cording to information furnished by Mr. Alexandar Wright, there were less than ur hundred persons working the mines at Yellem-Bullay, Devála, and Karambaut.

What number was employed near Nilambúr at that time is not known. It almost certain that the working of the mines by the natives in South-East Wynaad actically ceased with the extension of the coffee plantations in 1862—65. At the esent time, as far as can be ascertained, there are no mining operations carried by the Korumbars, Moplahs, or other tribes in this area.

In other parts of India, however, a considerable number are still employed in ashing the auriferous earths and the beds of the streams and in breaking up uartz, using the same methods and appliances as those described elsewhere.

Earnings of the Native miners.

The information collected by Lieutenant Nicolson respecting the earnings of the miners at the time when he was exploring the Nílgiris and the country adjacent does not accord with that obtained y the Committee which subsequently took evidence on this question.

Lieutenant Nicolson states in his letters to the Government that at the ines near Nilambúr the yields varied from the weight of one-third of a gold anam to the weight of ten gold fanams* per man per diem, and that at a hill named ombala Mallay (one of the Chulu Mallay range) the average yield was about one old fanam's weight per man per diem.

In his evidence when he was examined by the Committee he stated that the verage earnings from the *best* shafts with the methods of working then in vogue ere about the weight of a gold fanam per man per diem.

The Committee in their report to the Government assumed as the average proluce of each man's labor per diem one-third of a gold fanam's weight, and on this heir calculations of the total produce of gold in Malabar is based.

One witness examined by the Committee gave, as what the miners would consider a fair remuneration, half an old gold fanam (two annas) each per diem adding that the miners got generally less than this.

Another witness thought a quarter of a fanam's weight was the average.

A Sheristadar, Principal Collector's Cutcherry, Calicut, gave as the average produce from actual inspection four barleycorns per man a day.

Mr. King, the Deputy Superintendent of the Geological Survey, could not ascertain that either by washing the soils or crushing the quartz the miners ever got gold, except in very rare instances, in larger quantities than would pay the average day's work of each man, or from two to three annas' worth of gold (*Letter, dated Madras, 11th March* 1875).

Mr. Lindon, in a report dated October 1876, states that "a laborer, working on his own account, can raise, crush and wash about 16 lbs. of reef-stuff per day. In order, therefore, to give him a day's wages of four annas (say three grains of gold) the (say) 16 lbs. treated must yield *him* at the rate of about one ounce of gold per ton, and contain actually, nearly, if not quite two ounces of gold per ton of stone." In the pamphlet entitled *Gold prospecting in the Wynaad* it is estimated that less than 15 pennyweights of gold to the ton would not have found the workers in food, as it takes a man the whole day of ten hours to pulverize 12 lbs. of stone.

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* The average weight of the new gold fanam is 6 grains nearly, and 80 may be reckoned to the ounce troy; the average mint value of 100 pieces is Rupees 24-8-11.

The average weight of the old gold fanam is about 5·79 grains and the mint value of 100 pieces is Rupees 24-7-3—*Report of Committee, 14th December* 1832.

The star pagoda of gold was 19½ carats fine, and intrinsically worth 7*s*. 5½*d*., weight equal to 52½ grains troy. Twelve barleycorns are equal to one fanam's weight.

From these different and somewhat conflicting statements it is not easy to arrive at a result which would have a value in any attempt to estimate the quantity of gold procurable by the native miners either from a given weight of earth or vein-quartz, but there is some information available.

The Committee above referred to had some test-washings made during their stay at Nilambúr, and they found that "two maunds or 66 pounds of the earth from the upper stratum of the Mambaat mine being washed produced a quarter of a barley-corn, value one-hundredth part of a rupee; touch reported by the Company's gumastah 9½; time occupied in washing 20 minutes. Two maunds of the lower stratum produced a still smaller quantity * * * * * * * * * The same quantity of the red earth from Coopul produced one grain; time occupied in washing alone 50 minutes."

The first washing shows that the proportion of gold in the soil was equal to 4·24 grains per ton; and the last gave at the rate of 33·93 grains per ton. Now in Australia the results of actual mining operations by hydraulic or jet-sluicing prove that a yield of ·800 grains per ton will cover expenses, even where hired labor is employed and the water is paid for.

In Colonel Sankey's report on the Coliban and Geelong schemes of water-supply (Victoria, Australia) there is, in addition to the principal matter of it, much valuable and interesting information on the subject of sluicing auriferous soils. He estimated the quantities of water required to reduce a cubic yard of soils of different characters as follows:—

	GALLONS.
1. Stiff clayey soil	10,000
2. Medium	5,000
3. Easily worked	2,000

The nearest approximation to the average quantity of soil which each man can sluice in a day he gives as follows:—

	Per diem. C. YARDS.
1. Stiff clayey soil	10
2. Medium	20
3. Easily worked	35

These averages were ascertained, by direct experiment, to be as nearly as possible correct.

At Blackwood it was proved that, in sluicing medium soil from 10 to 12 feet in depth, one grain of gold per cubic yard would return ordinary wages.

As the soils on the slopes of the hills throughout the area occupied by gneissoid rocks in Southern India are not difficult to wash, and would come under the head of 'easily worked" in Colonel Sankey's classification, it is possible that sluicing on a large scale may in some localities become a profitable pursuit.

It is true that the soils in the Wynaad are nowhere very thick, but a modification of the arrangements adopted in Australia in sluicing would admit of large quantities of earth being treated with but a moderate supply of water.

Assuming that the proportion of gold in the soil was no more than the lowest named by the Committee, a man could earn in such a place as Mambaat at least twenty shillings per diem by sluicing on the large scale.

The imperfect means employed by the miners in washing the earth when the Committee witnessed the tests leaves room for doubt as to whether they recovered more than a percentage of the gold in the quantities of soil they treated; and instead of the results being discouraging as suggested by the Committee (gold-mining as an industry being then in its earliest stage) they are such as to lead to favorable conclusions both as to the value of the soils and the reefs.

Assuming that each miner got no more than the quantity named by the Committee and Mr. King, his earnings for the whole year, allowing twenty-four working days to the month, would amount to 24 pennyweights of gold only.

When the gold fields of Victoria were first "rushed" by miners the average earnings per man per annum were equal to 65 ounces of gold; afterwards, as the shallow diggings became exhausted, the yields decreased; and at the present time the average earnings of quartz and alluvial miners vary from 16oz. to 26oz. per man per annum.

What the average yield of gold from the richest earths was when the gold fields of Southern India were first opened cannot be conjectured. It may be believed that all the streams and slopes where the richer earths had accumulated and all the outcrops of quartz where gold was visible to the eye were eagerly attacked by the natives; and that at all times since the discovery of gold was made it has been the endeavour of the miners to find the most productive patches. Except as regards deep mining in the reefs which the natives could not undertake, the gold fields of Southern India may be looked upon, like those of many districts in Australia and California, as practically exhausted as far as it has been possible to exhaust them by the native system of working. Any comparison therefore between what the native miners earned in 1832 or since and the earnings of the miners of Australia formerly or at the present time can have no value in measuring the auriferous resources of Malabar.

When the miners commenced to work the fields in Australia and California they found numerous shallow deposits in gullies and "flats" where the gold derived from the disintegration of a great vertical extent of auriferous quartz veins was stored at depths varying from one or two feet to thirty feet or more; sheets of lava in many parts sealed up and conserved old stream-beds also rich in gold, and these as well as the earths on the slopes of the hills were easily worked. In Malabar there are no recent formations similar in character to those which were so productive in the countries named. It would be altogether unreasonable to compare the produce of the miners here with that now obtained by miners in Victoria. The native miner has a *mamooty*, a *murriya* or a *pautty*, worth altogether perhaps one rupee: the Victorian miners have machinery valued at £2,000,000, that is to say, they have appliances of the value for each man of £45. And this does not represent the enormous difference in their modes of labor. The Australian miners have extraordinary energy, great skill in using their appliances, and, above all, organization. They labor for the most part under the most excellent management and the most active superintendence. A native, it is said, can crush from 12 lbs to 16 pounds weight of quartz per diem: one heavy stamp-head in Australia will do as much work as 500 natives; and at present there are more than 6,000 stamp-heads in one colony alone.

It is well to remember, too, that a well-trained European miner will do as much ordinary work as five or six natives. With a good pick a practised miner would probably excavate more earth or rock in one hour than a native would do in five or six hours with a mamooty.

The only way in which the relative value of the gold fields could be tested would be to set a party of natives at work on an abandoned gold field in Australia or California restricting them to their ordinary modes of mining. It is doubtful whether they would earn one anna a day. Perhaps one pie would be nearer the mark.

Taxes paid by Native miners.

The taxes paid by the native miners may fairly be considered in connection with the amount of their earnings as estimated by different persons at different times. The Committee previously mentioned reported as follows:—

"In an extract of a paper, dated 9th January 1829, by Mr. Sheffield * * * * it is stated that in 1801 the gold dust in the Ernád country was farmed for Rs. 1,408-8-0. He mentions also that at the time of writing (1829) the privilege of gathering gold was farmed out above the ghâts for the sum of Madras Rs. 1,250, and below the ghâts in Ernád for Rs. 937-15-4, making a total of Rs. 2,187-15-4. Since 1803 a tax of Rs. 33 a-year each has been levied on a certain number of *pautties* or troughs employed in washing for gold. At present [1832] this amounts in Ernád to Rs. 839, which is a falling off of Rs. 569 a year since 1801, and in Wynaad to Rs. 1,260. Besides this the privilege of collecting gold in Caraloondy has within the last two or three years been farmed for Rs. 108, which makes the whole amount now received by way of tax upon gold paid to the Company Rs. 2,207."

It is said that there were 1,000 persons employed in gold-mining in the whole province of Malabar; and, assuming that the average yield per man was that estimated by the Committee, the taxes amounted to 5 per cent. on the produce, relatively a very heavy impost.

When the taxes paid directly by the gold miners in Victoria (1853) amounted to the large sum of £720,864, the proportion was no more than $6\frac{3}{4}$ per cent. on the gold raised. At the present time the taxes, rents, &c., paid directly by the gold miners in that colony amount to less than $\frac{1}{2}$ per cent.*

For each *pautty* a tax of Rs. 33 was paid, and consequently, if the two men employed to work it earned no more than the average, there must have remained to them as wages only 1 anna 7 pies each per diem. Allowing that they worked throughout the year this tax would amount to over 36 per cent. on the produce, and if they worked for only five months in the year it would nearly equal their whole earnings. These are fair deductions from the statements made in the report of the Committee and from the evidence given before them. The aspect of the case which I have presented never seems to have been considered by the Committee or they would have made further investigations. I have made inquiries and ascertained that the mode of collecting the tax was very different from that which was stated to the Committee. The native officer was accustomed to require the Rajah or his officers to state what number of pautties there were at work. A return was made perhaps of eight or ten when in fact there were one hundred or more at work. The principal native witness who appeared before the Committee neglected to mention this as the rule observed in transacting business in connection with the collection of revenue.

Auriferous reefs and Native workings near Devála.

In the descriptions of the auriferous reefs which follow it will be observed that in those places where there are enormous bodies of quartz exposed at the surface the old native workings are extensive. The most striking examples of this rather remarkable occurrence of what must have been highly auriferous quartz, where the reefs exhibit their greatest thickness, are to be found at Parcherry Hill, the Skull Reef near the Alpha Works, the reefs on the Sandhurst, Elizabeth and Strathearn estates, and at Karambaut. Though the natives worked the leaders in many localities, they found it evidently more profitable to break out quartz in such places as those mentioned; and it is highly encouraging, as regards the future mining prospects of the district, to find that the reefs of the Wynaad do not, as in most other countries, become poorer as they increase in thickness.

It would be wrong to infer from this that the thickest reefs are invariably the richest in gold: the facts adduced admit of no other conclusion than this, that the miner need not be discouraged when in following a vein he finds it enlarging. It has been often noted by those working quartz reefs in Australia that the absolute amount of gold per foot downwards does not decrease, but that where the reef thickens the gold is distributed generally through the stone and a larger proportion of stone has to be crushed to obtain the same amount of gold as in those parts where the reef was thinner. It would appear that this rule does not apply to the reefs in this country, but, until the veins have been opened throughout a considerable length and to some depth, no certainty on this point can be arrived at.

It has been considered advisable to use great caution in suggesting the probable connection of the outcrops of quartz as they appear at the surface—in laying down hypothetical lines so as to connect one outcrop with another. The direction of the lines of reefs may from the surface indications be guessed at; it can be ascertained in no other manner than by extensive explorations; and the facts mentioned in other parts of this report justify hesitation in laying down, as absolutely beyond question, any line of reef in the Wynaad.

At Sandhurst in Victoria notwithstanding that the lines of reefs have been largely mined and carefully mapped their strike at a small distance from the workings

* While the rents and taxes paid *directly* by the miners of Victoria are low it is right to state that under the system of "protection to native industry" they are very heavily burdened

either on the north or on the south is usually conjectural only, and in other localities in the same colony the miners have found it impossible to determine the course of the veins.

In the *Mineral Statistics* of Victoria it is stated in a note that the returns relating to the number of "distinct" quartz reefs which have been proved to be auriferous cannot be strictly correct, as parts of the same reef in some localities are held to be distinct reefs and named accordingly; and again as the reefs are further explored it is found that what were supposed to be separate reefs are not really distinct. In the Wynaad the difficulties in the way of determining even approximately the strike of the reefs is, it is scarcely necessary to say, far greater than in Victoria.

There is no information to be obtained as to the depth of the water-level in the rocks of the Wynaad, but it may be assumed from the character of the climate that water in most places will be reached at no great depth from the surface. This would be embarrassing and cause great cost in prosecuting mining operations if it were necessary to sink vertical shafts. As horizontal shafts will in nearly all cases be driven to cut the reefs, the depth of the water-level is of no great importance, except as affecting the minerals associated with the quartz and gold. Above the water-level the proportion of iron pyrites and other sulphides is smaller than below it.

The results of the treatment of the samples from many of the reefs will be regarded as discouraging by those who have not given much attention to quartz mining. It should be remembered, however, that in the greater number of cases the stone was broken from outcropping blocks, and it is a matter for surprise that so large a number should have proved to be auriferous and that so many should have yielded well. Enough has been done to prove that the area shown on the maps is one which must ultimately attract capital and that several localities will hereafter be the scene of successful mining enterprises.

It is not unlikely however that the first attempts will fail. Speculative undertakings having for their object the making of money by buying and selling shares are commenced invariably by appointing Secretaries and Managers at high salaries and the printing of a prospectus. This is followed by the erection of costly and not seldom wholly unsuitable machinery; no attempts are made to open the mine; and then, after futile endeavours to obtain gold, and a waste of capital, it is pronounced and believed that gold mining on a large scale will never prove remunerative.

It is probable that this story will be repeated again and again, here as in other gold-mining countries, until some one of the mines is opened by experienced persons who desire to secure profits not by dealing in shares but by mining.

Needle Rock.

Within the boundaries of the Needle Rock Estate there are quartz veins and alluvial workings.

The rocks throughout the central, northern and north-eastern parts, consist of quartz, hornblende and magnetic iron with granular quartz-rock in places. South of the bungalow there are numerous scattered blocks of weathered rock, exhibiting somewhat irregular rhombohedral and prismoidal forms. Where decomposed these enclose reniform and laminated limonite and hæmatite derived from the decomposition of magnetic iron. At Dawson's Diggings the direction of the foliation of the rock which is composed of quartz, felspar and magnetic iron, is nearly east and west; but there is a well-marked system of joints, like strike-joints, the direction of which is N. 20° E. and the dip E. 20° S. at 40°. There are other joints transverse to the latter and the foliation.

South-east of Dawson's Diggings the rock appears as if not much altered, it is in thin laminæ, and these are disposed in lines striking N. 55° W. and nearly vertical.

There are five separate outcrops of quartz at Needle Rock, the most important of which are the Buckingham Reef extending from the north-western angle of the estate south-eastwards for thirty-six chains or more, and the Chandos Reef which is seen about twenty-five chains southerly from the bungalow. The Buckingham Reef may be a continuation of the Monarch Reef and that which is found at the Dingley Dell Bungalow.

The Chandos Reef is nearly sixteen chains to the east of the line just mentioned the outcrop is at an altitude of 3,361 feet or 261 feet below the Buckingham. The quartz of the latter has a good deal of micaceous iron intermixed with it.

Both the reefs are strong and apparently persistent. No gold was seen in the stone which was broken out when prospecting; but Mr. C. R. Dawson exhibited specimens of quartz with gold visible from the outcrop on the southern boundary of the estate, which perhaps is a prolongation of either the Buckingham Reef or the Chandos Reef.

The character of the stone may be judged however from the gold found in the soil. Having been informed that rough gold had been washed out from shallow workings marked "Dawson's Diggings" on the map, and having inspected some of it, it was decided to continue the ground-sluicing operations which had been commenced by the Korumbars and also to wash by box-sluicing.

The Korumbars made an excavation forty-five feet in length, twenty-five feet in breadth, and two feet and a quarter in depth. They dug down to the bed-rock which everywhere is uneven. A ditch was cut for a length of thirty chains for conveying water to the workings; and I frequently observed the native method of washing. It was obvious that the coarse gold might be concealed in the crevices of the bed-rock, and escape the eyes of the Korumbars who searched for the larger pieces; and it was equally clear that some of the fine gold would be carried away beyond the end of the sluice. Some of the earth ("tailings") carried down by the water was washed by Mr. Thomas Laing, and he found gold in it. Still the yield obtained by the natives was sufficient to prove the value of the reefs from which it had been derived: the average was 1·18 grs. of gold per cubic yard.

Other experiments with the box-sluice were satisfactory; several small pieces of gold were got as well as fine gold; and there is little doubt hydraulic sluicing combined with a modified form of the box-sluice would at this place yield returns sufficient to give good wages to the natives.

Gold was found in the soil by sluicing and washing in other parts of this area.

The gold workings at Needle Rock were visited by His Grace the Governor on the 1st November 1878, when sluicing operations were going on; and gold was obtained by the Korumbars with their ground-sluice and by Mr. Thomas Laing with the box-sluice.

There is a good supply of water in this locality during the monsoon, but, if the reefs be mined, it will probably be found economical to use steam to drive the stamps.

From the appearance of the soil in all places where it was excavated it was apparent that it had been moved; indeed there is reason to believe that the hill sides in times long past were sluiced after the fashion now practiced by the Korumbars, and that the superficial deposits have nearly everywhere been robbed of their gold.

It was near Dawson's Diggings that the stone and muller used for pounding quartz were found.

Dingley Dell.

The main outcrop of quartz at Dingley Dell is found close under the bungalow where large masses of stone appear at the front and back of the house. In an excavation close to the outcrop the reef is of great thickness, perhaps twenty feet or more; its strike is N. 25° W. nearly; and it dips eastward at an angle of 30°. The dip however is not regular. The quartz is laminated, (the laminæ are rather thick); there is some of it jasperoid, in other places it is white; and there is much ferruginous quartz with white iron pyrites in nests. No gold was visible in the stone. It is said that rather heavy gold has been found in the soil not far from the reef.

About sixteen chains west of the bungalow there is another reef, which is probably merely a prolongation of that which is seen on the bandy-road about seventeen chains west of the western boundary of Needle Rock. If this be so the strike would be N. 20° W.

Eastward of and a short distance beyond the boundaries of the Dingley Dell tate the Korumbars say that there are native workings.

Mr. J. W. Ryan forwarded two baskets full of rather ferruginous quartz and th from Dingley Dell, and portions were tested—the yields being 2 dwt. 8·4 grs. ton, and 1 dwt. 19·8 grs. per ton. The samples were from depths of 3 feet and eet respectively, and necessarily are no fair indications of the value of the quartz.

Trevelyan.

The outcrops of quartz on the Trevelyan Estate are most probably connected, as hereafter stated, with the reef which appears near the Provident Bungalow.

The reef proper comes to the surface about twenty-seven chains north-easterly the bungalow, and along the line of reef south-easterly for some distance there e several old shafts. Between these and the bungalow there is a pretty strong der, which was cut when the Korumbars were ground-sluicing. Quartz with ld was found by Mr. J. Hodgson Williams in the trench and shown to me.

In three other places, as shown on the map, Korumbars employed occasionly by Mr. Williams, and for a short time by me, got gold by ground-sluicing.

About five chains south-easterly from the bungalow rather coarse gold as well fine gold was washed out of the stones and earth lying on the slope of the hill, d about twelve chains from the house the debris and detritus forming the banks d bed of a small stream yielded well.

Mr. Williams was active in prospecting with the aid of Korumbar miners, ho worked under the direction of an old Korumbar miner named "Matha," and us the occurrence of gold over a large area has been proved.

Mining operations could be conducted in this locality at no very great expense.

Provident.

On the Provident Estate at an altitude of 3,621 feet and very near the bungalow a quartz reef comes to the surface, which is no doubt the south-eastern extension of a reef which appears in e Trevelyan Estate. Mr. J. W. Ryan and Mr. J. H. Williams state that they w gold which was found here when a hole was being sunk for a post.

Strathearn and Maryland.

On the extreme northern boundary of the Strathearn Estate, and beyond the boundary, there are native workings extending over an area of five or six acres. The reef is seen exposed on the northern ce of the steep slope overlooking a paddy flat. At one spot its direction is north 7° west nearly; but following the several outcrops south-easterly the strike ppears to be nearly north 20° west—south 20° east.

About six chains southerly from the bandy-road there are old workings, and wenty chains south-easterly from the latter the reef again appears in the midst of mall pits and excavations. Outcrops are found near the Strathearn Bungalow, as hown on the maps, and the flat low land, west of the pulping house, has been orked by the natives.

The main reef shows strongly all along the outcrops, and it may be an extenion of the reef which is seen at the surface at the Hamslade Bungalow. If this upposition be correct the longitudinal extent is two miles and twenty chains and he strike north 18° 30′ west.

Mr. W. King is of opinion that the Strathearn Reef is a prolongation of the Skull Reef, and it is easy to trace outcrops all the way from the edge of the ghât o the northern extremity of the Strathearn Estate, but it is not so easy to deternine whether or not they are connected. Supposing Mr. King's view to be susained the strike of this line of reef would be north 28° west.

Mr. Lindon in a printed report, dated October 1876, expresses the opinion hat the Strathearn is an extension of the Hamsluck Reef (also traceable all the way by outcrops of quartz), and its direction in that case would be north 14° west.

As regards the outcrop overlooking the paddy flat there are, from the formaion of the ground, great facilities for mining and crushing the quartz.

There is a stream of water at the foot of the hill, and water could be stored t no great expense. It is at this point that operations might be undertaken with the best prospects of success.

The thickness of the vein is considerable, but until it is opened up, its real dimensions and true character will not be known.

There is a great quantity of broken quartz on the spot, showing that the natives must have found gold in sufficient quantities to remunerate them.

The yield of one sample of quartz taken from this reef was at the rate of 4 dwts. 21·8 gr. per ton; and another parcel gave 5 dwts. 19·77 grs. per ton.

Thirty-six chains north-easterly from the Maryland Bungalow a reef has been cut in making a road near the summit of the ridge, and in washing the soil and quartz gold was found in small quantities. At a lower level there are masses of quartz indicating the occurrence of a thick reef, which may perhaps pass through Pootha-cotah (where the natives say there are old workings in the thick jungles), and thence to the vein on the ridge overlooking Sheardale.

On the road from Richmond to Strathearn (see map) a vein, which seems to be a leader, is exposed for a length of about eight feet. Its direction was found to be N. 10° E.—S. 10° W., and the thickness two feet and a half. The rocks in the immediate vicinity strike N. 30° E. and N. 40° E. in the direction of the foliation, and main joints run nearly north and south (almost vertical).

Richmond.

There is one reef on the Richmond Estate which crops out about forty chains east of the bungalow. Its direction is north 15° west for a very short distance; but it is not improbable that it is a prolongation of the reef which is found in the Sheardale Estate. The dip and thickness could not be ascertained. The blocks of quartz near it, however, indicate that it is a strong vein. It has been named the "Richmond" Reef. There is a shallow pit near the outcrop, but it does not appear that the ground at this place has been largely worked by the natives.

North-eastward of the reef, and on the western side of the bandy-road there are native workings extending for a length of half a mile, consisting mostly of shallow pits.

These are old workings. Trees and shrubs are growing in and near the pits. Information respecting the rocks within the boundaries of this estate is given on the map.

Elizabeth.

On the Elizabeth Estate the outcrops of quartz are numerous and large blocks of quartz cover the north-western face of the high ridge which extends south-westerly and north-easterly.

Dawson's Reef, which is at an altitude of 3,591 feet, is perhaps no more than a series of strong leaders from the main reef similar to those which have been cut in making the road on the south-east. Here there is a long adit which could not be followed to its furthest extent as the roof had fallen in. For a distance of thirteen feet the inclination is at an angle of 30° to 35° and thence at a less inclination. The quartz was found to be full of pyrites, and gold was visible in some of the pieces. In places the quartz was "mice-eaten;" numerous cubes of pyrites partially decomposed and coated with limonite were seen; and some agatised quartz of lenticular form was implanted in the ordinary white or ferruginous quartz of the veins.

Thirteen chains south of the Korumbar village there is a large outcrop of quartz named the Elizabeth Reef; and the main reef appears again on the north-western face of the hill where it can be followed into the Sandhurst Estate. In looking at the lines on the map allowance must be made for the difference of heights and then the run of the reef can be followed. Over an area of nearly fifty acres, all within the boundaries of the Elizabeth Estate, the ground has been worked by the natives, and it was only when Mr. C. R. Dawson caused the jungle to be cleared that the extent of these old mines and the character of the mining operations were ascertained. Many of the shafts are similar to those at Glenrock; they are vertical for a depth of six or eight feet and thence level or inclined. There are besides the shafts, numerous large excavations and there is scarcely a square foot of ground that has not been turned over.

It is said that the natives used to fell the trees and make large fires on the blocks of stone in order to facilitate the work of breaking up the quartz.

South of the Korumbar village of Neru-muttum (literally—"water-level") there is a swamp at a considerable elevation; and water was conveyed by a channel to the point on the map marked "aqueduct." Here there are the remains of the old embankments on both sides of the gully, and the natives must have made a flume and supported it by a framework of the height of twenty-one feet. The flume was probably constructed of bamboos or hollowed trees. Beyond the aqueduct the water was taken to the face of the hill, no doubt in channels varying in height. The race or channel amidst the old workings which is at the present time most conspicuous and most easily traced is about fifteen chains in length, and at its extremity is twenty-five feet below the level of the flume.

There are numerous smaller channels leading into this cut apparently as catch-water drains.

On going over this ground the stranger is amazed at the great extent of the workings, and, if a miner, is astonished too when he observes the skill displayed by the natives as shown in the now crumbling remains of their earthworks and channels and walls.

Mr. Thomas Laing carefully prospected a portion of the area here referred to, and he found gold both in the worked-out soils on the north-western face of the hill and also near the aqueduct.

The rocks here are nearly of the same character as those occurring on the east and south-east. At A on map they are highly talcose, decomposing into a soapy clay. The direction of the foliation is nearly east and west (vertical); the main joints are well marked and are nearly at right angles to the foliation, and the dip is east at from 50° to 60°.

The weathering here is much like that of granite—hard cores of rock surrounded by concentric layers in various stages of decay.

I was not able to measure the thickness of the main reef or the principal "leaders" in this area, but the huge blocks of quartz which cap the hills and lie on the slopes and the longitudinal extent throughout which the reef and "leaders" can be traced are evidences of their strength and persistence.

The formation of the ground could not well be more favorable for carrying on mining works at a small expense, and even if steam had to be used for driving the crushing machinery the costs of extraction and crushing could not be large. Timber could be obtained suitable both for supports in the mines and for fuel; and I have no hesitation in stating that when the resources of this area are ascertained by miners competent to form an opinion and with capital sufficient to fairly test the ground it will become once more under different conditions a centre of mining operations.

Downham.

On the map of the Downham Estate a reef is shown west of the bandy-road which leads to Devála. The site is marked by huge blocks of quartz mostly more or less ferruginous; and on the slope of the hill towards the swamp there are native workings. An adit driven at a level a little above the bandy-road would prove this reef at small cost.

Mr. Thomas Laing found gold in the soil near the edge of the swamp which lies south of the Korumbar village.

The yields of gold per ton from the reefs on the Richmond Elizabeth and Downham Estates are given in Appendix H.

Harewood and Kintail.

The most important and the most interesting native workings on the Harewood and Kintail Estates are those which are found near the summit of the high hill north of the Harewood Bungalow. Here there are three vertical shafts from twenty to thirty feet in depth, and these are undercut by an adit the mouth of which has fallen away. At the entrance to the adit a mass of quartz *in situ* is exposed. Its direction as well as could be ascertained is north 20° west and at one point the dip is westerly. The country rock (gneissoid) is penetrated throughout by thin veins of white quartz varying from one-eighth of an inch to six inches in thickness. There are also both in the quartz and in the rock nests and veins of limonite and hæmatite, the latter in places stalactitic. Some of the quartz is slightly opaline and bluish in color.

The adit is about 126 feet in length, and very irregular in slope and direction. A few feet from the mouth there is a drive to the left from which a blind shaft has been sunk either on the underlie or for the purpose of following the "leaders" of quartz. Following the main adit onwards it was found that a similar system of working had been pursued. A careful examination showed that not unsuccessful attempts had been made to support the roof, the rock being left in some places; and in another, a pillar had been built. The adit was made after the shafts had been sunk and at such a level as to undercut them.

The ground has moved considerably since the mining operations were carried on; in some places there are long, narrow spaces left by the slipping away of the rock; much soil has been washed into the shafts and adit, and the changes thus effected, more particularly by the partial landslip, make it somewhat difficult at this time to ascertain exactly what was done by the miners. These old mines are situated on a very steep slope of the hill; there is no water near and it may be conjectured that the quartz was carried into the valley and treated after the methods of the natives. Though a careful search was made no broken quartz such as generally marks the site of other native workings was seen near the spot. Perhaps the debris may have been carried away by the rains. Where the veins are thickest the quartz is coarsely laminated and iron pyrites are scattered through it, while in other parts there are nests and cavities nearly wholly filled with peroxide and protoxide of iron. Three samples of stone were tested—one showed no gold, one gave at the rate of 1 dwt. 19·68 grs. per ton, and the amalgam of the last was lost.

Another sample yielded at the rate of 2 dwts. 4·41 grs. per ton.

This reef could be properly tested by a short adit. Sixteen chains east of the Hareword Bungalow there is an outcrop of a reef, and it again appears on a hill thirteen chains to the south-eastward, where there are a few shallow pits and a large excavation.

There is vein-quartz near the cattle shed (see map) and thin veins of quartz about six chains north-easterly where the soil has been washed.

A large vein, but irregular and with a low dip, appears on a high ridge overlooking Sheardale. Where strongest it shows about five feet of quartz. The same vein is found almost on the boundary between Sheardale and Harewood, and on washing the soil and detritus at this spot gold was got in small quantities. It was reef gold, not waterworn. The soil had evidently been washed by the natives.

On the eastern side of the road from the Dhoby village southwards there are native workings extending for a length of seventeen chains or more.

About seventy chains eastward (100°) from the Roman Catholic Church a reef comes to the surface on the slope of a hill. It is probably a continuation of one east of the Alpha Bungalow. It bears N. 24° W. from the Etucull Reef and N. 15° W. from the Cavern Reef.

A small shallow pit was sunk here, and Mr. Thomas Laing carefully tested the soil by washing, but no gold was obtained. There are no native workings to be seen near the spot.

The rocks on the Harewood and Kintail estates are highly interesting.

On the road between Harewood Lower Bungalow and Sheardale there are large symmetrical rhombohedral and prismoidal blocks and square prisms of dense granular quartz-rock some of it being true quartzite. The square blocks with the angles truncated were almost as smooth as if the stone had been cut and polished.

Near the Roman Catholic Church the direction of the foliation is N. 50° E. and N. 55 E. and the dip south-easterly at 60° nearly. One set of planes have the direction of N. 15° W. and there are other joints transverse to the foliation and master-joints. The rock is fissile, splitting off in thin layers in the direction of the lines of foliation. Mineralogically it does not differ much from the ordinary gneissoid rock of the country.

About twenty-four chains east of Harewood Bungalow the rocks are composed of quartz, mica, and felspar (plagioclase), coarse (altered) sandstone, and friable micaceous sandstone.

On the north-eastern boundary of the estate near the gap the direction of the foliation is N. 30° E. to N. 44° E., and the dip 85° to nearly vertical.

Near the outcrop of quartz on the hill overlooking Sheardale there is a good deal of magnetic iron in the rock. It is like that at Needle Rock presenting beautifully smooth prismoidal blocks in many places.

There are the usual facilities for working the reefs in the Harewood and Kintail Estates; there is an abundance of timber; and the land trends eastward and south-eastward towards streams which during the greater part of the year, carry a good volume of water.

Sheardale and Dunbar.

The Dunbar Reef is seen at the surface at the face of a very steep hill about twenty-two chains from the road forming the northern boundary of the Sheardale and Dunbar Estates. Its strike, as well as could be observed, is N. 30° W. and the dip easterly at about 27°. The thickness exposed is from three feet six inches to four feet. The total thickness could not be ascertained. The quartz is full of iron pyrites in places, and generally highly ferruginous. It is a remarkably good-looking stone, and it was disappointing to find no gold visible in it.

There is a pretty large excavation near the outcrop, but it is now covered with soil washed down by the rains.

Respecting this reef Mr. King writes thus:—

"Mr. Powell, the Superintendent of this garden, when down showing me the reef, was successful in knocking out pieces of quartz in which small streaks of gold were visible. The underside of this lode is very like in color and contents to that of the Alpha Company, the richer seam in the quartz being on this side. Leaders are numerous and large. The casing is of talcose schist and seamed with ferruginous and manganese streaks. The lode is traceable northwards into the Balcarras Estate, where there is a great show of white quartz on the eastern slope of one of the low hills. This part of the reef has been very extensively riddled by the old miners. In fact all its extension northwards towards Pandalur has been washed, and its immediate neighbourhood on the underside is still a favorite locality for washing during the rainy season. It runs through the Elizabeth and Sandhurst Estates, and close alongside the Caroline and Mr. Holmes' Application, and thence northwards."

From this description it would appear that the direction of the reef is N. 32° W.

On a cliff about twenty-two chains north-easterly there are veins of quartz which may probably indicate the north-western extension of a reef which crops out on the Adelphi Estate.

Thirty chains westward from the Dunbar Reef there are numerous large blocks of quartz and masses of country rock veined with white quartz.

North-east of the pulping-house there are loose blocks of quartz and at this spot also what appear to be native workings, and west of the pulping-house there are thin veins of quartz intersecting the rocks.

There are here the same favorable conditions for carrying on mining operations as on other estates in the district. The land trends towards a large stream, and there is thick jungle near from which good timber can always be easily procured.

In the lower parts of the estate the rock is decomposed to a great depth, but on the road which has been cut along the northern boundary fine sections are exposed. The direction of the foliation is shown in several places on the map. It varies from N. 35° E. to N. 60° E., and there are here, as elsewhere, systems of joints like those described in another place. At one spot there are masses of garnetiferous rock. The minerals associated with the garnets are white and glassy felspar and hornblende. The rock closely resembles that found at Nadukale.

At the bend of the road just above the precipitous cliff where the white masses of quartz appear the country rock is penetrated in all directions by veins of bluish opaline and white quartz, some specimens showing scattered crystals of felspar (orthoclase) and nests of greenish black mica (biotite).

The planes of division in some places have caused the rocks to appear as cuboidal blocks and in others as square or hexagonal prisms.

It is interesting to observe the weathering of the masses in this locality. The rock has decayed much after the manner in which granite decomposes when exposed to the influence of the atmosphere. Around a core of hard rock there are concentric layers in various stages of decay, those on the outer surface being nearly soft as kaolin.

Hamsluck, Hamslade, and Adelphi.

Thirteen outcrops of quartz were observed on the Hamsluck, Hamslade, and Adelphi Estates, as well as several areas which had been worked by the native miners.

Under the Hamslade Bungalow there is a strong reef, and near it gold can be washed out of the soil; and Mr. Minchin informs me gold has been got in the quartz also. This reef again appears at the surface at a point about seventeen chains south-easterly.

Nearly twenty-two chains eastward of the bungalow there is a reef which has been worked, and on this line there is a shaft five feet by two and-a-quarter feet and fifteen feet in depth which, it is said, was sunk by Mr. Sterne. The country rock here is everywhere intersected by small leaders and veins of quartz. The bearing of this reef is about N. 30° W.—S. 30° E; and it is perhaps a prolongation of the reef which crops out near the monument.

The Waterfall Reef is seen cropping out in the valley where a road has been made. It is about nineteen chains from the bungalow. Near it are veins of quartz which may be styled granitic, and also a dyke of diorite. Mr. Withers broke out stone from this reef and one specimen contained gold visible to the eye. From analyses made by Messrs. Johnson and Sons of London it appears that the yield per ton was at the rate of 3 pennyweights of gold and 2 pennyweights of silver. Mr. King gives the average yield as 11 pennyweights per ton.

About twenty-six chains south-easterly from the waterfall there is a large reef, probably averaging more than six feet in thickness, which from the formation of the ground rising, as it does, from the valley to a height of 250 feet or more westerly, is exposed for some distance in the direction of its dip. In fact the eastern slope of the hill may be said to be faced with quartz. On the lower side of the reef towards the stream there are large loose blocks of quartz lying about. There has been a landslip here at no distant date, and the surface has been recently altered by that and also to some extent by the heavy rains acting on the denuded area.

Mr. King tested stone from this reef, and he states that the average proportion of gold obtained was for the Hamsluck reef 3 pennyweights per ton, and for the Hamsluck (middle) 10 pennyweights per ton.

Messrs. Johnson and Sons' analysis of stone taken from the adit marked No. 2 on map showed a yield of 8 dwts. 18 grs. of gold and 8 dwts. 18 grs. of silver per ton.

Eight chains west of the high hill on which this reef appears there is another outcrop of quartz and gold was got in the stone. It is marked No. 3 on map.

There are blocks of quartz lying on the low ground north-easterly of the high hill marked C on map, which probably indicate the prolongation of this reef.

A vein of quartz comes to the surface on the south-eastern boundary of the Hamsluck Estate. Gold has been got in the stone. It is marked No. 1 on map. Near the line which divides the Perseverance from the Adelphi Estate and on the north-west and north-east there are outcrops of quartz in the midst of native workings.

On the outcrop of the reef marked with a cross on the map, Lieutenant Nicolson is said to have fixed his camp in 1831, and in Appendix B will be found his description of this country and the mines. When I visited the mines they were probably much in the same state as he found them, the changes occurring during the lapse of forty-eight years being limited to the washing into the shafts year after year of a small quantity of earth.

A large area has been mined by vertical shafts. These appear in groups of five, six, or eight and in most places are so close to each other that walls of no more than three or four feet divide them.

It is known that the ground has been worked in this manner for a length of about fifteen chains and for a breadth of nearly four chains, but whether to any much greater extent has not been ascertained.

In most of the shafts the first twenty feet is through decomposed country rock.

There are some sloping shafts sunk, no doubt, in order to follow the "leaders" or reef on the underlie.

The ground is strewn with fragments of quartz, and this spot now covered with jungle must at one time have had a busy population.

The Korumbars were asked why the shafts had been sunk so close together. They replied that the natives mined in this manner in order to have sufficient air and light. This could not have been the reason for a proceeding so remarkable. It is known that formerly under the native rulers the slaves were punished severely if they failed to get gold, and when one person was fortunate enough to find gold in his shaft the others would crowd around and sink other shafts as near to his as possible. In 1851—53, though under the local regulations, each man or party of men had a "claim" allotted with boundaries marked by pegs, the Australian miners often sank their shafts as near each other as their boundaries allowed. If one man got gold his neighbour put down a shaft on the very edge of his boundary, and not seldom found that the wash-dirt had been taken out before his shaft was "bottomed."

If the slaves were punished by their allowance of rice or ragi being diminished, or in other ways, when they failed to get gold in quantities sufficient to satisfy the demands of their master, it is reasonable to believe that they would have worked in the manner described.

There must have been an enormous waste of labor, as there was in early gold-digging times in Australia and California.

It is said that three natives worked at each shaft.

It is not clear what method was employed by them for hauling the quartz and rock to bank: in ascending and descending there was no difficulty; the holes cut in the sides of the shafts for the toes are still visible; it is however not certain that these holes were made by the men who sunk the shafts. They may have been cut by the natives employed by Lieutenant Nicolson, or by others subsequently.

It would take a considerable time to prospect this area and it could not be done without incurring expense, but it is beyond question that it is to be numbered amongst the many important and highly interesting mining tracts which are to be found in South-East Wynaad.

In other parts of the Hamsluck, Hamslade, and Adelphi Estates there are native workings as shown on the maps, and at one spot (E on large map) which has been largely worked by the natives rather heavy gold has been got. One piece of seven pennyweights (with a little quartz) was found by Mr. Minchin's coolies, and the people who opened the land for coffee say they often picked up small pieces of gold. It is now four or five years since the ground was worked, but the trench where the miners carried on ground-sluicing is still to be seen.

The rocks throughout the area comprised in these estates are generally similar in character to those already described, and information respecting the direction of the foliation and the dip is given on the maps.

It is necessary to repeat here what has been stated over and over again as to the extraordinary facilities for mining which present themselves in nearly every part of South-East Wynaad. The Hamsluck, Hamslade, and Adelphi Estates are on the edge of the ghât; there is thick jungle with noble trees quite near the reefs, and there are perennial streams the waters of which could be made to drive machinery of any power likely to be required.

The reefs, the strike and dip of which nearly correspond with those in other parts, are thick and persistent; the average yields of gold as ascertained by competent persons are high; and the time cannot be far distant when miners will bring their skill and knowledge to bear on the extraction of gold from veins situated so favorably.

Perseverance.

Thirteen chains eastward from the Perseverance Bungalow there is an outcrop of quartz, and within five chains of it some shallow alluvial workings.

Near the western boundary of the estate there are two outcrops of quartz close together—the one a thick reef and the other a "leader." Near them is an adit, now fallen in, which was probably driven for the purpose of working the thin vien.

On the northern boundary of the estate there is another adit surrounded by native workings.

A reef once worked by the natives is intersected by the eastern boundary. This is described elsewhere.

The quartz reefs in this area have a promising appearance and it is probable that the native workings are more extensive than is shown by the map.

Gold was found by Mr. G. E. Withers at the point marked B.

Prince of Wales' Company.

It is almost beyond doubt that the reef shown on the maps as extending from a little beyond the Alpha Works north-westward is a continuation of the Skull Reef.

On the ridge overlooking Devála the reef is exposed in a shallow excavation, where it is seven feet in thickness. It dips here to the westward at 44° nearly.

From this locality stone was taken which yielded gold at the following rates per ton:—

			oz.	dwt.	grs.
No. 1 Section	... ...	Button not weighable.			
„ 2 „	... ...	...	0	0	1·91
„ 3 „	... ...	...	0	2	4·40

The proportion of pyrites in the quartz was not large.

Subsequently other samples of stone from the three sections above referred to were treated and the average yield of gold was 1 dwt. 8·03 grs. per ton.

The stone was merely broken out at or near the surface.

The old native workings and the shafts and adits made by the Prince of Wales' Company are shown on the map. There are at least five shafts which were sunk by the Company and at least three adits, but it does not appear that any profitable work was done.

No difficulties would be found in making a thorough exploration of the reef and "leaders" in this locality.

The appearance of the quartz in every part where it was examined was highly encouraging.

Skull Reef.

It is not necessary in this place to give a further detailed description of the Skull Reef. The maps and the statements contained in special reports on this reef and the Alpha Company's Works (Appendices A and H) afford all the information it is in my power to give.

I have stated that I found it impossible to obtain any accurate information respecting the boundaries of the lands claimed by the Companies who have established mining works near Devála; and it is not known to me whether the "new reef" (shown on map), the outcrop of which is nineteen chains eastward of the Alpha Mill, belongs to the Prince of Wales' Company or to the Alpha Company or beyond the boundaries of both. It is undoubtedly a valuable reef. Quartz had

been brought to me from the outcrop in which gold was visible, and when surveying, and I had to fix its position, I caused some of the quartz to be broken on the spot, and specimens showing free gold were obtained in a few minutes.

It probably has some connection with one of the reefs (indicated on the map by native workings) which intersects the country rock between the Alpha Bungalow and the Cavern Reef.

Reefs east of the Alpha.

The area granted to or held by the Wynaad Gold Prospecting Company, according to the reports made, appears to include the Cavern Reef, the Etucull Reef, the Korumbar Reef, Bear Reef, Hamlin's Reef and the Monarch Reef.

Cavern Reef.

On the steep slope just on the edge of the ghât the natives have made a large lateral excavation on the outcrop of the Cavern Reef. There is also a vertical shaft near the mouth which is partly filled in with large stones. This was done probably to prevent injury to the workmen whilst they were making the excavation.

The direction and dip of this reef differ little from those observed elsewhere; the thickness is about five feet, less in some places and more in others; pyrites are abundant in seams and nests; much of the quartz is very ferruginous and gold is visible both in the body of the reef and in the casing.

The natives worked a good deal on the footwall, but the run of gold as visible in the stone was followed wherever practicable.

The average yields per ton of samples of stone taken from this reef have been as follow:—

	oz.	dwt.	grs.
Quartz	0	2	21·80
Pyritous quartz, the proportion of pyrties being large	4	19	3·00
Pyritous quartz	0	10	2·59
Do.	0	11	4·90
Do.	0	8	5·60
Do.	0	14	11·00
Quartz, no gold visible	0	11	15·50
"Casing;" small particles of gold to be seen	0	11	16·00
No. 1 Section	0	1	10·94
(A portion of this amalgam was lost.)			
No. 2 Section	0	0	17·47
Do.	1	15	17·47
No. 3 Section	1	0	9·88
No. 4 Section "Casing"	0	1	10·94
Pyrites	1	16	0·00

The position of this reef; the fact that the ground has been worked over a large area in the vicinity of it; its nearness to a perennial stream, and the character of the vein ought to be sufficient to attract the attention of miners and to lead to the development of mining operations which, though proverbially uncertain, ought, if the indications are to be trusted, to result in complete success.

There are very few reefs of a more promising appearance or more favorably situated than this.

Etucull Reef.

The Etucull Reef is found at the surface about sixteen chains north-easterly from the Cavern Reef. The face of the hill which this reef intersects has been cut away by the Wynaad Prospecting Company, and the old native workings are exposed. The main body of stone is not touched by any recent workings as far as could be seen, and there is reason to believe that it is under foot near where the numerous "leaders" have been followed by the natives.

A great deal of work has been done in this locality. In the pamphlet entitled *Gold prospecting in the Wynaad* it is stated that there are six native shafts within a radius of twenty yards, some as deep as seventy feet or more.

Specimens of quartz with gold visible were obtained from this reef, and pyrites said to have been broken out by the Wynaad Prospecting Company yielded at the rate of 2 oz. 1 dwt. 8·11 grs. per ton.

cause a fresh surface of quicksilver to be presented. Through the centre of this revolving muller was a pipe 15 feet long, down which the quartz sand was forced by hydraulic action and the sand had to pass through the quicksilver and over the side of the iron basin so as to leave the gold in the quicksilver.

"After leaving the amalgamator the sand passed through a series of Cornish buddles and a blanket table, and finally through a MacDougal's amalgamated spike trough, before being saved for final assay in the catch pits. The Cornish buddles and blanket table were erected for the purpose of separating the heavier pyritous particles from the silicious and earthy matter by gravitation, and the pyrites thus saved was subsequently treated in a reverberatory furnace built at the side of the works.

"The actual result of a crushing of one-hundred tons of stone treated in this way was at the rate of only three pennyweights of gold per ton.

"The assay of an average sample of the stone collected for this trial which was sent to England (one hundred weight) as a check to the trial made in India was nine pennyweights to the ton. Assays of the tailings from the blanket table and buddles gave from eleven pennyweights to five pennyweights to the ton, while the actual result from a trial of the tailings roasted in the reverberatory furnace and reground by hand gave only two pennyweights six grains of gold to seven tons of tailings. The unsatisfactory results obtained are attributed, first, to burning the stone in the kiln before crushing; this burning being now known to coat the gold so as to prevent amalgamation and also to prevent the ready separation of the pyritous and silicious matters by gravitation; secondly, the tyes and buddles were lined with iron sheeting to prevent any risk of leakage, and this iron prevented the settlement by gravitation of the heavier particles which rolled along the smooth surface; thirdly, the excessive and continuous heat of the reverberatory furnace prevented the saving of the gold, the gold having possibly volatilised, while the silica and iron particles frequently fused. The work was all done by men quite inexperienced, the services of any practical expert not being available in India. And notwithstanding all the apparatus in use, nine-tenths of the gold saved was taken from the copper-plate within six inches of the perforated gratings of the crusher.

"The stone was from 12 to 18 hours in the kiln and always 24 hours in the furnace before being raked out.

"The cost of raising 200 tons of stone, which was collected before any crushing operations were commenced, was Rs. 240 delivered at the kiln; after this there were no mining operations carried on unless for special trials. We calculate a ton as one cubic yard of broken stone."

It is to be feared that there will be other failures not unlike this.

If there is gold it is assumed, except in countries where men have been taught by experience, that any kind of machinery and any person willing to receive payment for managing it, must as a matter of course bring about satisfactory results.

Mining for gold cannot be conducted successfully in a haphazard way. It would be as reasonable to place a landsman in charge of a ship as to give the control of a gold mine and gold-mining machinery to one who has not qualified himself to perform satisfactorily the work required to be done.

Glenrock. The map of the Glenrock Estate shows three outcrops of quartz and native workings of great extent.

The rocks on the summit of Chic Hadiabetta are gneissoid, and in places somewhat granitoid. Masses are found containing a pretty large proportion of magnetic iron, similar to the formation lying to the east and north.

The vein-quartz is milk-white with pellucid grains of quartz scattered through it, and no pyrites were found in the place where the quartz was broken out.

The summit of Chic Hadiabetta is honeycombed with shafts, most of them resembling those found on the Elizabeth Estate—vertical for a few feet with a sloping adit therefrom. On the north-western and western face of the hill the pits and adits are numerous; indeed the appearance of these old excavations is striking, and the large amount of work done leaves no room for doubt as to the value of the reef and veins. The workings are continuous from the summit of the hill to a swamp (shown on map) where it is said Korumbars in former times used to sink shafts. The water interfered much with their operations, but it did not prevent them from getting out auriferous pyrites, which, according to the statements made, they carried to their homes and treated for gold.

The proprietor of the Glenrock Estate got very fine samples of heavy gold in the water-course which intersects this swamp.

Hadiabetta and the neighbouring hills are scored with the now indistinct lines of old channels in which the miners in former times had conveyed water to their workings; and from these and the number of excavations, as well as the area which they cover, one can judge how attractive this field must have been in past times.

The workings indeed may be said to extend from Hadiabetta to Parcherry Hill, and the reef at the latter is probably one of the same series which has been so largely mined at Glenrock.

The formation of the country in this locality, except that the hills are loftier, is similar to that generally observed in this tract, and the facilities for carrying on extensive mining operations are very great.

There is perhaps no part of the Wynaad where there is a surer prospect of developing prosperous mines than here, and a very small expenditure of labor would suffice to ascertain accurately the extent and the value of the reefs.

Within the boundaries of the neighbouring Phœnix Estate there are two outcrops of quartz—one near the summit of Hadiabetta and the other about twenty-eight chains southwards from it. The sites where gold has been found are marked on the map from information afforded by the proprietors of the Glenrock and Phœnix Estates.

They say that gold in unusually large pieces is found in this area, and a sample of coarse gold was shown to me by Mr. Williams, who had had Korumbars employed in washing.

On the Rosedell Estate east of and adjoining Glenrock there are old workings in which is exposed a large vein of quartz with several smaller veins thrown off from it.

The outcrop is a little above the road leading to Devála and about forty chains eastward of the Glenrock Bungalow. Where it is exposed the strike of the reef is N. 30° W. The quartz is similar to that found in the vein on the summit of Chic Hadiabetta, the casing is ferruginous, and very small plates of mica appear in it. There is also a little micaceous iron ore, and the quartz in the vein is stained with oxyd of iron on the faces of the laminæ.

When I visited this reef I was accompanied by Mr. H. V. Ryan, the proprietor of the Glenrock Estate, and I suggested that some explorations should be made. They were accordingly undertaken under that gentleman's direction, and several pieces of quartz with gold in moderately-sized grains and minute spangles were got without difficulty.

The Rosedell Reef is undoubtedly valuable and will in time be thoroughly prospected.

North-east of Rosedell and adjoining the Elizabeth and Richmond Estates is a small area marked Sandhurst on the map. Here the rocks are hornblendic. There is an unusually large outcrop of quartz in a line with the old workings on the high hill on the Elizabeth Estate. Immense blocks of pyritous quartz lie on the surface in the midst of old native workings. The altitude of the locality of the reef is 3,333 feet.

South of the road from Cherambádi to Devála, and about three miles west of Cherambádi and more than two miles north-west of Hadiabetta South Peak, there is a hill known as Yellembullay or Parcherry Hill. On a lower hill, a little to the south-west of Parcherry, there is an outcrop of quartz, or perhaps, to speak more correctly, a series of outcrops, some representing the main body of the veins and others strong leaders therefrom. At this point the reef has all the appearance of an irregular mass of quartz, and where it is possible to observe the dip and strike there is much uncertainty concerning them as they are often no more than the boundary lines of lenticular and wedge-shaped masses of country rock. Moreover, the whole of the hill is honeycombed with shafts, and adits, and great blocks of the reef with the surrounding country rock have sunk down bodily, almost completely closing the adits and shafts. It was extremely difficult to examine any portion of these owing to the falls of rock which have taken place since the workings were in progress.

Parcherry Hill.

It was not possible to ascertain the total thickness of the reef where it was partly exposed in a large excavation, but it is undoubtedly very great. The quartz

is everywhere full of soft iron pyrites and limonite and hæmatite; and on breaking some of the blocks large cavities were found nearly full of sulphur.

The native workings cover a large area, and the heaps composed of the broken quartz which have been thrown away are almost as regular in form as if tramways had been laid and trucks had been used and the stuff "tipped" over the end of the embankments.

A very great deal of work has been done at this place. Even as late as 1857 there were two hundred and more Korumbars engaged in mining at Yellembullay; it is said that they burned the stone, and that the women ground it on a flat rock near the workings, many of them earning as much as 1, 2, and 3 rupees per diem.

No gold was seen in the quartz though a careful search was made for it. On pounding the stone, however, and washing it gold was got in minute particles.

This reef and its leaders could be economically worked by a large open cutting and by horizontal shafts; and by storing water, which is practicable, the crushing machinery might be driven by a water-wheel. There are not the same facilities for procuring large timber in this locality as at Devála, but there would be no difficulty in obtaining fuel if it should be thought advisable to employ steam for crushing, &c., and it is probable that steam would be cheaper than water at this spot if the interest on the capital which would have to be invested in water-works be taken into account.

The altitude of the reef is 3,300 feet. About half a mile eastward of the workings there is another outcrop of quartz.

Assays show that the yield of gold from this reef varies from 1 dwt. 6 grs. to 13 dwt. 20·41 grs. per ton.

Naiken Shola and Little Windsor and westward to Vellirymulla.

On the Naiken Shola and Little Windsor Estate there are at least fifteen outcrops of quartz. The situation of these is shown on the maps which accompany this report. About twenty-five chains from the Cherambádi bazaar an outcrop of quartz is seen on the main district road, and in the swamp on the south not more than five chains distant from the outcrop gold was got by washing the earth. Gold has since been found by Captain Cox in the reef itself.

The Bazaar Reef is clearly traceable for a distance of fifty chains south-easterly from a cattle-shed near the bazaar, and about seven chains from the bungalow gold was washed out of the soil. Sixty chains south-easterly of this point the reef again appears in the jungle, and it may be assumed that it has a bearing of N. 36° W.

Near a stream where the Manilla plant is growing luxuriantly (see map) there are large masses of quartz indicating an outcrop. Some washing was done here, but no gold was seen. About twenty chains east of this stream another reef was found highly pyritous and promising well, but no gold was seen in it. There are three outcrops in this place.

On the eastern boundary of these estates, south of what is named Kallattimalai coffee, there is reef out-cropping near a stream which is traceable south-easterly into the jungle. There are also what appear to be very ancient alluvial workings at this spot. Seven dishes of earth (surface soil) taken from various parts near the reef were washed and a little gold was found in five. One dish of earth dug out of the bank of the stream near the reef yielded one pretty large particle of gold much water-worn.

The results of the explorations in this area indicate the probable existence of gold in the Bazzar Reef, and that on the eastern boundary of the estates in such proportions as would justify a reasonable expenditure of money in prospecting.

On the Cheppah Thodah Estate, north of Cherambádi, there are numerous outcrops of quartz, and in the coffee garden loose blocks of quartz are to be seen. There is one large reef not far from the bungalow which looks well. No native workings were seen on this estate, but only a small part of it was examined.

About sixty chains north-westerly from the Cherambádi bazaar there is a reef of quartz similar in character to those on the Naiken Shola Estate, and it is probably a prolongation of that which crops out near the bazaar road. One mile

west of the bazaar there is a vein of quartz intersecting the road, and sixty chains westward of this there is a very thick reef with numerous small "leaders" and veins in the vicinity. Nearly two miles from the bazzar another outcrop is seen on a hill to the right of the road.

On the Choladi Estate, which lies to the south of the road from Cherambádi to Vytheri and is distant a little more than two miles from the bazaar, there are several reefs and veins of quartz, some of which are probably productive. They bear north-westerly and south-easterly. The quartz generally is translucent, enclosing large and small particles of highly transparent crystalline quartz, the whole having a granular appearance. The reefs where exposed are not very thick.

The swamp at Choladi is said to have yielded gold in pretty large grains. Here some ground sluicing operations were undertaken and the results were as follows:—

First dish	...	No gold.
Second dish	...	A few specks.
Third dish	...	Seven or eight specks; a fair result.

Two dishes of stuff taken from the bank of the stream were washed, and in one there were two specks of gold, in the other none.

The material in the bed of the swamp consists of a blue clay with a relatively large proportion of black iron sand.

It is certain that if the swamp were sluiced down to the bed-rock the yield of gold would be very much greater than that obtained by such washings as were attempted when this locality was prospected, but they were undertaken solely for the purpose of ascertaining the probable character of the adjacent reefs and not to determine the value of the alluvial deposit in the swamp.

Between Cherambádi and Moopenaad eighteen separate outcrops of quartz were observed. The position of these is shown approximately on the general (Ordnance) map herewith. Many of these reefs are several feet in thickness and they throw off leaders which penetrate the country rock in all directions, but principally appearing as nearly horizontal veins and strings.

About eleven miles from Cherambádi and on the right-hand side of the road as you travel towards Moopenaad there is a swamp in a coffee garden in which lie large blocks of quartz close to an outcrop. This Neddikarna swamp is not unlike that at Choladi and is probably auriferous. The reef strikes from north-west to south-east and is evidently in places of great thickness. It is granitoid, has a granular appearance, and is composed of quartz with plates of mica. Nowhere in this locality was any other mineral observed in association with the quartz.

The whole of this area, intersected as it is with quartz reefs nearly parallel to one another and not more than from forty to fifty chains apart, seems to have had little attraction for the native miners. Gold is found in the swamps and in the beds of the streams, proving that the reefs themselves are auriferous; but it is, to say the least, doubtful whether at any time the natives found remunerative employment in any of the auriferous reefs or streams between Cherambádi and Moopenaad.

On the Moopenaad Estate there are great masses of quartz appearing at the surface on the banks of a stream east of the bungalow. The quartz, which is micacised and granitoid in character, more resembles quartz-rock than vein-quartz. In other places there are well-marked veins, greatly contrasting the more massive quartz which occurs generally. The latter is mostly saccharoid or granular, transparent particles of quartz impacted irregularly in snow-white quartz being common. There were no pyrites seen, and indeed the most of the rock and veins consisted of iron-free quartz.

No native workings were seen at Moopenaad. At Vellirymulla the hills are sharper in outline than at Cherambádi or Devála and they are well clad with vegetation. Fragments of quartz are seen nearly everywhere. On the slope of a hill towards a swampy flat and not very far from the river I was shown some pieces of quartz with gold visible in them—really good specimens—lying on the ground.

I gathered all of these that I could see and then sought for more, but no quarts similar in character to those showing gold was to be found. I then caused earth to be taken from the spot where the specimens had been lying and had it washed, and not a particle of gold was to be discovered. Every care was taken to ascertain the facts connected with this rather remarkable occurrence of rich specimens lying exposed on a path daily trodden by persons employed on the estate; but nothing further was elicited than the fact that the specimens bore a great resemblance to those to be found at Wright's Level near Devála.

On the ridge beyond the site of this discovery a very good reef appears on the surface; the quartz is pyritous, but no gold was seen in it.

In the bed of the river a little gold was found in the soil and gravel.

On proceeding to the Vellakul Toda (white-stone stream) a good exposure of rock was observed. All of it was more or less granitoid and its mode of decomposition was like that of granite, shelling off and hardening towards a core. In places the foliation was distinctly marked.

On the road to Munniya Poya a few small quartz veins were seen, and several dishes of earth were washed in a swamp not far from Mr. Brunton's Bungalow, but no gold was found.

On the Munniya Poya, where it intersects a swampy flat near the pulping-house, there is a large outcrop of quartz, and numerous small leaders are thrown off from it. The quartz is in part ferruginous and laminated. Several dishes of earth were washed here, and gold was found in all but one.

Here, as elsewhere in the western district, no native workings were seen, though the proportion of gold in the soil would lead one to infer that the reefs and veins are quite as rich as others where the natives have labored. If the country were carefully prospected it is more than probable that a discovery of importance would be made.

Nedukale.

At Nedukale, which lies about four miles west from Nelakotta and about six miles in a straight line northerly from Devála bazaar, there are two outcrops of quartz—one about ten chains north-easterly from the Gadbrook Bungalow, and the other twenty-seven chains south from the junction of the Pekki Pula with the Ponnéni Pula. The first is visible at the surface for some sixty yards or more; it seems to strike N. 25° W., S. 25° E., and is at least twenty feet in thickness. Gold was not found in the quartz of this reef or in the soil near it. The stone exposed has not the appearance of auriferous quartz, it is mostly dense, very white, and not mineralized.

The reef near the river (marked Breakfast Reef on the maps) is auriferous. Numerous dishes of earth dug out near the outcrop were washed and gold was found in nearly every one.

This reef contains a good deal of iron pyrites and is not unlike some of those lying south-east of Devála. It is about four feet in thickness, but its true character could only be ascertained by opening it for some length. It seems to throw off strong leaders towards the west.

There is a swamp planted with coffee (No. 3, Cudlacullee), not within the boundaries of the area embraced by the map, south-easterly of the bungalow, and both in the surface soil and in a seam of blue clay underlying the soil, gold was got by washing. Some of the results were such as to lead to favorable conclusions as to the character of the reef which crops out on the north. In the midst of this swamp there are large loose blocks of quartz, and numerous, more or less smaller, water-worn fragments of quartz. On "washing off" iron-sand, garnets, and fragments of hornblende were found in the dish.

In another swamp west of the river and marked No. 1 on map gold was found. Five dishes were washed and gold was seen in four.

The rocks in the neighbourhood of Nedukale are usually hard, dense and massive, though showing foliation in many places very distinctly. A little north of the Breakfast Reef (see maps) the rock is garnetiferous.

The situation of the reefs at Nedukale, outcropping as they do on the edges of steep slopes, admits of their being mined by horizontal shafts; quartz could be got out at a small cost and there is a good supply of water close at hand which could be used for moving crushing machinery. Timber could be got also at no great expense.

No native workings such as are found on the south and west were seen at or near Nedukale, but at one point there are indications of an excavation having been made near the bank of the river; and the natives say that very large pieces of gold were washed out of the sand and gravel taken therefrom.

Reefs between Devála and Gúdalúr.

There are several outcrops of quartz between Devála and Gúdalúr, but the character of the quartz changes as one travels eastward, the stone becoming in many places almost granitic like that found so abundantly in the areas surrounding Vellirymulla.

On the Bolingbroke Estate, at an altitude of 3,134 feet, there is a large reef with strong leaders and small veins of quartz thrown off westward.

The direction of the reef is nearly north and south, but its strike could be observed in only one place and for a very short distance. The stronger leaders are nearly flat. There are here and there some small pits recently dug, where the leaders are exposed; much of the quartz is solid and massive, in places laminated, and in following it downwards it is seen to be "mice-eaten," or, where decomposition has not set in, full of pyrites.

The reef itself has been partially explored.

From the excavation in what appeared to be one of the main western leaders quartz was got at the time of my visit with gold visible in it.

The appearance of the stone would seem to warrant the belief that it is throughout more or less auriferous. The old workings seem to have been confined almost entirely to the sluicing of the earth near the reefs. I could not discover any such excavations in the solid quartz as are found near Devála.

The yields from the Bolingbroke reef have been as high as 1 oz. 1 dwt. 3·35 grs. per ton. (See Appendix H.)

The Pulliamparah Reef is marked by the occurrence on the surface of large blocks of quartz. Its strike cannot well be ascertained, but it appears to be nearly N. 30° W. The quartz is everywhere full of pyrites and it much resembles the outcrop on the Bolingbroke Estate.

About five miles on the Devála side of Gúdalúr there are outcrops of quartz in several places. Much of the stone is cavernous, where the pyrites have decomposed and disappeared; in other blocks the ordinary iron pyrites are rather abundant.

On the Nundhutty Estate there is a reef near the bungalow. The quartz is granular and opaque and there is a good deal of mica in it.

There are large blocks of quartz lying on the outcrops of a reef at Gúdalúr, a short distance from the Public Works Bungalow. Large plates of mica are associated with the quartz, there are no pyrites to be seen, and it does not appear that gold has been found in the immediate locality.

The character of the rocks changes suddenly at Gúdalúr; the hard dense country rock is composed of quartz and hornblende; garnetiferous masses occur; and the veins of quartz are infrequent and very thin.

It is said that there is a large outcrop of quartz near Pykara, but I have not visited the spot.

The river-drift at Seeputee is mentioned elsewhere. The adit is at an elevation of 2,841 feet.

Karambaut, Murada, and Eddacurra.

On leaving the bungalow at Hamslade and following the track which leads through the jungle towards Eddacurra the descent is rapid. The altitude of the Hamslade hill is approximately 3,106 feet, and at a distance of little more than one mile the altitude is 1,798 feet, showing a decrease of 1,308 feet.

The jungle from the edge of the ghât to the last-named point is dense : each tall tree has a crown of foliage so close as to cause a perpetual shade ; the under-growth of shrubs in some parts is thick and the climbing plants reach the highest branches of the tallest trees.

Many of the trees are not only high, but of great girth. One (Naaga Murrum) measured thirty-three feet in circumference at a height of three feet from the ground.

At a point less than two miles from the Hamslade Bungalow and at an altitude of 1,216 feet a large stream was crossed. The bed was full of masses of water-worn rocks. Throughout the rocks observed were gneissoid in which appeared with frequence numerous small veins and strings of quartz.

About twenty chains south-westerly from the river there is a large outcrop of quartz. Enormous blocks of this rock are piled one on another, indicating a reef of very great thickness. When broken the stone did not present the appearance of being auriferous, and no gold was seen, but native workings were observed not far from the reef. It may therefore be regarded as auriferous, and it would be injudicious to attach too much importance to its appearance as gold is found in the Wynaad in the most unlikely-looking stone.

The reef appeared to have a strike of N. 40° W. Other streams were crossed in following the route to Karambaut, and in most of them there was a good " wash " consisting of sand, clay and water-worn stones.

The grass huts at Karambaut were erected on a flat spot near a stream and in the midst of bamboo thickets. Though the place was hot and close, shut in as it was by bamboos, it proved to be convenient as it was near the old native workings.

Karambaut is distant about four miles in a straight line from Hamslade, and the altitude was found to be 484 feet.

In the bed of the stream there was a considerable deposit of sand and gravel which a quarter of a mile up was from 4 to 5 feet in thickness.

Prospecting was commenced as soon as possible. Two pans of earth taken from the bank of the stream were washed, and a few particles of gold were found in both. The results indeed were highly encouraging.

Subsequently the Korumbar miners were set to work in the bed of the stream. As the gravel was said to be 30 feet in thickness at the place where operations were begun it was impossible to reach the bed-rock ; but the heavy sand remaining after sluicing contained gold.

The sand and gravel in the bed of this stream are constantly undergoing changes which result in the deposit of fine and coarse gold throughout its extent, the heavier particles of course gradually finding their way to lower depths, and finally to the bed-rock if no other impermeable stratum intervene.

The bed of the stream is enriched by the rains of every monsoon, but the proportion of gold brought down each season cannot be measured by washing to the depth of only a few feet.

At a distance of little more than three chains from the grass huts huge blocks of quartz lying on a low spur indicated the outcrop of the Karambaut Reef. It was not easy to arrive even approximately at the strike as the ground was everywhere strewn with quartz ; and the old native workings extended all along the line of reef for a distance of a mile and-a-half and for a great breadth. It appeared to be N. 15° W. The ancient sluices, as well as those of more modern construction, and the deep-walled channels for conveying water and for washing were of considerable length, and clearly testified to the immense time and labor which had been devoted to gold mining at this spot.

Specimens of the rocks were collected as well as samples of quartz from various points ; and on the latter being pounded and washed free gold was seen in the dish. Several pieces of more or less pyritous quartz were subsequently tested and the yields varied from a mere speck of gold to 9 dwt. 11·13 grs., 17 dwt. 23·38 grs., and 1 oz. 4 dwts. 1·4 grs. per ton.

Fragments of garnet and hornblende were found in the iron sand which remained in the dish after washing off.

The stream near the reef is, I am informed, commonly known as the Karambaut river. Mr. Alexander Wright, a planter in the Wynaad, tells me that he has seen as many as fifty Panniar's washing the earth for gold in the vicinity of the reef just described.

Quartz could be quarried here at a small price per ton ; an abundant supply of water could be derived from the mountain streams, and excellent timber is to be got within a very short distance.

The climate, it must be confessed, is unsuitable for Europeans, and even the natives at certain seasons are attacked by fever. Whether the same evil influences would prevail if the country near the reef were partially cleared, and the workmen were properly lodged and fed is a question which cannot at present be satisfactorily answered.

At Murada, three miles south of Karambaut, three reefs were found intersecting hard dense gneissoid rock.

In the bed of a stream flowing into the Keilaka Poya, about thirty chains north-west of the Rajah's house, the first, which was named the Stream Reef showed a strong body of barren-looking quartz. It is traceable for a mile and-a-half and its strike is west of north. The Korumbars state that the natives have never worked either the soils near this reef nor the reef itself, and I could not discover that there were any old native workings near it.

Two samples of stone taken from the Stream Reef were tested by amalgamation and minute particles of gold were obtained, but not a weighable button.

About five chains north-east from the stream there is another outcrop of quartz, and two chains from the latter, a reef which appears to be similar in character to the Stream Reef.

The samples tested by amalgamation showed gold, but in very small quantity.

The strike of No. 2 reef was ascertained to be N. 15° W. nearly. As the other reefs were not opened the dip and strike could not be noted.

The country is open where these reefs occur, and the stream which is intersected by one of them is said to be perennial.

If the reefs were opened up near the stream it would be necessary to sink vertical shafts, and to provide machinery for winding and for pumping water.

The route pursued after leaving Murada was nearly in the direction of the Keilaka Poya, and the stream was crossed twice. About one mile above Edacurra rafts were procured and we floated down as far as the bridge.

There was not much to observe between Murada and Edacurra. The track (close to the river) was principally through swampy flats overgrown with tall grasses. On the banks of the stream a chocolate-brown deposit, consisting of clay, sand, fragments of country rock and angular pieces of quartz, was seen, which may be in some parts auriferous.

Three-quarters of a mile south-west from Edacurra, a reef having a strike west of north outcrops in the jungle at an altitude of 332 feet. There was only surface stone to be seen. On testing some samples a very small quantity of gold, not weighable, was obtained.

In the vicinity of Edacurra a hornblende schist (Tremolite) occurs. The country is low and flat or slightly undulating, and it is mostly covered with recent drift probably overlying tertiary deposits. Whether or not it would be easy to penetrate to the bed-rock and whether there is a rich auriferous layer resting on that can be matter for conjecture only. That the rock from the surface downwards contains gold is certain, but only rather costly prospecting operations would prove or disprove the existence of auriferous *leads*.

The mines near Nilambúr were not visited.

On returning to Devála the ghât road was followed, and at a distance of five miles from Edacurra and at the foot of the ghât a reef was seen having a

strike of N. 15° W. Near this spot the country rock is much decomposed, but the veins are in place. About twenty chains north-east from the reef there is an exposure of rock intersected by thin veins of quartz bearing N. 10° W., and still further to the north-east at a distance of about ten chains a fine large body of stone is outcropping.

On ascending the ghât and not far from the foot the direction of the foliation of the country rock was observed to be N. 40° E. and about two miles south-west of Nadakani N. 60° E.

Near the head of the ghât and about one mile from the bridge at Nadakani there is a large reef of quartz.

At one part of the road the rock broken up for metal was massive hornblende, and diorite was found at one spot (not in place), the only occurrence of a trappean rock observed during the journey.

Nanjanad.—It is not easy to indicate the areas which have been worked for gold, presumably by the Natives, in the Nanjanad Valley. The quartz workings are extensive, and as they are found principally on land used for grazing it may be supposed that they remain now very much in the same state as the miners left them. It is different with what may be called the alluvial workings in the old stream bed.

Though numerous evidences of the work done in former times are to be seen they have been obliterated by the Burgher Cultivators over an area whose limits cannot now be discovered: On my last visit the Burghers were engaged in levelling ground which had been sluiced for gold. The uneven surface was being made smooth and in course of preparation for sowing grain; and how many acres may have been thus treated cannot now be ascertained. Here in Southern India as in Australia the cultivator follows the miner; and a gold field that at one time afforded employment to thousands of persons becomes in a short time unrecognisable by its former inhabitants. The bright green crops of grain and the removal of the trees and scrub completely alter the character of the landscape and render it as unlike a gold field as any tract can well be.

It is certain that much work was done at one time by gold miners along the course of the stream which rises near the Belmont Tea Estate and flows thence through the Nanjanad Valley.

About one mile north-eastward from the Nanjanad Chuttrum there are outcrops of quartz which have been worked to some extent.

Prospecting operations have been carried on here during the last four months, but no quartz showing gold visible to the eye has been found and the results of experiments have been unsatisfactory.

Mr. Thomas Laing has washed several dishes of earth taken from the slopes of the hills in this area and several have shown gold; and quartz pounded by him and washed has in some cases given a few particles of the metal.

In testing the stone by amalgamation several samples showed no gold: others yielded minute grains, but no weighable button was obtained.

The reefs are thick—some strike nearly N. 70° W.—and all along the outcrops westward of the stream known as Buk-kanhalla, there are old workings to be seen. The quartz is ferruginous, but the proportion of undecomposed iron pyrites is usually very small. Near the veins there are seams and nests of black oxyd of manganese intersecting the country rock and coating the quartz.

Strong "leaders" are thrown off towards the north and these have generally a low dip.

Nearly one mile and a half west from the stream where these outcrops occur there are numerous heaps of quartz broken into very small pieces; and the excavations are large and deep. One sample of quartz from this locality yielded at the rate of 6 dwt. 13·47 grs. per ton, and another between 5 dwts. and 6 dwts. (a portion of the amalgam was lost).

These old workings are near what is said to be a perennial stream, and the quartz could be economically mined by adits. The locality is one which might be

prospected with some certainty that the results would fairly exhibit the character of the reefs of the Nanjanad Valley.

The quartz is in most places white, but there is a proportion of brassy yellow pyrites and much of the stone resembles that found at the Skull Reef near Devála.

Two dishes of earth were washed here and gold was obtained in both.

Avalanche.—After crossing the range about one mile south of the Nanjanad Chuttrum, up to which point the country rock is intersected by well-marked large veins of quartz, there is a change in the character of the strata. Numerous very thin veins of quartz, nearly every where following the direction of the foliation of the rocks, present themselves; and not a reef is to be seen.

At Avalanche and near Kudiakad the strike of the rocks is N. 60° E.—S. 60° W. varying but a few degrees. They are quartzose and a little magnetic iron is seen in places, but hornblende is rare. In the beds of the rivers rounded water-worn blocks were found very similar in composition to a basaltic rock, and here quartzose gneiss was got with minute foliated particles of graphite.

These were not traced to the rocks *in situ*.

In this locality also thin veins of quartz were observed running in the direction of the strike of the rocks, and there were intercalated masses of garnetiferous rock.

Though it was easy to collect specimens of pure quartz, no really persistent reef was seen; and it was soon evident that this was not a locality which would reward the Prospector.

Mr. Thomas Laing made a cutting in the banks of a stream on both sides where there was a good "wash," and tested several dishes of the earth overlying the bed-rock, but no trace of gold was found; and many dishes of earth washed in other places gave the same unfavorable results. Quartz also was crushed and washed at various points and not a speck of gold was discovered.

Sispara.—Careful attention was given to every feature in travelling from Avalanche to Sispara—in the neighbourhood of Sispara—and thence down the ghât for some distance; but nothing was seen which would encourage the miner to search for gold; and though many dishes of earth were washed in the most likely places, no gold was seen anywhere.

About two miles and-a-half north-east from the mud-hut at Sispara the rock is composed of quartz and felspar in coarse grains and closely resembles a binary granite; but where a weathered surface is observed the lines of foliation shown by slightly projecting indurated veins composed mainly of quartz indicate a gneissoid structure. Again, down the ghât and elsewhere thick bands of ternary granite consisting of quartz, felspar, and black mica form the mass of the country rock; but these again are only intensely metamorphosed strata coinciding in direction with the ordinary foliated gneiss, and not true granite.

Where these bands occur the detritus is exactly like that derived from granite; and where the rock has decomposed pieces can be picked up having a small specific gravity: they consist of a skeleton of silica (quartz); the more perishable associated minerals (chiefly felspar) having become Kaolin or having dissolved out altogether.

On the edge of the plateau and in the jungle down the ghât several slab-shaped pieces of white and crystalline quartz were dug out of the soil, not resembling the quartz in the country rock; but in these pyrites and oxyd of iron were absent, and no gold was seen in them.

Several dishes of earth were washed at and near Sispara, but not a trace of gold was found.

I have not yet had opportunity to examine all the minerals and rocks collected during the journey; but there is no reason to believe that the tract lying between the southern part of the Nanjanad Valley and Sispara is likely to yield gold in quantities sufficient to remunerate the miner either from the masses of quartz (nearly every where granitic) or from the soils.

It may be mentioned here that some samples of quartz collected by direction of His Grace the Governor when His Grace visited Sispara yielded minute particles of gold by amalgamation. The locality as pointed out to me will be shown on the map.

Machinery for treating auriferous quartz, &c.

The machinery and appliances for crushing auriferous quartz and saving gold are simple in themselves and easily managed when the principles on which they are designed are understood. Neither that portion of the work of reduction which is purely mechanical, bringing the mineral into such a state as to admit of metallurgical treatment, nor the metallurgical treatment itself is of such a character as to call for more than the knowledge which is to be gained in any large quartz-crushing establishment. A competent superintendent may not be an engineer, nor a chemist, but he should have a sufficient acquaintance with mechanics and mechanical processes, and he should be familiar at least with the chemistry of the metals and minerals with which he has to deal.

The machine for crushing quartz consists of a series of stamp-heads arranged in batteries of four or five. To each stamp-head is attached a lifter with a circular disc. A horizontal shaft, provided with wipers (so placed as to catch the discs) when put in motion causes the stamp-heads to act as so many pestles. The wipers are arranged in such a manner as to make the stamp-heads in each battery fall successively, but the order in which they fall is not the same in all mills. And each stamp-head rotates, making part of a revolution each time that the wiper catches the disc.

The stamp-head moves in an iron box or coffer having spaces covered with perforated plates for the passage of the crushed quartz. The bottom of the coffer is packed with broken quartz to the depth of three inches and on the broken stone lies the false bed of wrought iron.

In the best mills the stamp-head with its shank or lifter weighs from 6 cwt. to 8 cwt., in some the weight is as low as 2 cwt., and in others as high as 9 cwt. The height the head falls varies from 6 inches to 15 inches, and in the number of blows per minute there is a wide range; in one mill the number may be no more than 45, and in another 85.

Connected with the mill there ought to be one or more machines for breaking the blocks of quartz into small pieces. When the quartz is brought to the mill the smaller pieces are picked out and sent direct to the stampers and the blocks to the stone-breakers. A stone-breaking machine will break about eight tons of quartz per diem. As the price of labor is very low in India it might be practicable to have all the stone broken by hand, but the saving effected (if any) by employing manual labor would be very small.

A self-feeding apparatus is almost indispensable. It not only saves labor, but also ensures regularity in feeding.

The water trough is usually placed under the self-feeding hopper.

In front of the coffers are three or more troughs containing quicksilver, and below these are the tables. The tables should be evenly and securely fixed and in such a manner as to admit of the inclination being altered if necessary. They should be at least twenty feet in length. The strakes (subdivisions of the table formed by fastening narrow strips of wood to the floor) should be about fourteen inches in breadth. In all well-planned mills there are breaks in the tables, generally at intervals of three feet, the upper edge of the lower strake being about two inches below the slightly overlapping edge of the one above. The tables should be made quite smooth, and the utmost nicety is required in setting them so that the inclination may be the same throughout, and any line at right angles to the strakes absolutely horizontal. The same care should be employed in putting on the blankets; they should lie flat and cling to the boards.

Closely-woven green baize is perhaps the best material for blanketing.

At the extreme end of the tables there is another trough containing quicksilver, and finally a waste trough through which the sand, pyrites, slime, &c., pass to settling boxes.

The boxes are cleaned out from time to time during the working day, often at intervals of a few hours.

The separation of the pyrites from the sand, &c., constituting the tailings is now generally effected by some form of buddle.

Borlase's buddle with Munday's patent scrapers is believed by many to be the best. It consists of a circular wooden trough or basin from eighteen to twenty-four feet in diameter. It is about one foot six inches in depth. The tailings consisting of crushed quartz, pyrites, &c., are made to pass along a sluice and fall into a box whence they are conveyed by pipes to the sides of the trough. The greater specific gravity of the pyrites causes the mineral to separate from the quartz sand and to remain on the floor of the buddle, while the latter being carried down the table passes away through a discharge pipe. In order to prevent the loss of the valuable material two or three rims or stops are fixed on the floor of the basin. The pyrites are raked by knives, which, as well as the pipes conveying the material to the trough, are made to revolve round the central shaft. A machine making seven or eight revolutions per minute is recommended. The knives are raised or lowered by means of screws.*

The concave buddle has had the attention of Mechanical Engineers for some years, and several improvements have been adopted from time to time. Other ore-dressers have also undergone modifications with a view to fit them for the use of the gold miner, and some forms of percussion tables have given good results.

The pyrites, however excellent the system of concentration may be, are never entirely free from a certain proportion of quartz sand; but this is not to any serious extent objectionable when the material comes to be roasted in the furnace. Numerous forms of furnace have been devised for roasting pyrites; one kind after another has been tried and it has been found in this as in all other appliances for treating auriferous pyrites and auriferous quartz that the simplest plan is invariably the most efficacious. An inclined reverberatory furnace on the following plan is highly approved of in Australia:— It consists of a fire-box from which the heat and products of combustion pass over a hearth into condensing chambers. The charge is supplied through a hopper and gradually drawn down over the hearth by rakes until it reaches a channel near the fire-box, whence it is drawn into a pit at the side of the furnace. Four or five small doors are provided into which the rakes are inserted. As the charge is drawn downwards to the bottom of the hearth it becomes gradually heated, more and more, and to such a degree as to decompose the sulphides. The roof of the furnace over the hearth should be arched.† In a well-constructed reverberatory (oxidating) furnace all the sulphides thrown into the bed are completely decomposed in a short time.

A dull red heat is maintained throughout, and until the sand is actually raked out into the pit there is a continuous stream of heated air playing upon the pyritous minerals.

It is not necessary to describe other furnaces designed for roasting sulphides; but it may be mentioned that Hocking and Oxland's patent revolving furnace saves manual labor and presents also other advantages.

In India, however, it is advisable and almost indispensable that every appliance should be of such a kind as to be easily constructed and easily worked.

In using the several appliances for crushing quartz, &c., and for saving the gold it is necessary to give attention to the character of the principal minerals and the metal as they occur in the Wynaad.

Iron-free quartz in which gold is found in some reefs near Devala has a hardness of 7 and a specific gravity varying from 2·5 to 2·8. Where associated with limonite or other forms of sesquioxyd of iron the specific gravity of the rock is increased in a ratio with the preponderance of the accidental ingredient. The iron pyrites commonly occurring in nests and cavities in the quartz either as crystals

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* A description and a plan and section of Borlase's buddle are given in the report of the Board appointed to investigate the methods of treating pyrites in Victoria. And descriptions of other forms of buddles are contained in the "Gold Fields and Mineral Districts of Victoria."

† Report of the Board appointed to investigate the methods of treating Pyrites, 1874.

(not seldom with gold visible when the crystals are broken) or massive has usually a hardness of 6· or 6·5, and a specific gravity varying from 4·8 to 5·2. The magnetic iron has a hardness of 5·5 to 6·5, and its specific gravity is 4·9 to 5·2. The native gold found in the quartz has a hardness of 2·5 to 3, and the specific gravity varies according to the amount of silver or other metals with which it is alloyed, b it may be stated at from 12 to 19.

All these are to be subjected to the stamping process. The quartz is the hardest of all and the most difficult to reduce to fine grains, but its specific gravity is less than that of pyrites and very much less than that of native gold; and in dealing with it both the pyrites and the gold are liable to be beaten into fine particles, and, unless precautions be taken, lost. In arranging the bed on which th quartz, &c., are made to fall there is first of all the wrought-iron bottom an underneath this a layer of finely-broken quartz. A large proportion of the particle of free gold are deposited in this layer and easily recovered if water alone be used, but if quicksilver is put into the coffer the raw pyrites beaten to powder accumulate and "sicken" and "flour" the quicksilver, and this metal, with any gold it may have taken up, is carried away. It is therefore advisable to crush the quartz in the coffers without quicksilver and to save the auriferous pyrites which pass through the gratings for subsequent treatment.

The number of perforations per square inch in the gratings should be regulated by the character of the gold. In Victoria the number of perforations per square inch is in some mills as low as 60 and in others as high as 342. It is only by observation of the results that the degree of fineness of the perforated plates can be determined. In crushing quartz from some of the reefs in the Wynaad fine gratings would be required, and even where coarse gold occurs, as in some parts of the reef at Wright's Level, at Rosedell Reef and others, it would be desirable to use fine gratings, because there is usually with the coarse grains much fine gold.

The speed at which the stamps may be driven so as to secure the greatest advantage varies with the height of the lift, but a high speed is in all cases desirable. With stamps weighing about 8 cwts. and lift of (say) 9 inches the number of blows per minute should not be less than 75 or 80; and, fed with properly broken stone, each stamper should crush at least 2 to 2½ tons per diem of twenty-four hours as a constant average. The average quantity of quartz crushed in one mill in Victoria is, for stamps weighing 6 cwts. each, 2 tons 4 cwts. per head for twenty-four hours, and for stamps weighing 8 cwts. each, 4 tons per head per diem. In some mills in Victoria the average quantity is no more than 5 cwts. and in others as much as 3 tons 7 cwts. (on the average) per stamp head per diem are put through. The water used per head per hour should vary, depending in a great measure on the kind of material under treatment; but it would not be less, on an average, than 400 gallons. In Victoria mills the quantity used per head per hour is from 50 to 900 gallons.

The quantity of mercury put into the ripples in like manner is dependent on the amount of gold in the stone: in some mills it is as low as 4 lbs. and in others as high as 70 lbs. per stamp head. It is not difficult in practice to determine what weight can be used with the greatest advantage. The loss of mercury per stamp head per week in Victoria (which means in nearly all cases a loss of gold as well) varies from half an ounce to twenty ounces.

[illegible]ets should be changed very often when the proportion of pyrites in the crushed material is large. The further they are removed from the ripples the less often are they changed. As a rule the blankets next the ripples should be renewed every hour, those next every three hours, and those still lower at longer intervals. This matter must be left to the skill and experience of the Superintendent. If any of the decomposed country rock, such as is found in the Wynaad, should come to be mixed with the auriferous quartz, frequent changes of the blanketing would probably be necessary.

Instead of putting the material which accumulates on the blankets through amalgamating barrels it would be more economical in most cases to treat it exactly as the concentrated tailings are treated, namely, in the furnace and by subsequent amalgamation. But this, like nearly everything else connected with the extraction

of gold, can be judged of only when the works are in operation. When the blankets are washed it is easily seen of what the sand, &c., consist. The barrels are usually of cast iron and about 3½ feet or more in length and somewhat less than half that in diameter. The charge will weigh perhaps 1,000 lbs., and for every pound weight of material there should be added 4 ounces of quicksilver at least. The pyrites, &c., are dampened and put into the barrel, which revolves slowly making about 12 or 15 revolutions a minute. After this has gone on for a few hours, say six or eight, all depending on the character of the sand and the amount of gold it is supposed to contain, hot water is added and the operation is continued for three hours or more at a slackened speed, and finally the quicksilver is withdrawn from the barrel and the sand mixed with quicksilver and amalgam is so treated as to cause it to separate from the latter. This last process, in what manner soever it may be conducted, is often tedious, difficult and unsatisfactory.

It may be mentioned in this place that the gold got in the several parts of the mill and appliances is, as ascertained by Mr. R. H. Bland of the Port Phillip Works at Clunes in Victoria, as follows:—

	PER CENT.
Stamp beds	66·08
Mercury boxes	22·95
Blankets	10·97

The tailings are dressed up to an average of 3 ounces or 4 ounces of gold to the ton of material, and an average of about 85 per cent. of the gold as determined by assay is extracted. The cost of operating on the tailings including the buddle, roasting, grinding, loss of mercury, &c., averages about £2-14-5 per ton, or about £1 per ounce of gold got.

The tailings which are caught in the settling boxes are sent to the buddles and when the concentration is effective about 80 per cent. or more of the practically non-auriferous quartz sand is washed away and the remaining auriferous pyrites and free gold remain for treatment.

All this seems simple enough, but there are still difficulties in the way of saving the pyrites by the buddle alone. Nearly all the highest authorities who have written on this subject of concentrating are of opinion that a classification of the sand operated on according to the size of grain should be made; but the greater number of mill-owners appear to think that the buddle is sufficient. Professor G. H. F. Ulrich and Mr. J. Cosmo Newbery, B. Sc., than whom there are no higher authorities on this question, believe that classification will be found beneficial and will eventually be adopted. They state that they have "come to the conclusion that if the crushed pyritous material after passing the usual amalgamating appliances, (quicksilver troughs, copper-plates, &c.) was, by one triangular double trough and two pyramidal boxes, classified into three sizes of grain, viz., coarser sand, fine sand and slime, and the first treated by self-acting jigging machines, the other two by Borlase's buddle, it would prove a more satisfactory process for the saving of the pyrites than any at present in use."

It is unlikely that, at least for some time to come, any other appliance than the buddle will be used in Southern India, but if the mines should be successfully worked, there will no doubt be every attempt made to bring the machinery employed to a state as near perfection as possible.

The pyrites when freed as far as is practicable from quartz sand are sent to the furnace. Every care should be taken in roasting, and time in conducting this process must not be considered. The sulphur (and the arsenic), if any, must be driven off. Though in most cases the oxidization is effected rapidly—the more rapidly if a steady current of air is made to pass over the material—still it necessarily takes some time to dispel the whole of the sulphur.

It has been proved by experiments in the laboratory that partially decomposed iron pyrites causes more "flouring" of mercury and consequent loss than undecomposed pyrites,* and this should always be borne in mind when treating these

* Ulrich and Newbery.

auriferous sulphides. Undue haste or inattention on the part of the person in charge of the operations would certainly result in serious loss to the proprietors of the mine who would probably never ascertain the cause of the deficiency of yield of the pyrites.

Not a few who have had experience in treating pyrites in the furnace believe that they gain an advantage by mixing the pyrites with charcoal, and certainly there is much to be said in favor of this practice. If the fires be well and steadily maintained and the construction of the furnace is good there is no need of the addition of any combustible substance; but otherwise it is advantageous. A small proportion of quartz sand, whether present as the result of imperfect concentration or purposely introduced to prevent the agglutination of the particles of pyrites, tends to ensure a more easy, rapid and perfect oxidization; but a highly experienced Mining Manager in Australia, Mr. H. Rosales, is of opinion that though the quartz sand in calcining prevents caking in the subsequent process of amalgamation (in a Chilian mill for example) it causes a great loss of quicksilver. The quartz sand undoubtedly has the effect described just as the iron sand often associated with auriferous quartz cuts up the mercury and amalgam and makes it impossible when experimenting to save them in the ordinary way.

It is not at present possible to say what quantity of such fuel as is found in the Wynaad would be required to calcine one ton of pyrites: it is known, however, from what is stated in this report, that many trees growing near Devála yield timber which is excellent as fuel, and it is not probable that the quantity ordinarily used in Australia, viz., one ton of wood for every ton of pyrites, would be exceeded. With a good furnace, and careful feeding of the fires, the amount of fuel might be probably even less than is here named.

For the purpose of amalgamation, the next process to which the roasted pyrites are subjected, Wheeler's pans are commonly used; but many managers prefer the Chilian mill; and the arrastra (inferior as it is) is still found in several well-conducted works. In amalgamating with the Wheeler's pans a charge weighing about 5 cwt. is put into each pan and quicksilver is added according to the judgment of the operator. The quantity of quicksilver varies greatly; one will use as much as 12 lbs. of the metal to 1 cwt. pyrites, and another less than 4 lbs.

The great importance of breaking up the quicksilver, of mixing it thoroughly with the pyrites, and thus bringing it into contact with the fine gold is well understood; but when this is done effectually there is the greater difficulty in recovering the quicksilver and amalgam. A very small quantity of sodium amalgam added to the material prevents "flouring," but the utmost care is needed in using this aid to amalgamation. A solution of soda or any alkaline solution is beneficial. It is at this stage by mechanical action that the flouring is caused, as any one can easily prove by attempting amalgamation in the presence of substances that cut up the quicksilver.

The Chilian mill is greatly in favor in many large and long-established works; and a summary of the evidence of Mr. H. Rosales respecting it cannot but be of interest to gold miners.* He says —

"In amalgamating, charges the mill (a small one 12-inch faced roller) at starting with 110 lbs. of mercury, then adds 66 lbs. of damp calcined ore, works dry for ten minutes, breaking up the mercury; works ten minutes more in a thick pasty state; adds clay-pipe full of mercury containing 2½ per cent. sodium amalgam, and works again ten minutes; then flushes off for ten minutes, runs off water and fine sand, leaving the mercury and heavy sand in bottom of pan; adds 66 lbs. more of roasted pyrites, and repeats the process; every week cleans out pan, and squeezes the quicksilver through chamois leather. To secure thorough amalgamation, the mercury must be floured through the mass, and a loss to a certain extent put up with. If the mercury be left in mass at the bottom of the pan, and the roasted material in the form of slime very little loss of mercury occurs, but a very great loss in gold. Adopts the following method to collect the amalgam (broken up mercury):—(1) a large force dolly to dilute the slime; (2) two of Rittenger's Small-basin Tyrolese mills (3) two small force dollies; (4) copper plates, with blanket Strips; after every flushing off the floured mercury collected on the plates is rubbed off with a few drops of quicksilver containing 2½ per cent of sodium amalgam; (5) blankets and large dolly. Tyrolese mills can be advantageously applied to save amalgam and

* Report of the Board appointed to investigate the Methods of Treating Pyrites, 1874.

broken up mercury. The loss of mercury has averaged about 1½ lbs. to 2 lbs. per ton of calcined ore."

A loss of mercury equal to 2 lbs. per ton of calcined ore may or may not in all cases represent a large loss of gold. Assuming that the average yield of pyrites is 2 oz. 13 dwt. per ton, the loss of gold would be equal to 10 grs. for every ton of pyrites treated, or, adding the value of the mercury, a sum of nearly 10 shillings per ton which represents a loss of about 5 per cent. This cannot but be regarded as unsatisfactory, but as there are improvements effected nearly every day in the methods of treating pyrites it may be assumed that the loss in this operation will soon almost disappear. When we compare the above results with those which were regarded as excellent some fifteen years ago we may surely gather hope and confidence as to the future. The loss of 10 shillings per ton of pyrites treated may be regarded as the greatest that can arise from the waste of quicksilver. The average loss is probably less than 5 shillings per ton.

The Board appointed in Victoria to report on the several methods of treating pyrites give the following table showing the number of tons of quartz crushed by certain Companies in 1873, the number of tons of pyrites saved, the yield of gold from the quartz and the pyrites respectively, and the cost of treating the pyrites:—

Name of Company.	Locality.	Number of Tons of Quartz crushed.	Number of Tons of Pyrites saved from the Quartz.	Yield of Gold from the Quartz alone.	Yield of Gold from the Pyrites alone.	Cost per Ton of treating the Pyrites including Concentration.	Information supplied by
				oz. dwt. grs.	oz. dwt. grs.	£. s. d.	
Llanberris Quartz Mining Company, Registered. (a)	Ballarat ..	23,020 for the Company; 5,969 for the public.	143	2,003 13 14	151 3 0	3 0 0	J. Thomas, General Manager.
The Hope Mining Company, Registered. (b)	Morning Star Hill, Wood's Point.	3,025	About 56.	2,104 1 18	35 8 0 from 21 tons 8 cwt. (d)	3 10 0(e)	J. Bailey, Superintendent.
Adventure Company.	Taradale ..	..	..	1 to 2 oz. per ton.	6 to 8¼ oz. per ton.	..	E. L. Kitchingman.
Walhalla Gold Mining Company, Registered.	Stringer's Creek.	8,102	7,242 tons of quartz yielded 2½ per cent. of pyrites.	11,504 12 0	341 12 0 from the 2½ per cent. of pyrites saved from the 7,242 tons of quartz.	£4 to £5	H. Rosales, Manager.
Port Philip and Colonial Gold Mining Company.	Clunes ..	820,859(f)	3,609	338,871 19 4	13,623 11 12	3 6 2	R. H. Bland, Manager.
Caledonian Quartz Company's Machine.	Maldon ..	2,597	214	1,367 19 0	321 5 0	1 6 0	R. D. Oswald.

(a). Cannot give the return of gold from the public crushing. The method of treatment adopted was by the use of the buddle, Wheeler's pans, and reverberatory furnace.

(b). Parcels of pyrites treated for the public from the Morning Star and other reefs in the district have yielded from 2½ oz. to 7½ oz. to the ton.

(d). A poor sample; the balance saved remains in stack awaiting treatment. A lot of 89 tons 7½ cwt. previously treated yielded 259 oz. 3 dwts. of gold, or an average of about 3 oz. 6 dwts. per ton.

(e). The cost could be reduced at least £1 per ton by lengthening our furnace and adding a second Chilian mill to our plant, which would enable us to reduce double the quantity at a very slight increase to the cost now incurred for labor, &c.

(f). Crushed between June 1857 and October 1864.

The table shows that the quantity of pyrites saved was generally in a small proportion to the number of tons of quartz crushed; but at the Caledonian Quartz Company's Works the proportion of pyrites recovered was 8·2 per cent.

It has been stated already that to crush raw pyritous quartz with quicksilver in the coffers is certain to result in loss, both of quicksilver and gold, and if mercury is not used in the coffers the ordinary copper plates may be dispensed with. Copper

plates are considered almost as necessary as ripple boxes by many managers of mills, but experiments have shown that in most cases they cause a loss of amalgam.

In the Wynaad, in the many futile attempts made to treat the auriferous stone, it was the practice to roast the quartz before sending it to the mill. Where the proportion of gold in the stone is large, and if sulphides are absent, it is not injudicious to calcine the quartz previous to crushing; the quartz is made friable, and a greater quantity can be crushed per day—but if sulphides are present calcining is injurious. The effect of calcining when pyrites are present is to cause a glazing of the particles of gold in such a way as to make amalgamation with mercury impossible. The pyritous material can never be thoroughly oxidised in a kiln; a lower sulphide is formed which coats the particles of gold. The "slags" seen at the works in the Wynaad when examined under a lens show why the yields were so far below what might have been anticipated from the appearance of the free gold in the quartz before it was sent to the stampers.

The price of unskilled labor in Southern India is low, and it might be advisable in working some reefs to have the heaps of stone when broken picked and all the non-pyritous material sent to a kiln to be roasted if by assay such material showed a yield sufficient to make the treatment of it profitable.

It is now known that gold in the Wynaad is usually most plentiful in the parts of the reefs which contain pyrites, and therefore the methods of extracting gold, commonly adopted in Australia, are most likely to give good results.

It has not been thought desirable at this stage to give minute descriptions of all the various chemical processes for treating pyrites which have from time to time attracted attention. Professor E. J. Chapman, of University College, Toronto, has great confidence in the method employed by him. The buddled ore is mixed with a tenth of its weight of nitrate of soda, and the mixture passed through an iron cylinder or gas retort, fixed at a slight inclination and heated towards its centre to moderate redness, when the sulphur and arsenic become in part rapidly eliminated and in part absorbed chemically by the alkali of the nitrate. The ore is then leached in water; the soluble compounds rapidly dissolve out leaving the bulk of the ore in the form of a dull earthy residiuum. This is passed a second time, somewhat more slowly through the heated cylinder, when practically all the gold contained in it is set free. The gold may be extracted by amalgamation or by chlorine.

At my request Mr. J. Cosmo Newbery reported on this method and the following is an extract from his report:—

"The treatment with nitrate of soda is one which I do not think applicable in this country (Victoria); it will probably give an increased yield of gold, but the cost of this extra yield will be more than its value. By the present method of treatment careful concentration of the sand, roasting, and amalgamation, about eighty per cent. of the gold in the pyrites is obtained. If we say the pyrites contains two ounces of gold per ton this would give a loss at present of eight pennyweights of gold, worth 32 shillings (taking gold at £4 per ounce). Now the amount of nitrate recommended is one-tenth of the weight of the ore to be roasted (2 cwt. per ton), worth in this country 24 shillings per cwt., so that without including extra labor, fuel, &c., the 32 shillings' worth of gold would require 48 shillings' worth of nitrate of soda. This is supposing the whole of the 20 per cent. now lost were to be recovered by the use of this salt, a result hardly to be looked for. This loss of 16 shillings per ton would have to be recovered from the arsenical pigments, which are at present of little or no value here. Tons of arsenic are taken from the flues of our pyrites furnaces and buried or thrown away as there is no market for it."

When at Blackwood, in Victoria, I had an opportunity of seeing the apparatus invented by Mr. A. Robertson as adapted to the chlorination process and of listening to his explanations. Whether or not his system has been brought successfully into practice I cannot say, but the matter is in the hands of an energetic and able man, and if any one will make the process applicable to the extraction of gold from pyrites, Mr. Robertson is in a fair way to do it.

All these processes have a certain amount of interest for persons intending to embark their capital in gold mining in the Wynaad. At the same time it is clear that under existing circumstances the simple and easily managed methods, now in

or in the largest reduction establishments in Australia and California, are most ely to prove remunerative.

Appendix C shows the results of the process of treating pyrites at the establishment founded by F. Claudet and J. A. Phillips at Widnes, near Liverpool. heir method deserves consideration, if only because of the prospect afforded of me of the sulphides here becoming articles of export.

The prime mover best adapted to give motion to the stampers and stone-reakers is undoubtedly a steam engine. It is easily managed, and is constant in s duty, but to work it, as compared with some other prime movers, is costly. In he Wynaad there are numerous perennial streams (varying, it is true, during the easons in their volume of water), which in many places might be used either for over-shot wheels, breast wheels or turbines. And water in this district can be easily and cheaply conserved.

On the edges of the ghats a sufficient fall can be found every where; and whatever the form of water-engine power to move even one hundred head of stamps can be obtained at no great cost.

The situation of the reef and the surrounding circumstances would serve to determine whether or not it would be more economical to employ steam or water; but it may safely be asserted that a complete plant, consisting of ten stamp-heads with engine, stone-breaking machine, buddle, saw, and frame, necessary buildings, reverberatory furnace, and all other works could be erected for £5,000.

Allowing, then, 10 per cent. on the capital, and providing also for a competent mining manager and two European miners (sufficient, if success should result, for the efficient management of one hundred stamps and the mining operations which would then be necessary), and providing also for stores, &c., and contingencies at the rate of 25 per cent. on the whole, the annual returns would be, if the quartz yielded gold at the rate of 2 dwts. per ton, nearly equal to the expenditure; if at the rate of 3 dwts., £690 per annum, and if at the rate of 5 dwts., £3,570 per annum.

This estimate may be put in another way: some eleven years ago it was ascertained that in one mine in Victoria, Australia, the costs of raising and treating quartz were as follow:—

	£	s.	d.
Getting quartz, at 3s. 10½d. per ton, say	0	4	0
Cartage per ton	0	1	6
Crushing, including wear and tear, &c.	0	3	9
Contingencies	0	0	3
	0	9	6
A yield of 5 dwts. per ton, say, at 3s. 6d. per dwt. ...	0	17	6
Leaving a clear profit per ton of	0	8	0

The prices actually paid for similar work by the Alpha Gold Mining Company, as stated in a return furnished by the Managing Director, were as follow:—

	£	s.	d.
Raising quartz, Rs. 2 per ton	0	4	0
Carriage, Rs. 1-8-0 per ton	0	3	0
Crushing, Rs. 1-13-0 per ton	0	3	7
	0	10	7
Add contingencies as above	0	0	3
	0	10	10
A yield of 5 dwts. per ton, at 3s. 6d. per dwt.	0	17	6
Leaving a clear profit per ton of	0	6	8

Why the Alpha Company failed to derive fair profits from their operations is told in another place in this report.

It is scarcely necessary to state that if, instead of ten stamp-heads, fifty or one hundred were erected, the profits would be in a largely increased proportion.

The question of the introduction of Chinese labor for the purpose of working the gold mines of the Wynaad is one which I am not competent to discuss, as I have not a sufficient knowledge of India or of the several peoples inhabiting it.

In Australia the Chinese miners are exceedingly industrious and skilful; and they are successful in working the shallow auriferous deposits, following the European miners and getting gold under conditions which would not be accepted by even the poorest "hatter."

The Chinamen are employed in the alluvial mines in Victoria in all the mining districts, and their wages vary from fifteen shillings to thirty-six shillings per week. They labor often as long as nine or ten hours per diem, and neither cold nor heat nor wet seems to affect them injuriously.

They are easily managed by Europeans, but they might not behave well in the midst of a mixed population like that of the Wynaad.

Results of the treatment of auriferous quartz in Victoria, Australia.

In considering in what manner the quartz veins of the Wynaad and those in Southern India generally may be mined most advantageously, and in what manner the auriferous quartz should be treated, one turns naturally for information to the records relating to the large operations in Australia where experience gained during the past twenty years, appliances perfected by engineers ever on the watch for improvements, and methods of treatment suggested by the experiments of chemists in the laboratory, leave but little to be desired as regards the economical extraction on a large scale of gold from its matrix.

From what has been already stated, it is clear that in various parts of Southern India,—and certainly in the Wynaad,—there are reefs which ought to give profitable returns to the capitalist, if the same skill in mining and the same appliances for extracting gold were brought to bear on the operations as are at this moment indispensable to success in the largest gold-producing countries in the world.

Now that the old theories respecting the modes of occurrence of gold are no longer accepted even by the ignorant,—now that it has been proved that quartz-reefs are productive at greater depths than any to which the miner can penetrate by vertical shafts, and that in the latter rich veins have been cut more than 2,000 feet from the surface and quite 1,300 feet below the level of the sea,—the miner is encouraged to undertake works which a few years ago would have been regarded as reckless enterprises. In one mine in Victoria 11,500 tons of quartz, obtained at depths varying from 430 to 1,060 feet from the surface, yielded from 1 oz. 3 dwts. to 5 oz. 14 dwts. per ton; and elsewhere in the same colony the yields of stone got at levels as low as 500 and 1,000 feet from the surface have given at the rate of 1 oz. 14 dwts. to 2 oz. per ton.*

The mining records relating to this part of Australia afford instructive lessons to all who are interested in gold-mining in any country. They show that the average yield of 13,402,915 tons of quartz crushed and treated in Victorian mills has been 11 dwts. 6·30 grs. per ton; and that during the year 1876, 1,011,808 tons 4 cwt. gave an average of 10 dwts. 13·48 grs. per ton. It is a noteworthy fact, in connection with these returns, that the greatest quantity of gold is not obtained from the veins which yield the largest amount of gold per ton. For instance, in the last case cited the quantities crushed in the three most important quartz-mining areas were 315,407 tons 6 cwt. yielding an average of 6 dwts. 14·46 grs., 356,927 tons 10 cwt. giving at the rate of 11 dwts. 22·86, and 111,716 tons 10 cwt. with an average of 7 dwts. 14·45; on the other hand, where the yields per ton were 16 dwts. 22·47 grs. and 1 oz. 3 dwt. 12·58, respectively, the quantities of stone crushed were 88,729 tons and 40,784 tons. In some districts of Victoria parcels of quartz treated in 1874, 1875, and 1876, yielded as follows* :—

* *Mineral Statistics of Victoria.*

Tons crushed.		Average Yield of Gold per Ton.		
	1874.	oz.	dwts.	grs.
		0	5	14·31
		0	3	4·47
104,256		0	6	7·86
14,810		0	3	21·82
91,427		0	6	20·67
8,980				
44,921				
	1875.			
		0	5	18·27
		0	2	22·93
97,830		0	3	19·89
18,667		0	6	22·99
9,805		0	5	11·81
9,814		0	5	13·63
26,524		0	6	22·47
39,553				
16,112				
	1876.			
		0	5	2·54
		0	6	8·78
116,770		0	3	16·68
112,232		0	3	10·97
10,000		0	4	19·89
14,206		0	5	3·96
23,507				
46,350				

During the three years above mentioned 880,641 tons of quartz were crushed which yielded an average of only 5 dwts. 12·78 grs. per ton.

Where the reefs are thick or where the "leaders" are numerous and the facilities for mining are great, the returns, even when the yield per ton is very small, are far more profitable than those from veins in hard rock, however rich they may be. The Black Hill Company at Ballarat crushed 283,550 tons of quartz which gave an average of only 2 dwts. 23 grs. per ton; yet the dividends paid amounted to £23,900; the machinery cost £10,030; and the Company paid £24,235 for "claims" (*i.e.*, lands on which to mine).

Numerous similar cases could be mentioned where the operations have been profitable, and yet the average yields per ton very small, namely, 2 dwts. 13·4 grs., 3 dwts. 6·01 grs., 3 dwts. 7·89 grs., and 3 dwts. 18·53 grs.

One remarkable case, which however cannot but be regarded as exceptional, is that of the Independent Company, Black Hill, Ballarat. They obtained the quartz they crushed with great facility, working in an open cutting, and the yields, though very small, were remunerative. "During the early part of 1863 the average yield was 3 dwts. 12 grs. per ton; from October 1863 to May 1864, 7,453 tons gave 910 oz. 0 dwts. 12 grs. of gold equal to 2 dwts. 10·6 grs. per ton; and 24,447 tons taken at different dates between May 1864 and December 1865 from the cutting gave 2,043 oz. 10 dwts. 2 grs. equal to 1 dwt. 16·12 grs. per ton."*

During a period of eight years the records show also that in the part of Australia above referred to 40,002 tons of pyrites and pyritous quartz were operated on by certain mining companies, and that the average yield per ton was 2 oz. 13 dwts. 7·81 grs.

In these operations all the bye-products were lost,—the sulphur and all the other constituents of the pyrites,—but with such aids as the chemist has given many of these might be saved and turned to profit.

From 1864 to 1875 inclusive, 1,728,959 tons 7 cwt. of "quartz, tailings, &c.," were crushed in Victoria and yielded 306,831 oz. 10 dwts. 23 grs. of gold, being an average of 3 dwts. 13·18 grs. per ton.

In other parts of this report the yields of gold per ton. of quartz taken from several reefs in South-East Wynaad are given, some the results of experiments

* *Victorian Exhibition, 1872 (Mining and Mineral Statistics).*

made by Mr. W. King, the Deputy Superintendent of the Geological Survey of India, and others by Mr. Lindon and the writer; and the proportion of gold per ton is such as to justify the commencement of mining operations on a scale which would fairly test the character of the veins. If well conducted and successful, such operations would lead ultimately to the thorough development of the gold mines of Southern India. It is satisfactory to be able to add that specimens of the quarts sent to Victoria by the writer have been analysed by Mr. J. Cosmo Newbery, B.Sc., the Superintendent of the Laboratory in Melbourne, and the results, as recorded in Appendix E, more than confirm the conclusions arrived at by those who have investigated the reefs near Devála.

It is obvious that in this part of the world no such "prospecting" as that which has resulted in the discovery of rich reefs in Australia and California can be expected, even if the gold mines were proved to be richer than those of the countries named. The people generally have occupations which they would be loath to leave for what might be an uncertainty; and it is more than doubtful if their means,—their ability to maintain themselves for such periods as they would have to do unproductive work,—would permit of their following gold mining as a pursuit in the same manner as it was followed a quarter of a century ago in Australia and America. Hence, it will happen that discoveries of rich veins here will probably be relatively few as compared with the number of the reefs and made only at long intervals. The excavations and pits of the native miners,—works prosecuted in times past and now nearly everywhere abandoned,—are, however, often sure guides to the reefs in which gold occurs. It may be truly said that the veins now known to be highly auriferous have been discovered by tracing the old workings on or to the outcrops.

The facilities for mining these auriferous reefs, as already stated, are very great; the reefs in most places appear at the surface either on the summits or on the slopes of the ranges; and the contours of the hills are such as to admit of horizontal shafts being driven so as to intersect the reefs. All the costs of winding, pumping water, and the maintenance of machinery with the expenses of fuel and management attendant thereon are thus avoided. The difference in the price per ton of getting quartz under such favorable circumstances as those described and in other places where vertical shafts are required to work the veins is very great. In the Beechworth District (Victoria) there is one gold field where the formation of the country admits of the quartz being mined by horizontal shafts, and the average cost there of raising quartz and delivering it at the machine is 2*s*. 2*d*. per ton, whereas in other places, where vertical shafts are sunk, the cost per ton varies from 12*s*. 10*d*. to 27*s*. 4*d*. The cost of breaking out quartz in mines worked from vertical shafts, and under the most skilful management, may be set down at from 4*s*. to 9*s*. per ton; and including the cost of machinery, dead-work, and delivery at the reduction works a total cost of at least 12*s*. per ton. The prices charged for crushing and treating quartz, too, are different in different districts. In some they are as low as 2*s*. 2*d*. per ton, and in others as high as 14*s*. and 20*s*. per ton. Where water-power can be employed for giving motion to the crushing machinery, the cost of reduction is usually very low as compared with that where steam is used, the proportion being for Victoria according to circumstances and position as 1 to 4 and in California as 1 to 2 nearly.

The wages paid to miners and others in Victoria, even where profitable results are obtained from quartz giving only a very small proportion of gold per ton, are high. Miners are paid from 38*s*. to 48*s*. per week, laborers working on the surface from 30*s*. to 45*s*., and engine-drivers and others from 42*s*. to 70*s*. All the materials used are also costly; for instance, props are £12 per 1,000, laths 24*s*. per 100, logs 1*s*. 10*d*. per cubic foot, sawn timber 6*s*. per 100 feet, and firewood 25*s*. per cord. The prices paid for timber continue to increase, as the forests in the vicinity of the mines are now in most cases denuded, and fuel, &c., have to be brought from great distances; but in spite of all these difficulties, a severe but a wise economy in all departments connected with the mines and the reduction works enables the companies to pay good dividends to the shareholders.

What may properly be described as economical quartz-mining has been known and practised but for a very few years. When attention was first given to the auriferous reefs in Australia, the method of treatment was similar to that now and in times long past pursued by the natives of Southern India. The stone was broken out of the reef, and the "specimens" with gold visible to the eye were pounded by hand and the gold washed out.* Subsequently the "Dolly," a log of wood shod with iron and suspended from a sapling over a stump, was in use as a crusher, and finally stampers moved by water or steam were introduced, and quicksilver for amalgamation employed. Very slowly improved processes were adopted, and important discoveries were made, but it was not until the miners had been at work for some sixteen years that a proper system of treatment was generally adopted. In the early days of quartz-mining in Australia as much as £8 and £10 per ton were paid for crushing, and the tailings consisting of auriferous pyrites, quartz, sand, &c., were thrown aside and formed large heaps near each crushing plant. Years afterwards, when the value of the pyrites came to be known the heaps of "tailings" were sold to and re-washed by Chinamen again and again. The pyrites were slowly decomposed by exposure to the atmosphere and the gold set free, and some profit accrued at each washing. When, however, the tailings were collected in settling boxes and sent to the buddles, the pyrites concentrated, roasted in a suitable furnace, and subsequently ground with mercury, a large amount of gold was obtained. So excellent is the process now commonly adopted that at least 86 per cent. of the gold contained in the material (as determined by assay) is extracted.

The Wynaad Prospecting Company state that they were able to break out quartz and deliver it at the kiln for Rs. 1-3-2 per ton, and now that nitro-glycerine compounds for blasting have been greatly improved and made as safe as it is perhaps possible to make them there is no reason why, in quarrying the large bodies of quartz that appear at the surface in so many places in the Wynaad, the cost per ton should much exceed that paid by the Public Works Department for quarrying hard country rock. From information afforded by the Executive Engineer, Nilgiris, it appears that a native laborer, working eight hours per diem, can, in ordinary cases, quarry about $1\frac{1}{2}$ cubic yard of solid rock per diem, and his pay is six annas per diem, that is to say, the cost of quarrying is four annas per cubic yard. The same authority gives the price of excavating earth by native labor at two annas per cubic yard. By making adits or sinking shafts and using dynamite, rock can be quarried, it is said, in reports lately received, at the rate of nearly 140 tons for every pound weight of lithofracteur exploded.

The consideration of these facts leads to the conclusion that while it is possible quartz-mining, with such rude machinery and crude treatment as were common some twelve or fifteen years ago, might have yielded profits in some places in Southern India, the reefs generally could not have been worked remuneratively.

But the conditions are now changed, and it is beyond doubt that the old gold mines of Western and Southern Asia, and Eastern and Southern Europe, will sooner or later be re-opened by Europeans, who will provide themselves with all those appliances which have been brought almost to perfection by mining managers in Australia and California.

Assays of gold.

The gold obtained in the Wynaad is unequal in fineness, that from the soils being of the best quality. It has been observed in other countries that the finer the particles of the gold procured from alluvial deposits the higher is the quality.

The following figures are taken from a report furnished to the Government on the 13th January 1832 by the Mint Committee, of assays of gold made by the Mint Master's Assayer:—

* At Ballarat, even as late as the year 1872, many small co-operative parties of miners were making a living on some of the reefs by picking out the best stone and crushing it with hammers and getting the gold by "washing off" with a cradle and tin dish. So inefficient was this method of treatment that a parcel of 100 tons of tailings cast aside and subsequently sold for £5 yielded, when treated in the battery, a profit of over £100.—*Victorian Exhibition* 1872 (*Mining and Mineral Statistics*).

Coopul Mines	Gold ...	99·22
	Silver ...	·78
		100·

Value of an ounce of gold of this fineness ... ... Rs. A. P. 43 4 8

Nilambúr Rajah's Mines	Gold ...	94·53
	Silver ...	5·47
		100·

Value of an ounce of gold of this fineness ... ... Rs. A. P. 41 4 0

Devála Mines	Gold ...	90·88
	Silver ...	8·86
	Copper .	·26
		100·

Value of an ounce of gold of this fineness ... ... Rs. A. P. 39 10 6

The Assay Master made a further report on seven samples of gold on the 10th February 1832, showing the following results :—

Nilambúr Mines	Gold ...	94·53
	Alloy ...	5·47
		100·

Value of an ounce of gold of this fineness ... ... Rs. A. P. 41 3 8

Exactly similar results were obtained from another sample of the gold of the Nilambúr Mines :—

Nilambúr Mines	Gold ...	96·09
	Alloy ...	3·91
		100·

Value of an ounce of gold of this fineness ... ... Rs. A. P. 41 13 8

Coopul Mines	Gold ...	98·96
	Alloy ...	1·04
		100·

Value of an ounce of gold of this fineness ... ... Rs. A. P. 43 2 10

Coopul Mines	Gold ...	99·22
	Alloy ...	·78
		100·

Value of an ounce of gold of this fineness ... ... Rs. A. P. 43 4 2

Coopul Mines	Gold ...	98·96
	Alloy ...	1·04
		100.

Value of an ounce of gold of this fineness ... ... Rs. A. P. 43 2 10

Carcatode Mines	Gold ...	99·22
	Alloy ...	·78
		100·

Value of an ounce of gold of this fineness ... ... Rs. A. P. 43 4 7

Mr. King, under date 11th March 1875, reported that two samples of gold obtained from ordinary washings of surface soil were assayed at Calcutta with the following results :—

Number 1	Gold ...	93·00
	Silver ...	7·00
		100·
Number 2	Gold ...	90·90
	Silver ...	8·67
		99·57

Three samples of reef gold collected by Mr. King were examined in the laboratory of the Geological Survey of India, and the proportions of gold and silver were for each as follow :—

No. 1	Gold ...	67·07
	Silver ...	32·93
		100·
No. 2	Gold ...	82·69
	Silver ...	11·32
		94·01
No. 3	Gold ...	86·86
	Silver ...	10·96
		97·82

Nos. 1 and 3 of the above were assays of reef gold got from different parts of reefs, No. 2 was from one part of a reef close to the outcrop.

In another report it is stated that the percentage of pure gold in a sample of metal obtained by washing the earth was 97·5, and from a sample of matrix gold 92·875.

Mr. J. W. Minchin sent some gold to Mr. H. B. Medlicott, the Superintendent of the Geological Survey of India in 1875, which was supposed to be stream gold (it was really reef gold), and it was found to consist of gold 84·7 and silver 15·3.

The same gentleman also sent a sample of auriferous quartz got near Devála to Johnson and Sons, Assayers to the Bank of England and Her Majesty's Mint; and they gave a certificate to the following effect :—

		Grains Troy.
Assay of 5 lbs. of auriferous quartz ...	Fine gold ...	19½
	Silver ...	5⅝
The proportions of the above being...	Gold ...	79·13
	Silver ...	20·87
		100·00

Mr. King, having had assays made of gold from six reefs, gives the average for Wynaad gold as follows :—

Gold	86·86
Silver	10·96
Dross	2·18
	100·00

Mr. J. Cosmo Newbery, B.Sc., Superintendent of the Technological Museums and Laboratory in Melbourne, has examined some samples of quartz forwarded by

me from the Wynaad, and from auriferous pyrites and quartz taken out of the Skull Reef he found the yield per ton as follows:—

			oz.	dwts.
Gold			49	10
Silver			37	6
The proportion being	Gold ...	57·02		
	Silver ...	42·97		
		99·99		

In Victoria the fineness of the gold obtained from the alluvial workings varies considerably in the different districts, but "the fineness is pretty constant for each field and will seldom deviate from the average mark more than a few eighths of a carat grain."

At the Wool-shed near Beechworth and at Ballarat, Maryborough, and McIvor, Victoria, the fineness recorded is as high as 23 carats $2\frac{7}{8}$ carat grains, and in Gippsland as low as 20 carats $3\frac{3}{4}$ carat grains.

Amalgam gold from the Mariner's Reef, Maryborough, Victoria, marks 23 carats $2\frac{7}{8}$ carat grains and 23 carats $3\frac{3}{4}$ carat grains. It is the highest known matrix gold.

Gold got from the reefs on the Goulburn river, Victoria, varies in fineness from 17 carats $0\frac{1}{8}$ carat grains, and 17 carats $2\frac{1}{8}$ carat grains to 23 carats $1\frac{5}{8}$ carat grains.

The gold obtained from the quartz veins by crushing and amalgamation is higher or lower in quality according as the quartz is treated, and the differences in samples from the same reef are frequently very great though the gold in its native state may be pretty uniform in character.

The proportion of pure gold in samples of native gold found in various parts of the world is given here for comparison with the above results. The figures are extracted from a table in *Dana's System of Mineralogy*:—

	Gold.	Silver.
Wicklow Company, Ireland	92·32	6·17
Transylvania, Vörospatak	60·49	38·74
Katharinenburg	95·81	3·58
Do	70·86	28·30
Czar Nikolajeosk (Miask)	92·47	7·27
Boruschka (N. Tagilsk)	94·41	5·23
Beresof..	91·88	8 03
Petropavlooski...	86·81	13·19
Siranooski, Altai	60·98	38·38
Schlangenberg, Altai...	64·00	36·00
Malacca	90·89	8 98
Siam, Pachim	88·57	6·45
Africa, Senegal	94·00	5·85
Do. do.	84 50	15·30
Brazil	94·00	5·85
Bolivia, Ancota	94·73	5·23
Do. Tipuani	91·96	7·47
North Grenada, Bogota	92·00	8·00
Do. Marmato	73·45	26·48
Do. Santa Rosa	64·93	35·07
Peru, Carabaya	97·46	2 54
Do. Yungas	78·69	21 31
Novo Scotia, Tangier...	98·13	1·76
California	96·42	3·58
Do.	75·86	20·67
Canada, Chandiere	89·24	10·76
Australia	99·28	0·44
Do. Oneo	85·23	14·77
Tasmania	92·77	7·23
Do. Fingal	90·89	8·02

"The average proportion of gold," says Dana, "in the native gold of California as derived from assays of several hundred millions of dollars' worth is 880 thousandths, while the range is mostly between 870 and 890. The range in the metal of Australia is mostly between 900 and 960 with an average of 925."

Gold is found associated with rhodium and with palladium and silver. There is an argentiferous telluret of gold, a plumbo argentiferous telluret of gold and a sulpho-plumbiferous telluret of gold, "the color of which is a deep lead grey, very brilliant, crystallizing in slightly elongated hexahedral tables. Its fracture is lamellar; it is soft and stains slightly. Its composition is as follows:—

Gold	9·0
Silver	0·5
Lead	54·0
Copper	1·3
Tellurium	32·2
Sulphur	3·0
	100·0"*

Gold is found in association with ores and metals in various proportions; and such ores and metals, many of them now rare, may perhaps hereafter be found in quantities in some places, and become remunerative to the miner.

Only by a careful chemical analysis can the proportion of gold in any given quantity of quartz, pyrites, or other mineral be ascertained; but for all practical purposes assays by amalgamation are sufficient. The methods pursued in treating quartz taken from the reefs in the Wynaad have been as follow:—

Methods of testing auriferous quartz and auriferous pyrites.

When a reef was tested in sections, the stone from each section was taken out in far larger quantities than were required for testing, each heap of quartz was broken into small pieces, and the whole was well mixed; and from the heap so mixed the portion to be treated was taken. The stone was broken still smaller and weighed; and it was then ground very fine on a suitable stone, another stone being used as a muller. The finely pulverised stone was put into a clean iron pan and roasted until fumes were no longer given off, until it was certain that it was in a fit state for amalgamation. If after roasting the pulverised material seemed to require it, it was again ground on the stone. The heat at all times was so regulated as to prevent the possibility of "glazing."

The roasted stone was put into an enamelled dish, and a proper proportion of quicksilver was added.

The whole was then thoroughly rubbed by hand, at first dry; subsequently a little cold or hot water was poured in until a paste was formed; more water was added, the stuff being thoroughly rubbed all the time, and finally the amalgam or (if there was no gold) the quicksilver was washed off, the utmost care being taken to prevent the loss of any quicksilver. The water and sludge from the enamelled dish were poured into other vessels, and these were most carefully examined subsequently, and if there was doubt, and sometimes when there was no doubt as to the results, the sludge-sand, &c., in these were treated again, the amalgam or quicksilver was most often placed under the flame of the blowpipe but at other times nitric acid was used and the gold (if any and of sufficient quantity) was weighed.

The results were calculated in the ordinary way.

It happened occasionally that the roasting was not sufficiently protracted or that all the material subjected to the roasting was not ground as fine as it ought to have been, and then it became necessary to subject it to further roasting or to use acids to decompose the sulphides. In all cases the utmost care was taken to preserve the conditions necessary for effective amalgamation.

The quartz collected in various localities was treated in the same manner as that taken from sections of the reefs.

In order the better to illustrate the value of this system of testing quartz I took a quantity of sludge and sand from which the gold had been extracted, and which had been saved in pans, and into this I put half a grain of very fine gold. The gold was well mixed with the sludge, &c.,—quicksilver was then added and the operation of amalgamating performed in the ordinary manner. The amalgam was

* *Manual of Practical Assaying* by John Mitchell, F.C.S.

treated also in the ordinary manner, and the gold recovered weighed ·4786 grains nearly, showing that the loss was 4·28 per cent. The loss may be partly accounted for by the mere handling of the fine gold in a very damp atmosphere, *i.e.*, weighing it, transferring it to the dish of sludge, &c., and reweighing it. This system however is, when very carefully managed, so certain that if the actual assay produce of a parcel of quartz was at the rate of one ounce per ton, the gold got by amalgamation would weigh 19 dwts 3·5 grains. It will be observed that the result in every case must necessarily be slightly in defect, never in excess. Messrs. Johnson and Matthey, the well-known Analytical Chemists, in a report to the Directors of the Port Phillip and Colonial Gold Mining Company, make the following statement :—

"We finally had recourse to amalgamation and were surprised at the ready results so obtained (having been led to suppose that the mineral—Pyrites—was unworkable under that process)* * * * * * The results recorded by the Analysts are highly interesting :—

	oz.
The pyrites (raw) gave by "assay"	11·425
Obtained by amalgamation	10·400

"The pyrites exposed to the decomposing influence of the atmosphere from 15 to 20 days being laid out in a thin layer and occasionally stirred :—

	oz.
Assay	11·425
Obtained by amalgamation	10·850

"The pyrites calcined in an ordinary calcining furnace slowly and at a low temperature :—

	oz.
Assay	11·400
Obtained by amalgamation	11·275"

The loss by the amalgamating process was in the first experiment 8·97 per cent., in the second 5·04 per cent., and in the third 1·1 per cent.

Timber and Timber trees in the Wynaad.

It is all-important to the gold miner that he should be able to procure a supply of good timber in the near neighbourhood of his operations. Even where the yield of gold is high, whether from alluvial deposits or quartz veins, this matter is of so much consequence that, if there should be difficulty and great expense in obtaining firewood and supports for the mine, the profits may be so greatly reduced as to lead to the abandonment of the works.

In the Colony of Victoria the statistics of gold-mining show that the cost for firewood, &c., props, and cap-pieces, laths and slabs and sawn timber used in the mines have been for three years as follow :—

	£
1874	441,731
1875	365,176
1876	328,401

These figures show that the timber used for every ounce of gold raised costs 7*s.* nearly, or, assuming this as the average, that every ton of quartz raised and treated costs for timber alone 3*s.* 6*d.* nearly. In cases where the quartz yields gold of average value per ton of 10*s.* only or less, such a charge would be severely felt; but in many mines, owing to the modes of working the reefs and to the economy practised, the costs for timber are very much less than the average.

When in Victoria, Colonel Sankey* ascertained that at one mine at Sandhurst the consumption of firewood was fifty cubic feet per stamp-head per week and the cost 6*s.* 6*d.* Mr. Bland of Clunes stated that firewood was about 27*s.* per cord of 128 cubic feet, equal in weight to 2½ tons, and for steam purposes equal to one ton of coal. Others considered that four tons of wood were equal to one ton of coal.

The cost therefore of firewood in Victoria for crushing one ton of quartz is from 5*d.* to 8*d.*, and firewood at the time Colonel Sankey made these inquiries was about the same price as it is now at Devála.

The miners in the colony mentioned have again and again drawn attention to the want of a sufficient supply of timber in their several districts. In some places

* *Report on the Coliban and Geelong Schemes of Water-supply*, 1871.

it has to be drawn from forests far distant from the mines; and it is well known that this alone has seriously affected mining operations and prevented the opening of promising *leads* and reefs.

Inquiries have been made respecting the timber-trees in the forests adjacent to the mines at Devála, and it appears from the information furnished by Colonel Beddome, the Conservator of Forests, and Mr. J. W. Minchin, who from long residence is well acquainted with the district, as well as from observations made when this area was being prospected that "an almost inexhaustible supply of large trees is available."

Colonel Beddome has supplied a list of the principal trees growing in the Wynaad in the neighbourhood of the gold mines and on the Carcoor Ghât and on the slopes below Devála, and he has indicated those best adapted for conversion into logs, props, slabs, planking, &c.

The names of the latter, together with some information taken from the *Flora Sylvatica for Southern India* by Colonel Beddome, are as follows :—*

Mesua ferrea.—Two varieties; iron wood, valuable for engineering purposes. In the Wynaad abundant; not utilized and seems hardly to be known; called in the Wynaad *Naaga* or Nàghá or *Nàghà champa.*

Mesua, Sp.—From the Nilambúr jungles; common; much used by the natives for building purposes; durable and not liable to be attacked by insects.

Hopea Malabarica.—A very large tree with a most valuable hard timber, Carcoor Ghât, Wynaad; called *kallu* in Malabar.

Cedrela toona.—White cedar of Europeans. A large tree with an erect trunk; known as *kal kilingi* on the slopes of the Nílgiris; much used for furniture and cabinet purposes and also for building.

Chickrassia tabularis.—A tree of large size, often 8 to 10 feet in girth, with a thick, straight trunk 60 or 80 feet to first bough. Much used for furniture; said to be used at Madras for all purposes for which ordinary mahogany would be used in Britain.

Schleichera trijuga.—One of the most valuable unreserved timbers; wood much prized in some districts; makes excellent crushers for sugar and oil-mills; is in use for building and a variety of purposes. In Canarese it is called *chakota* and *Akotà.*

Dalbergia latifolia.—Blackwood or rosewood trees. Grows to a very large size on the mountains. Some trees considerably over 20 feet in girth. The timber is one of the most valuable in India and generally fetches a higher price than teak; it is heavy, strong, fibrous, close-grained and durable; extensively used for gun-carriage purposes. The tree is abundant in Wynaad and Coorg. Planks four feet broad are often procurable after all the external white wood has been removed. The Canarese names are *Bitti* and *Thòdagatti.*

Pterocarpus marsupium.—A most valuable timber tree next to teak and black-wood; a large and very beautiful tree attaining a fine size in the western forests and in favorable ravines and sub-alpine jungles elsewhere. Size and manner of growth differ under different circumstances; often very poor and scrubby. Common all round the foot of the Nílgiri Ghâts. Two thousand trees were seen by Dr. Cleghorn along the roads through the Wynaad notched with a V-shaped incision for the extraction of kino; called in Canarese *Whonay, Hove,* and *Wulla Honay.*

Acrocarpus fraxinifolius.—One of the largest and loftiest trees in the Madras Presidency, generally of very straight growth with large buttresses at the base. It is sometimes 27 feet in girth above the buttresses; timber light and much resembles that of the *Cedrela toona;* much used by planters at Coonoor and in the Wynaad for building purposes, furniture, &c.; and in Coorg it is largely use for shingles; called *Kilingi* by the Burghers on the Nílgiris.

* Some notes have also been extracted from a work entitled *The Timber Trees, Timber and Fancy Woods, as also the Forests of India and Eastern and Southern Asia* by Edward Balfour, L.R.C.S.E.

Xylia dolabriformis.—A large tree. It is excellent for post, railway-sleepers, naves of wheels, and all purposes demanding great strength, and it is in use for building purposes called *Pirwa* in Canarese (South Canara).

Terminalia tomentosa.—One of the most useful of the timber trees; grows to a very large size and very straight; used for house-building; it bears a good transverse strain and is a wood much esteemed for all railway purposes. Used also for boats and canoes, solid wheels of carts, &c. The Canarese names are *Matti Mairthee*, *Madi Muttee*, and *Karrai Mutti*.

Terminalia paniculata.—A fine large and valuable timber tree; timber not equal to that of *Terminalia tomentosa*. Said to be improved by being kept under water; often called *Matti* or *Mardah*; known by the name of *Keerijal* in South Canara.

Eugenia Jambolana.—A very large and beautiful tree; wood much used in native house-building, for cart-framing, agricultural implements and for a variety of other purposes. Resists the action of water, some say almost for ages, and is used for well work. Not very strong or durable except in water. Called *Narala* in Canarese.

Lagerstræmia Reginæ.—A good-sized tree; tough and very durable under water, though it soon decays under ground; much used by the natives for building purposes and in boat-making. In the Madras Gun Carriage Manufactory it is used for light and heavy field cheeks, felloes, and cart naves, framing and boards of wagons, limbers and platform carts and ammunition box-boards. It is called Challa in Canarese.

Lagerstræmia microcarpa.—A large tree. The wood is straight, fibred and elastic; much used for building purposes, flooring rafters, &c., and also in dock-yards. If left exposed in the forests it very soon rots and is rapidly attacked by white-ants. It is universally known by its Tamil name of *Ventek* and is called *Balandur* and *Billi nàndi* in Canarese. Some think that the value of this wood has been underrated. It is said to have great "stiffness" and wooden bridges have been built of it.

Vitex Altissima.—A very large tree; trunk erect and of great girth; one of the most valuable of the timber trees. The wood is hard, durable and fissile, with a coarse grain; does not split or warp; it is much in use for building, construction of carts, and many other purposes. It is called *Sampagapala* in Canarese.

Tectona Grandis.—Teak tree. One of the most valuable timber trees in the world. In some favorable situations it has a girth of 22 feet, and a straight trunk of some 80 or 90 feet to the first bough, elsewhere it is less than 9 feet in girth, but is usually beautifully straight. The timber it yields is so well known as to need no description here.

Phyllanthus emblica.—A good-sized tree. The wood is hard, fibrous, and flexible; tolerably close and straight grained. It is remarkably durable under water on which account it is much in use for well rings; it is also used for building purposes, furniture, gun-stocks, &c.

Bischoffia Javanica.—A very large tree with a tall, erect trunk often of great girth. The timber is very hard and durable and is used for building, planking, &c very little known or utilized in general.

Briedelia retusa.—A large tree; trunk pretty erect; a very valuable timber tree, wood very stiff, strong, close-grained and durable, but not easily worked. It is used for house-building, construction of carts, agricultural implements, railway sleepers and for a number of other purposes.

Girouniera reticulata.—A large and valuable timber tree; wood very hard and heavy; a valuable engineering timber.

Artocarpus hirsuta.—A very lofty tree attaining upwards of 200 feet in height and of great girth. Timber strong, tolerably close and even-grained; much in use for ship-building, house-building, furniture and other purposes. In Canara (Mysore) it is called *Hebalsu*. It is said to be valuable for canoes and for planks.

The total number of the principal trees mentioned in the manuscript list furnished by Colonel Beddome is fifty-six, and all might be used as firewood.

Mr. Minchin has forwarded a paper containing the native names of trees growing in the Wynaad, the timber of which is suitable for mines.

The names are as follow:—

Poon	murrum	or Poon spar	Splits well.
Parley	,,	or Spurious Guttapercha or Milk tree	Do.
Muttee	,,	or Ven Teak ,, ...	Do.
Veettee	,,	or Blackwood	Good for posts and sets.
Cheera	,,	or Buttress tree	Splits well.
Iney	,,	or Jungle Jack	Good for posts and sets.
Ugalee	,,	or Cedar tree	Splits well.
Naaga	,,	or Iron wood tree	Good for posts and sets.

Mr. Minchin adds:—"The commonest trees in the forests are the Parley murrum and the Naaga murrum and are the easiest got at for firewood. On the Coomary land, where the forest has been cleared for cultivation and allowed to grow up again, the commonest tree is the Venda murrum (*Sponia Orientalis*) or charcoal tree, which is the quickest-growing tree in the Wynaad, but it does not last many years and is of no value for timber. It yields a very good charcoal, which is used by the natives for making gunpowder."

That charcoal can be procured easily and at no great cost is of some importance. It is essential that the miner should have a proper supply in all large operations. It is used in sharpening tools, &c.

Mr. Minchin says that the price of sawn timber, cut in various dimensions, is at the present time at Devála one rupee per cubic foot, and that logs and firewood cost for cutting and carting about two rupees per ton.

Major Morant, R.E., Executive Engineer, estimates the cost of jungle-wood sawn to scantlings at one rupee per cubic foot.

The late Manager of the Prince of Wales' Tribute Company, Devála, states that the cost of fuel was Rs. 3 per ton; but when the Alpha Mine was at work the cost, it is said, was Rs. 5 per ton.

In a report by Colonel Beddome published in the *Madras Mail* of the 22nd April 1879 it is mentioned that the average price of wood (for fuel for railway purposes) for the last five years has been Rs. 5-15-11 per ton delivered on the engine.

Occupation of lands in the Wynaad.

Up to the present time I have not been able to procure any map showing the areas which are claimed or occupied by the Zemindars or others (except coffee planters) in the Wynnad; as already stated, it has been found impossible even to ascertain the boundaries of the lands which have been granted for mining purposes. Mr. W. Logan in a letter dated 16th June 1875, in referring to the surveys of the Wynaad, states that "little or nothing apparently has been done in the direction of demarcating *private forests and waste lands belonging to natives.*" Whether the boundaries of these lands have been surveyed or not it is impossible for me to say; but, in view of the probability of lands being applied for by persons desirous of mining for gold, it seems desirable that no time should be lost in publishing maps showing—

(*a*) The lands held in fee-simple by Europeans and Natives.
(*b*) Lands leased for cultivation or other purposes.
(*c*) Lands held on tenures other than leases.
(*d*) Waste lands of the Crown.

This is not the place to discuss the manner in which lands should be leased for mining purposes, nor would it be right to offer opinions which might be opposed to the policy of the Government, but it is perhaps proper to suggest that regulations should be framed and published under which persons could make applications—

1*st*.—For licenses giving the right to "prospect" for gold.
2*nd*.—For leases of lands containing auriferous rocks.
3*rd*.—For licenses to take and divert water for mining purposes.

The manner in which lands held under the various tenures should be dealt with, the taxes (if any) to be paid by landholders who grant leases for gold-mining purposes and the method of assessing mining properties are questions solely for the consideration and final decision of the Government. It is, however, now well ascertained in countries where gold-mining is an established industry that the fewer impediments placed in the way of mining enterprise and the lighter the exactions, the more certain are the profits to the revenue. The State gains largely indirectly, and, in sacrificing the revenue which might be obtained directly by laying imposts on the miner, it encourages him in his labors and leads him to undertake explorations which, if he were heavily taxed, he would never contemplate.

I hope I have expressed with sufficient distinctness the opinion I entertain respecting the gold fields of South-East Wynaad.

The facts will speak more strongly than words to those acquainted with gold mines. Gold has been found on the south near Eddacurra and on the north near Nellacottah, on the west near Vyteri, and on the east as far as Bolingbroke, that is to say, over an area of more than 500 square miles.

The reefs are very numerous and they are more than of the average thickness of those found in other countries; they are of great longitudinal extent, some being traceable by their outcrops for several miles; they are strong and persistent and highly auriferous at an elevation of less than 500 feet above the sea, and they can be traced thence upwards to a height of nearly 8,000 feet; near them gold can be washed out of almost every dish of earth that is dug; the proportion of gold in some of the soils and reefs in the neighbourhood of Devála is large; and, the country presenting the greatest facilities for prosecuting mining operations at the smallest cost, it must be apparent to all who have given attention to this question that sooner or later gold-mining will be established as an important industry in Southern India.

The retardation of this event will be caused, not by the meagreness of the resources—they are large,—but probably by the mistaken notion that wherever there is gold all the care, all the forethought that would be deemed requisite in other pursuits may be disregarded in conducting mining operations.

In concluding this report I would wish to bring to the knowledge of His Grace the Governor that throughout the period I have been engaged on the duties assigned to me I have received the most generous assistance from all the officers of the Government with whom I have been brought in contact or to whom I have had to apply for information.

To the planters in the Wynaad I have been also greatly indebted; and, if I had to mention the names of all the gentlemen who from time to time took the trouble to accompany me in my explorations and to point out the sites of old workings and the outcrops of reefs, the list would be a long one.

I cannot sufficiently express my sense of the value of the assistance they one and all so cheerfully rendered.

Mr. Thomas Laing has at all times performed his duties to my entire satisfaction, and it is to be hoped that the injury to his health caused by hard labor and exposure may ultimately be repaired.

Mr. G. E. Withers, whose local knowledge is great, gave me, during the period he was employed in the Wynaad, all the assistance in his power, and to his explorations, undertaken some years ago, the country is indebted for a knowledge of the occurrence of rich reefs of quartz near Devála.

I have the honor to be,
Sir,
Your most obedient Servant,

R. BROUGH SMYTH,
Mining Engineer.

APPENDICES.

APPENDIX A.

DEVALA, 18TH *February* 1879.

From

R. BROUGH SMYTH, Esq.,
Mining Engineer.

To

J. H. GARSTIN, Esq.,
Acting Secretary to Government,
Revenue Department.

SIR,—Referring to the paper, dated 10th January 1879, No. 42, wherein I am instructed by the Government to ascertain how it is that notwithstanding the presence of considerable quantities of gold in the reefs at the Alpha Mine and to the extent reported by me the operations have not proved successful, and especially whether this want of success has arisen from any peculiar difficulties in separating the gold from the matrix at this particular spot, or from the cost of labor or fuel or from other reasons within or beyond the control of the mine proprietors, I now do myself the honor to submit the following report for the consideration of His Grace the Governor in Council.

Preliminary.

Immediately on receipt of the instructions above referred to, and as directed by the Government, I communicated with the Directors of the Alpha Company and sought permission to make a careful examination of the mine, and at the same time I asked a number of questions respecting the operations of the Company.

Subsequently I wrote to the Secretaries and Treasurers in Madras requesting them to furnish such information respecting the work done in the past as they could supply.

The Directors very promptly furnished papers relating to the expenditure of moneys, the quantities of quartz raised and the results, and they replied to some of the questions asked by me; and I would wish to record my appreciation of the assistance afforded by them, by Messrs. Parry and Company and by Mr. G. E. Withers who at one time had the management of the works under what is known as "The Prince of Wales' Quartz Reef Gold Prospecting Company," a Company which held and worked the Alpha Mine on tribute for a brief period.

Though necessarily from the nature of the duties which I have had to discharge since I came to this district, I was well acquainted with the mine and the machinery of the Alpha Company, I have since the receipt of instructions made a further careful examination of the land held by them, the reefs, and the works erected for the purpose of reducing the auriferous quartz.

The Area granted to the Alpha Company.

I have not been able to obtain a plan or a sufficient description of the boundaries of the area granted to the Alpha Company. The extent is said to be fifteen acres, but on the map of the Ouchterlony Valley and three Amshoms of South-East Wynaad the area marked "Alpha Company" exceeds one hundred acres.

The lines of demarcation as pointed out to me on the ground seem to embrace a larger area than fifteen acres.

The boundaries are thus described in the prospectus of the Company:— A block of fifteen acres bounded on the west and south by two large streams, and on the east and north by four demarcation stones.

As my report deals principally with only so much of the main reef as is known to be within the area granted to the Company, the question of boundaries need not be further referred to.

The Quartz Veins.

The principal quartz vein intersecting the land is that known as th ef." It appears at the surface at various points between "Wright's Level" and t oundary of the Company's area, and is traceable further northward for a great Wright's Level is on the eastern slope of the range that forms the western rim of ained by the Carcoor Poya, and is distant thirty chains from the Alpha mill.

The country is intersected by streams trending to the Carcoor Poya, and there are low an high hills, some very steep, but nearly all with smooth contours.

At Wright's Level the vein is from four to five feet in thickness near the surface, an seven feet six inches at a depth of thirty feet. Its strike for a distance of more than one chai is nearly north and south and the dip is east at an angle of 30° to 40°.

The quartz in some parts of the vein is laminated, the laminæ being from two to fou inches and more in thickness, and they are nearly parallel to the line of strike. These ar crossed by other lines transverse to the dip and strike, and there are in places thin veins c talcose clay cutting the reef transversely. There is also solid iron-free nearly white quartz Near the surface the stone, when broken out, is seen to be highly ferruginous and is colore yellow, bright red, and bluish purple. Much of the quartz is cavernous, honey-combed, c mice eaten, and the associated minerals near the upper part of the vein are limonite and othe oxyds of iron due to the decomposition of iron pyrites which are found in considerable quan tities in the deeper levels. Sulphur is also seen occasionally in cavities. I have not seen an sulphide of antimony or any of the ores of lead.

Northward, twelve chains from Wright's Level, an adit made by native miners has bee re-opened by me, and the thickness of the reef at this point is four feet; the strike is nearl north and south, and the dip is nearly due east at an angle at the outcrop of 45° and at depth of twenty-four feet 60° nearly.

A section taken from the middle of this reef shows massive white nearly iron-free quart It is ferruginous and cavernous near the hanging wall and foot wall.

At the large excavation from which the reef derives its name about twenty-two chai north of Wright's Level, the vein is thick: at the face it is not less than fourteen feet from th hanging wall to what appears to be a "horse," the extent of which has not been ascertaine The total thickness of the reef at this point is not known. The general character of the ston is similar to that at Wright's Level, but there is much more sulphur. It is not difficult to fin rather large quantities of clean sulphur in the cavities. Here also there is an absence those minerals that are most detrimental to amalgamation. The strike of the reef is N. 20° W and the dip N. 70° E. at an angle of 18° to 30°, but the dip nowhere is uniform.

About four chains and fifty-six links north-westerly from the excavation the reef is aga seen on the bandy-road where it intersects a low hill. Here the dip is N. 80° E. at an ang of 40°, and the thickness as well as can be observed is six feet. On the north-western side the hill the outcrop is again found, and it is seen also on the further side of a stream whic runs at the foot of the hill. On a bandy-road south-easterly of the Skull Reef there are th ferruginous veins containing numerous cubes of iron-pyrites decomposing into limonite whic are said to be highly auriferous. The "casing" of the reef throughout is generally a talco schist.

There is another reef within the boundaries pointed out to me, west of Wright's Level a one near the Alpha Bungalow. Neither of these has been opened by the Company.

The Mines.

Now that the thick and high grass is burnt on many of the ridges it is comparatively ea to follow the outcrops of the reefs and to discover old native workings. Since this report w commenced I have examined very extensive native workings south and west of Wright Level quite on the edge of the ghât. The ridge southward of the Alpha workings has be sluiced on both sides, and a channel has been cut in the valley about five feet in width a eight feet in depth for a length of more than three hundred yards. There are also numero subsidiary small channels and deep and large excavations. On following the main chan downwards (it commences at the outcrop of the reef at Wright's Level) in a direction 8° sou of west a strong vein of quartz is found nearly three hundred and fifty yards from the Alp workings. One shaft has been sunk here, but the reef has not been excavated. It appears have a strike of N. 30° W., and is probably a continuation of that which crops out in the jun on the further side of a stream trending towards the ghât. The existence of these nat workings and the reef referred to is, I am informed, unknown to the proprietors of the Alp Mine. Surrounding the recent excavation at Wright's Level there are other native workin evidently very ancient. There are several shallow pits and small excavations, and heaps broken quartz are to be seen all along the strike of the reef. At one place, between Wrigh Level and the Skull, there is a shallow pit communicating with an aperture like a chimney which it is probable the quartz was roasted.

Near the Skull and for some distance northwards the workings are numerous, and at Skull itself there is an excavation, the full extent of which cannot be ascertained as the r has fallen: as far as it can be examined it shows a width at the entrance of twenty-nine lin a breadth at the broadest part of fifty-three links; and it measures seventy-five links to mouth of a drive which cannot be followed until some expenditure is incurred in clearing it a securing it. The height of the excavation from flow to roof is twenty-five links. There vertical shafts communicating with this excavation, which no doubt were sunk long before

adit was commenced. The amount of work done on the reef is conclusive proof that the native miners found gold in quantities sufficient to remunerate them. They appear to have dug into the soft casing and taken stone from the footwall, but they did not confine their operations to this part of the reef. They followed the run of gold wherever they were able to do so.

According to the information I have been able to obtain it appears that the Alpha Company commenced their mining operations by quarrying stone in the old native workings at the Skull, where they took out about one hundred tons of quartz. Subsequently they quarried stone near Wright's Level, and then the adit named Wright's Level was driven for a length of about twenty feet.

At a point a little more than ninety feet eastward of Wright's Level and twenty-five feet below it an adit forty-two feet in length, five feet in width, and six feet in height was driven to cut the reef; and the reef is now seen in the "face" where a hole has been sunk in quartz to the depth of five feet. The Company or the Tributers also put down a shaft east of, but quite near, Wright's Level. It was sunk to the depth of forty feet where the reef was struck, and it is said good stone was got from the bottom. Further northward, but still within a few yards of Wright's Level, a shaft was sunk to the depth of sixteen feet and an adit was driven cutting the shaft about five feet from the bottom. This is known as "Harris' Tunnel." On the slope of the range towards the ghât and about three hundred and thirty feet east of "Harris'-Tunnel" another adit was driven evidently for the purpose of cutting the reef. It has been continued for a distance of over fifty feet. It is not timbered, and near the mouth there is a fall of earth. It has intersected a small vein of quartz. It is nearly on the same level as the other adit below Wright's Level. A shallow pit was sunk south of the large excavation at Wright's Level with, I am informed, good results.

Another shaft now filled in and completely covered with broken quartz was sunk on the dip a few feet south of Wright's Level. It was fourteen feet in depth and a drive was put away for a distance of fourteen feet. It is stated that rich stone was got in the shaft and drive. Subsequently rich stone was broken out, it is said, at the north-western corner of the excavation.

The excavation at Wright's Level as it appears at present is eighty feet in length, twenty-two feet in breadth, and from ten to fifteen feet in depth.

Near the excavation at the Skull and about fourteen feet below it some native workings were re-opened by those who had the management of the mines. What is known as "Binny's Level" is situated a little distance northward of the Skull. The reef was cut here about twenty feet from the entrance. Still further northward is "Ryan's Level" which is about twenty-five yards from the battery. A commencement only was made with this work. Indeed it may be described as a hole from which broken quartz—the results of native labor—was carried away to the battery. An adit known as "Withers' Level" not far from the works was driven about fifty feet and then abandoned. It did not cut the reef. It was undertaken prior to the formation of the Alpha Company.

It would seem then that quartz in some quantities was taken and crushed by the Alpha Company and Tributers from the Skull, from the excavation at Wright's Level, and from shallow pits and short adits near Wright's Level; and that seven adits were driven at various points and two shafts sunk which, even where the reef was struck, were, for reasons probably known to the Managers, discontinued. These works, the seven adits, and the two shafts were unproductive, and it would be difficult to discover why they were undertaken at all. Having regard to the position of the battery nothing was to be gained by making adits east of Wright's Level.

It is probable that the Company expended some moneys in other similar works not known to me. I have, however, made every effort to ascertain the facts.

Yield of Gold from Quartz.

It will be apparent from the statements already made that little has been done to develop the reef within the boundaries of the Alpha Company's area or to determine its value. The apparently purposeless scratchings on the surface and the useless expenditure of moneys in driving short adits and sinking shallow pits have not even had the result of proving the character of the reef except at one or two points. It is however evident from the character and extent of the native workings and from experiments made in the laboratory that the stone in some places is highly auriferous.

The yields obtained by myself have been as follows:—

Wright's Level.	OZ.	DWT.	GRS.	
1. No gold visible in the stone at the rate of ...	0	11	6·0	per ton of 2,240 lbs.
2. No gold visible in the stone	2	16	1·6	,, ,, ,,
3. A little gold to be seen	56	13	19·5	,, ,, ,,
4. Gold visible in the stone	204	11	16·7	,, ,, ,,

Large blocks of quartz were broken out at the spot where the stone giving these results was obtained, and in several of these gold was visible. In one or two instances loose gold was found in cavities; and indeed some of the quartz was so rich that if portions of it had been tested the yields would have occasioned excitement amongst persons not acquainted with quartz-mining and unheedful of the cautions and statements which would necessarily have accompanied the report of any such yields. According to the judgment of those well able to form an opinion some of the quartz from the reef near Wright's Level would have yielded at the rate of 1,000 oz. or more per ton. The value of the reef, however, cannot be measured by such results. Where this quartz was obtained the vein is about four feet in thickness, and the heaviest gold is found mostly in the upper part of the vein, as it is now exposed, and near the foot wall, throughout a thickness of two feet only. It is to be followed downwards across the line of dip for a distance of sixty feet where there is good stone showing gold near the footwall. Quartz with pyrites obtained from the adit below Wright's Level, and not on this run of gold, gave at the rate of only 3 dwt. 23·04 grs. per ton.

At the face of the large excavation at the Skull a vertical section of the reef was taken, and the results for the several parts were as follow :—

	Rate per Ton. OZ.	DWT.	GRS.
1. One foot in thickness (hanging wall)	0	0	16·19
2. Three feet in thickness	0	0	9·92
3. Four feet in thickness	0	1	2·20
4. Five feet in thickness	0	2	2·21
5. Six inches in thickness	0	0	4·25

Northward of the excavation and within a few yards of it the run of gold is found, and quartz from that portion yielded at the rate of 1 oz. 4 dwt. 5 grs. per ton.

Mr. W. King, B.A., the Deputy Superintendent of the Geological Survey of India, estimated from preliminary crushings made by him that the yield per ton of the reefs in this district would be 7 dwts.; and he refers to the results obtained by the Tributers who worked at Wright's Level, viz., 11 dwts. and 17 dwts. per ton.

In the table attached to Mr. King's report in the *Records of the Geological Survey of India* (No. 3—1878, Vol. XI) it is stated that 769½ tons crushed by the Alpha Company gave an average yield of 2 dwts. 9 grs. per ton. One large parcel included in this return yielded only 1 dwt. 17 grs. per ton, but another parcel—6½ tons—treated at the Wynaad Prospecting Company's works yielded 19 dwts. 22 grs. per ton.

In a report, dated 2nd April 1875, Mr. King writes as follows :—

"Among the lodes detailed above [referring to a table] the Skull reef about to be mined by the Alpha Company was tried most carefully by seven parcels of quartz obtained from one cross cut through the reef where it is 15 feet wide. There was no gold visible in the sample which gave the proportion of 25·92 dwts. to the ton. This rich proportion of gold is from a band of laminated quartz about 2 feet thick within a couple of feet of the footwall or underside of the reef. The average proportion from this two-feet band would be 22·68 dwts. or taking the 10th, 12th, and 13th feet of the 15-feet cross-cut, from each of which I have samples, we get a proportion of 16 dwts. for what appears to be the richest part of this reef. The work was done by hand and dry crushing."

In a pamphlet entitled "Gold Prospecting in the Wynaad" a table is given which purports to be an extract from a report made by Mr. King. The experiments were made on quartz taken from the Skull reef, and they are as follows :—

"Appearance, Color, &c.	Results.	Depth in cross-cut from back of reef.
Compact, coarse texture, laminated, white color ...	2 dwts. to ton.	1st foot.
Still-white in color but stained with ferruginous matter	2·5 dwts. to ton.	3rd foot.
Whitish, discolored with iron	None.	5th foot.
Whitish, discolored with iron, good color in dish-host in amalgamation	..	7th foot.
Still-white but ferruginous matter	5·18 dwts. to ton.	10th foot.
Highly colored, red and brown, ferruginous, cellular with white iron pyrites; gold visible	19·44 dwts. to ton.	12th foot.
Highly colored, red and brown, washed and amalgamated in my presence by Mr. Withers; gold not visible	25·92 dwts. to ton.	13th foot."

In a printed report made by Mr. R. Lindon to the Directors of the Alpha Company there are results of trials as follow :—

	OZ.	DWT.	GRS.
Quartz from Wright's Level, picked specimens	25	13	0
Quartz from Wright's Level, picked pieces without gold visible.	11	13	0
Quartz from Skull working	0	6	16

It would be altogether injudicious to attempt to give an average from the above results; but they are sufficient to prove that the reef within the boundaries of the Alpha Company's area is in some parts highly auriferous, and, having regard also to the large extent of native workings, that its character is such as to justify a Mining Company in opening it thoroughly with a view to the erection of works for treating the quartz.

The Machinery and Works.

The machinery consists of a battery of fifteen stamps in three groups of five and a fourteen horse-power steam-engine having a tubular boiler and a fire-box constructed to burn coal. It was intended that this engine should drive also a pulverizer and a circular saw, both of which can be connected with the engine and are under the same roof as that which covers the stamps and the engine. The stamps, including the shanks and discs, are said to weigh about 3½ cwt. each, but they appear to be very much heavier. Motion is given to the stamps by cams attached to a shaft. The coffers in which the stampers work have in front of them only (and not at the back) perforated iron plates with 125 holes to the square inch. There are three copper plates four feet six inches in width—one is seventeen inches in length, one three feet eleven inches and the lowest twenty inches. These are divided by ripples. The angle of inclination of the plates is from 3° to 3½°, but they are not even. They bulge a little in some places. The tables are from ten feet eight inches to twenty-six feet in length, each group of stamps having tables of different lengths; each table is in three partitions, seventeen inches in width; the angle of inclination of the tables is 6°. The blankets were nine feet in length, and only nine feet in length of the tables were covered with blankets. The tailings ran through launders to catch-pits.

A small furnace for roasting the tailings, a retorting furnace and kilns for roasting the quartz previous to crushing, complete the list of appliances at the mill.

The information I have received furnishes a melancholy history of the various attempts to work the machinery. When it was erected, it is said, it worked very well, that is to say, the machinery moved smoothly, but it never crushed any such quantities of stone as ought to have been crushed. One day about eight tons of stone were crushed; but the Alpha Company crushed, at the best of times, only seven tons in twenty-four hours, and even this rate would not be maintained. It was found impossible to move the stamps, the pulverizer and the circular saw at the same time. The engine, it is stated, was worked at a pressure of 60 lbs., but it was never possible to keep up steam. It usually took three hours to get up steam. No firewood was stored. It was cut green, and even old wood that was gathered was often quite wet.

The present condition of the battery and tables is, of course, worse than it was when they were erected. The weather and use have injured them; and one of the Managers, in order to re-arrange the tables of the middle battery according to his ideas, cut away one of the main bed-logs, and since that was done the vibration has been so great with the machinery in motion as to shake the tables to pieces. The wood of the tables is shrunken and warped; there are numerous apertures through which water, quicksilver, and amalgam could escape; and I am told that 35 lbs. of quicksilver were found under one table. The fall from the coffers is not on to the plates; there is a space of over an inch between the plates and the edge of the coffers, and even now the course which the water and tailings took as they escaped through this aperture is plainly to be seen under the tables. The fastenings too are bad; the nuts and washers below the coffers do not cover the holes in the plates for the bolts, and the mercury and amalgam fell through the spaces thus exposed. Some of the arms of the drum for the belt connecting the engine with the pulverizer are broken, owing, it is supposed, to their having been screwed up too tightly.

The pulverizer is said to have reduced the tailings to a fine powder, but the quicksilver "floured" owing to the iron pyrites not being properly roasted.

About 10 cwt. of "tailings" could be ground by this machine in a day. Owing to the condition of the machinery I would not deem it prudent to put the pulverizer in motion. It is to be noted that the taps through which the quicksilver or amalgam flows from the pulverizer are made of brass. They are now nearly entirely eaten away.

The Treatment of the Quartz and the Results.

From information furnished by the Directors it appears that mining operations were commenced by the Alpha Company in February 1875 and ceased in March 1876, and that the total quantity of quartz treated from first to last was 779½ tons. The time occupied in crushing and treating this quantity was seven months, including stoppages. The gold obtained weighed 91 oz. 12 dwt. 23 grs., being at the rate of 2 dwt. 8·43 grs. nearly per ton. This is inclusive of six tons and-a-half which were treated at the Wynaad Prospecting Company's Works for the Alpha Company, and which, as already stated, yielded at the rate of 19 dwt. 22 grs. per ton. The average cost of raising quartz was Rs. 2 per ton; the average cost of conveying the stone to the mill was Rs. 1-8-0 per ton, and the average cost of crushing Rs. 1-13-0 per ton. The total cost of raising and crushing quartz is stated to have been Rs. 2,971-6-0.

To these must be added the following items as given in the statements furnished by th Directors :—*Firewood (estimated) Rs. 50 (per week)*; Timbering in the mine, Rs. 150 *blasting-powder, Rs. 700*; and quicksilver (quantity used not known), Rs. 3,000. The cost supervision is set down at Rs. 2,384 for seven months only. The machinery is stated to ha cost Rs. 25,000, and the erecting of it about Rs. 1,800. The construction of roads co Rs. 795-7-7.

The aggregate of these sums, including interest on the capital invested, shows that quarts, for raising, treating, supervision, stores, &c., must have cost more than Rs. 15 per or, to put the matter in another way, that the gold was obtained at an expense of Rs. 127 ounce.

The balance sheet of the Alpha Company, prepared by the Secretaries and Treasur (copy hereto marked A), shows that the sums expended in preliminary expenses were 8,708-4-5, and in supervision, management, &c., Rs. 14,679-11-9; and the only point in statement that is really important is the relatively small sum expended in actual mining ope tions, which under the head of "Mining, Felling, and Storage" is set down as Rs. 11,327-0. The value of the gold got, the result of these operations, is stated at Rs. 3,037-6-3.

The stone treated at the Wynaad Prospecting Company's Works, six tons and a-half, got from the reef at Wright's Level, and it cost for sinking the shaft and raising Rs. 70-10 for breaking Rs. 3-10-0, for conveyance to the Works Rs. 21, and for crushing Rs. 65; total Rs. 160-4-0.

The gold got sold for Rs. 297-6-3. The stone treated by the Alpha Company at their works was not roasted before being sent to the mill; but the "tailings" collected in the settling pits were roasted in a furnace and ground in the pulverizer. I have not been informed as to the results of the treatment of the tailings.

The stone crushed for the Alpha Company at the Wynaad Prospecting Company's Works was roasted before being crushed.

"The Prince of Wales' Quartz Reef Gold Prospecting Company" took possession of the Alpha Works on the 1st June 1877 under an agreement with the Alpha Company. They commenced mining operations on the 17th August 1877 and continued to mine with some interruptions until the end of February 1878. The pecuniary results of this adventure are shown in the balance sheet hereto marked B. The value of the gold got, including specimens, is stated at Rs. 8,132-10-8.

Copies of the reports furnished by the Manager, as well as several papers relating to this Company's proceedings, have been placed in my hands for perusal by one of the proprietors, and I gather the following facts from them :—

Quartz crushed and treated.

	TONS.	Average Yield per Ton. OZ.	DWT.	GRS.
Wright's Level	41			
Skull Reef	63			
	104	0	2	18·5
Skull Reef	12	0	2	5
Wright's Level	50	0	11	19
Do.	50	0	16	12·5
Do.	104	0	14	21·34
Do.	2	0	8	0

The average yield per ton from these parcels was 10 dwts. 12 grs. nearly. Pieces of quartz containing gold were sold for Rs. 1,251-4-0. The "specimens" containing gold got from the parcel of 104 tons are said to have been sold for Rs. 920, and it may be assumed therefore that the stone was very rich.

There is not much information to be obtained as to the mode of treatment pursued by the Alpha Company, but it is stated that the stamper-boxes were charged with quicksilver, not largely, and that they relied mainly on their copper plates and ripples for saving the gold. They used sodium amalgam very freely.

The Manager of the Prince of Wales Tribute Company has furnished many details respecting the mode of treating the quartz when the results of the operations were apparently to some extent satisfactory to the shareholders.

Kilns were built, and the stone before being sent to the mill was roasted. Wood was placed in the kilns and the stone piled thereon and the roasting was continued for forty-eight hours.

He informs me that a small quantity of quicksilver was put in the coffers two or three times a day according to the estimated richness of the stone. On the copper plates 2½ per cent. of sodium amalgam was used with the quicksilver, and in the pulverizer as much as 3 per cent. Still the quicksilver "floured."

Blankets of the ordinary kind were used, and the length covered by the blankets was nine feet. They were washed every half-hour. It seems that all the tables were for this length covered with blankets and the water was allowed to spread itself over the whole.

Water was conveyed to the mill through troughs which discharged into a tank, and an iron pipe, fed from the tank, was fixed in front of the battery. To this were attached smaller pipes provided with taps, two to each battery, and when the supply was sufficient the water must have entered the coffers with great force. The flow, however, was not even, the smaller pipes were often choked with grass, and owing to the troughs or boxes being badly made and improperly placed the water escaped and sometimes there was not sufficient for the tables.

The stone was broken by hand, before being sent to the mill, at a cost of nine annas per ton.

The feeding was very irregular. It happened not seldom that so much quartz was put into a coffer as to stop the action of the stamper, and at other times the coffer was not fed and the disc struck upon and injured the cam.

Oil from the machinery often dropped on the plates and it found its way also into the coffers.

Tailings escaped from the catchpits.

The stone treated, as already mentioned, must have been rich. In one "cleaning up" of a stamp-box coarse pieces of gold were found weighing from 6 grs. to 3 dwts., and of these about thirty were obtained; one piece weighed about 7½ dwts.

Causes of Failure.

The first important step taken by the Alpha Company was to erect machinery, and subsequently they made attempts under the advice of various Managers to open their main reef. As stated in another part of this report, they first quarried stone at the northern portion of it, but no successful northern extension of the reef and subsequently at the southern portion of it, but no successful effort was made to mine systematically. There was consequently unnecessary cost incurred in getting stone, and great cost in conveying it to the mill.

There was no stone-breaking machine at the mill; the stone was broken by hand. There was no self-feeding apparatus; the feeding was irregular, and the platform on which the quartz was delivered was not partitioned off from the stampers and engine. The dust rose sometimes in clouds and fell on the bearers, injuring them and rendering necessary a large supply of oil, &c., for lubricating the various parts of the machinery, some of which often dropped on the plates, thus making effective amalgamation impossible, even if there had not been other detrimental influences in operation.

A great error was committed by the Tribute Company in roasting the quartz in kilns before sending it to the mill. Nearly all the quartz in the reef is more or less pyritous, and the percentage of iron pyrites in several sections probably varies from 0·1 or less to 5 per cent., and when this is placed in a kiln in the manner described elsewhere in this report it is impossible to oxydize the sulphur. The fusible lower sulphides coat the gold and prevent its amalgamation with mercury. The roasted stone I have seen in Devála is often a slag, and any gold in it must be "glazed."

Sodium amalgam appears to have been used in excessive quantities. This amalgam has all the valuable properties ascribed to it by the patentee, Mr. William Crookes, F.R.S.; but the utmost care and caution are necessary in using it in the extraction of gold and silver. A very minute quantity of sodium amalgam added to quicksilver has the effect of rendering the metal more mobile and more "eager" for gold, and therefore it is the more likely to escape from the mill and carry the fine gold with it unless the ripples are properly arranged and other precautions taken.

It was a mistake to put quicksilver in the coffers. The undecomposed pyrites, reduced to powder, would accumulate in the coffers and cause the "sickening" and "flouring" of the mercury. The metal breaking up into minute globules or adhering to the powdered pyrites would be carried away.

If no quicksilver had been put in the coffers, the copper plates might have been dispensed with.

The inclination of the tables was excessive. Instead of 1 in 10 they should have been not more than 1 in 14 or 1 in 16.

The water from the battery (often insufficient) was allowed to spread itself over the whole extent of the tables; whereas, as there was not sufficient water, but under any circumstances, it should have been so regulated as to carry the tailings evenly over the blankets. And the length of the blanketing, nine feet, was not enough. I have been informed that iron pyrites from the Alpha Mill was taken out of the bed of the stream quite 200 yards away, and that it was found to yield 1 oz. to the ton.

Buddles were not used for concentrating the tailings, and a large proportion of the stuff sent to the furnace must have consisted of quartz.

The furnace which was built by the Tributers is unsuitable for treating pyrites.

The steam-engine was never equal to the duty required of it. One of forty-horse power would be needed to drive the stampers and keep in motion the pulverizer, fully charged, and the saw. The Alpha Company and the Tributers are said to have crushed 1,102 tons of quarts in fifteen months: if the machinery had been effective, and if the works had been skilfully managed, at least 11,000 tons should have been reduced in fifteen months.

During the whole period that the works were in operation, when only an average of 3·8 tons were crushed per diem, the expenses of management, dead-work, &c., were running on as well as interest on the capital invested, and it is not a matter for wonder that doing only one-tenth of the work that ought to have been done the two adventures were not remunerative.

The greatest credit, it appears to me, is due however to the projectors for their spirit and enterprise. They failed because they did not first of all commence to mine, and because they had not appliances for saving gold.

How the Operations should be conducted.

A run of gold in the main reef is found at Wright's Level, and this has been followed for a distance of sixty feet. I would advise that in the first instance this run should be followed still further on the underlie—say—if the good stone continues—for 100 feet or 150 feet; that the shaft should be well and safely timbered, and that skids should be put in so that the quarts might be brought to grass with facility. It may be assumed, judging from the stone already taken out, that the quarts from this shaft would yield a fair proportion of gold.

This preliminary work, but productive, would indicate the best site for a main adit, and that will be found at a point on the slope of the ghât eastward of Wright's Level.

This main adit running west should be driven at a low level so as to intersect the reef at a considerable depth below the outcrop on the ridge.

From this adit and other cross-cuts the reef could be mined economically. It could be stoped from different levels quite up to the surface. A site for the battery could be found near the mouth of the main adit. All these undertakings and all arrangements connected with them should be well considered, and the objects in view should be to open the mine on a good plan and to raise a large quantity of stone which, from careful assays, should show such a yield per ton as would justify the erection of machinery.

I recommend that water-power be employed for driving the machinery, either an over-shot wheel or a turbine.

I regret to say that I am not sufficiently acquainted with the laws or regulations in force in India under which water may be diverted, but it would be no doubt practicable to arrange for the diversion of water from the stream near the Wynaad Prospecting Company's Works.

Perhaps reservoirs would have to be constructed for storing water.

The relative cost of using steam and water in this district cannot be fairly estimated by me, as I am ignorant at what cost fuel could be got if proper arrangements were made for procuring it in large quantities, but in mills elsewhere the proportions are—for water about ·2, and for steam 2·1.

There is not much at the Alpha Mill that could be used in any new adventure. The stamps ould be made available, and the coffers seem to be uninjured and might again be set up; but my humble opinion it would be more economical to procure a new plant furnished with all e best appliances than to patch up the machinery at the Alpha.

All patent contrivances that have not been proved to be of value by a lengthened experi-ce should be rejected, and only those adopted that are known to have yielded good results d now find a place in the best-conducted mines.

As well as a battery there would be required—

(*a*) A stone-breaking machine. The smaller pieces of quartz would be separated from the larger and sent direct to the stamps and the latter to the stone-breaking machine.
(*b*) A self-feeding hopper.
(*c*) A buddle for concentrating the "tailings" which are saved in the settling boxes.
(*d*) An inclined reverberatory furnace for roasting the "tailings." This would consist of a fire-box, hearth, &c., and should be on the plan of some of those that have given the best results in Victoria.

The quarts should be crushed raw. Quicksilver should not be used in the coffers, and er platforms are likely to cause a loss of amalgam, and I do not recommend that they

should be employed. Ripples and blanket-strakes will do the work more effectually. The tables should be twenty feet or more in length and about fourteen inches in breadth for each stamp-head; the fall should be about one in sixteen (if a good supply of water is maintained), and they should be coverd with closely-woven green baise.

Experience would, of course, lead to some modifications in the arrangements, but it would not be difficult to adjust the length and fall of the tables so as to meet any conditions that might arise.

Summary.

I have endeavoured to indicate as briefly as possible the causes which prevented the Alpha Company from obtaining profitable results from their adventure. I am satisfied that their machinery and appliances are such as to make it impossible to save the gold even if the best scientific and technical knowledge was brought to bear on the operations. The one fact that oil and grease were allowed to fall on the copper plates and to get into the coffers is sufficient to show what the state of affairs was when the best results were obtained.

The main reef within the area held by the Alpha Company is nearly 2,000 feet in length; it is from 4 to 14 feet (at least) in thickness; in one part the quartz is of extraordinary richness, and other parts have yielded well.

Native miners have picked what must have been auriferous quartz all along the out-crop, and at the "Skull" their excavations are extensive. The position of the reef and the formation of the ground both offer facilities for economical mining.

It appears that the yields of gold have been for 779½ tons of quartz 2 dwts. 9 grs., and for 322·66 tons, 10 dwts. 12 grs.; and the gold was got, as I have shown, under the most disadvantageous circumstances.

These results may be compared with some operations in Australia.

The compilation of mineral statistics was commenced in Victoria in 1860, and from 1860 to 1876 (inclusive) information has been obtained respecting the results of the treatment of 13,402,915 tons of quartz, and the returns show an average yield of 11 dwts. 6·30 grs. per ton. The average yield of gold from 1,011,808 tons crushed in Victoria during the year 1876 was 10 dwt. 13·48 grs. per ton.

The Black Hill Company at Ballarat crushed 283,550 tons, which yielded an average of 2 dwts. 23 grs. per ton and the dividends paid amounted to £23,900. It is stated that the machinery cost £10,030, and that the Company paid £24,235 for "claims" (*i.e.*, land on which to mine).

Other Companies have treated large quantities of quartz yielding averages per ton of 2 dwts. 13·4 grs.; 3 dwts. 6·01 grs.; 3 dwts. 7·89 grs.; and 3 dwts. 18·53 grs., and have paid dividends.

The prices paid by the Alpha Company and Tributers for labor, for timber, and for fire-wood are no criteria to guide me in estimating the costs of mining at Devála. Under skilful management arrangements would be made for procuring all necessary supplies at the minimum cost, but in desultory operations the maximum cost as a matter of course has to be paid.

In reply to the questions in the paper, dated 10th January 1879, No. 42, I can safely say that the want of success of the Alpha Company has not arisen from any peculiar difficulties in separating the gold from the matrix, and I cannot believe the cost of labor or fuel would be so great here as injuriously to affect mining pursuits.

In this report I have omitted all details that appeared to me not necessary to the full elucidation of the questions with which I was instructed to deal.

I have the honor to be,
Sir,
Your most obedient Servant,

(Signed) R. BROUGH SMYTH,
Mining Engineer.

Note.—The late Manager of the Prince of Wales' Tribute Company states that the wages paid for native labor were from four to five annas per diem; the cost of fuel was Rs. 3 per ton; the cost of drilling in hard rock was four annas per foot, and in soft rock two annas per foot; and the cost of driving such adits as are seen here varied from six annas to Rs 3 per foot.

The cost of carrying stone from the "Skull" to the battery was six annas per ton, and the cost of carting stone from Wright's Level to the battery was thirteen annas per ton.

APPENDIX B.

Reports of Lieutenant Nicolson and other Papers relating to Gold in Malabar.

From

W. SHEFFIELD, Esq.,
Principal Collector of Malabar.

Calicut,
10th January 1831.

To

THE SECRETARY to GOVERNMENT,
Revenue Department,
Fort St. George.

I have the honor, with reference to your letter of the 4th instant, to acquaint you, for the information of the Right Honorable the Governor in Council, that I have already charged in my accounts the value of the gold dust procured in this district on account of Government, amounting, as per annexed memorandum, to Rupees 5,287-11-5. Of this quantity, by far the greatest portion has been forwarded to the Presidency; the remainder being 2,908½. New gold fanam's weight, valued at Rs. 1,326-6-2, will be delivered over by me to Mr. Hudleston, who has been instructed to collect as much more gold dust for the use of Government as can be obtained

Places where the Gold Dust was found and the Quantity procured at each Place	Weight in new Gold Fanams.	Rate at which the Gold Dust was purchased per 10 new Gold Fanams' Weight.	Amount Value.
		Rs. A. P.	Rs. A. P.
Carcatode in the Ernád Taluk	3,501½	5 0 0	1,750 12 0
In the Nilambúr valley	2,758½	4 12 0	1,300 14 3
Caraloondy on the sea beach in the Sherraad Taluk	1,561½	4 7 3½	695 7 3
Moonanaad, Moopeynaad, and Nambollacotta in Wynaad	3,657½	4 3 3½	1,537 12 2
Gold fanams transmitted to weigh the gold dust with	10		2 13 9
Total	11,459		5,287 11 5

I beg, however, to state that, in consequence of an increased demand for this valuable commodity, owing to a greater number of persons resorting to this province from the eastern districts of Coimbatore, Madura and Trichinopoly to purchase it, the price has risen in the average 5½ per cent., or from Rupees 4-2-40 to 4-3-35 for ten new gold fanams' weight.

Though gold is found in all the rivers of this district, from the stream which falls into the sea at Elatoor, about eight miles north of Calicut, and as far south as the numerous streams flowing through the Pálghat valley, which at their junction, about 15 miles below Palghatcherry, form the great Ponáni river, some of which reach the southern boundary between Cochin and Malabar, about 110 miles to the southward of Calicut, the places and streams which afford the largest supply of gold dust are the following:—

The Toodakull river, which rises in the Koondah mountains, and after dividing the Walawanád Taluk from the taluk of Neringanaad falls into the great Ponani river at Moochickul, about two miles north-east of Turtullah.

The Arliparambur, a rivulet which flows through Walawanád and part of Neringanaad and joins the Toodakull river about two miles east of Cherpalcheri.

The Arnakyem river, which has its source in the Moorkoorty and Koondah mountains, and forming the boundary between the Ernád and Walawanád taluks, and, passing the towns of Malapuram and Tirurangádi, it meets the sea at Caraloondy.

The Carcatode stream, which rises in the Moorkoorty valley and joins the Arnakyem river near Pynaad in the Ernád Taluk.

The gold found at the places above mentioned is the purest that is procurable in the district, its touch being equal to 9½.

The sea-beach from the town of Parparangady to Caraloondy, and thence to Beypore, extending about eight miles in length, the latter place being seven miles south of Calicut. Here the gold is equal to 8¾, and it is evidently washed down from the mountains during the great freshes in the south-west monsoon, and after being carried out by the flood beyond the

mouths of the Beypore and Caraloondy rivers, it is thrown back by the action of the surf, when the sea runs high and is much agitated by tempestuous weather, and deposited on the sands much higher up than the sea usually reaches when the weather is moderate.

Kutchambara on the bank of the Coodarapoya river, which comes from the Moorkoorty valley and unites with the Beypoor river, about two miles below Nilambúr. The touch of the gold found here and in the bed of the Coodarapoya river is nearly 9½.

The Karumpoya and Poonapoya, or golden river, both which streams take their rise in a high range of mountains called the "Paral Mallah" situated north-east of Moorkoorty and forming part of the main chain of the Nilgiris, and, when collected in one body near Poolliemparra in Wynaad, the stream receives the name of the "Paundypoya;" but this, on its approach near the ghâts, is again divided into two streams, and the main branch, called in the Nilambúr valley the Carumbye, rushes down the Alliampully Cherrum. The Poonapoya descends the mountains between Alliampully and the Caracoor Cherrum; and long before its junction with the Carumbye it receives both the Kellakumpoya and Caracoorpoya.

The Kellakumpoya and Caracoorpoya above mentioned; the former river rushes down from Wynaad into the Nilambúr valley through the Cundaloor Cherrum, and the latter descends from Devála to the right of the road through the Caracoor Pass.

Gold dust is also found on the plains in the Nilambúr valley and frequently on elevated spots, particularly at Teeroowally, a hill near Mainbaatangady, about 150 feet above the level of the Beypoor river, during the highest freshes; and on the slope of this eminence gold is procured some feet below the surface of the ground in pits dug by those who come in search of it.

North of the Beypoor river it is found in the Teeroowambaddy Division of Polwye in a mountain stream, which, descending the ghâts to the left of the road through the Tambercherry Pass, runs through the Tambercherry and Polwye districts and forms a junction with the great Beypoor river between Pawoor and Shirwaddee and opposite to Mapooram in the Ernád Taluk. The touch of the gold found here and of that which is generally procured in the Nilambúr valley is about 8½.

Above the ghâts, in Wynaad, gold is found in Parkureetil, a higher table-land between Manantoddy and Nambollacotta, at a place called Choolloyde in Moonanaad, and at Nellyalom and Ponáni in Moopeynaad. It is likewise found at Devála and its immediate vicinity in Nambollacotta, but the gold of Wynaad is much inferior to that which is washed down from the lofty mountains actually appertaining to the Nilgiris and Khondahs, its touch being only 7½.

The manner in which gold dust is found and separated from the soil is as follows:—The earth or sand in the mountains, hills, paddy fields, and beds of rivers and rivulets known to be impregnated with this valuable ore is dug up, but it is only in or near water, and consequently in running streams, ruts, ravines, and breaks in the mountains and ground into which the course of the water is most likely to drive the ore during the rainy season, that gold is dug for; and, being put into a pantty, a kind of wooden tray hollowed in the centre and not unlike a turtle's shell, the soil is immediately submerged in water just enough to overflow it and no more, and kept in an undulating motion by the washer with one hand, while the earth is stirred up with the other until all the earthy particles are washed entirely out of it and a sediment is left in the hollow, consisting chiefly of a mixture of black sand and particles of iron and gold. The pantty is then taken out of the water, and, one end of it being somewhat elevated, water is gently poured upon its contents until the gold distinctly appears on the border quite divided from the principal mass. The golden particles are separated with a grain or two of quicksilver which is rubbed into them and then put in a piece of tobacco leaf, which, being placed in a crucible, or more generally between two pieces of lighted charcoal, the heat causes the quicksilver to evaporate, and the gold is then taken out in a pure state.

When gold dust is found in streams, a wooden trough about 4 to 4½ feet long and fifteen inches wide is frequently used, and into this the sand or soil from the bed of the river or rivulet is thrown as fast as it is taken out and then washed by the person in charge of the trough, who is constantly stirring the sand with his right hand and pouring a gentle stream of water upon it with his left, until nothing remains but heavy black sand and particles of iron and gold; and when the dust appears on its borders, it is collected with a proportion of quicksilver and then separated in the manner before mentioned.

When gold is found in small pieces, which is often the case in the beds of the several branches of the Beypoor river flowing through the Nilambúr valley before they all unite above Mambaatangady, there is no occasion for quicksilver or heat.

In the rainy season the pantties are worked upon the mountains, hills and other elevated spots; but these places, owing to the want of water to assist the operation, are abandoned at the end of the rains and the pantties are employed during the dry months in the beds of rivers and smaller streams.

The sands on the sea-beach between Parparangady, Caraloondy, and Beypoor are most productive during the months of June, July, August and September, when the rivers which fall into

the sea at Beypoor and Caraloondy are filled by the south-west monsoon; but gold is found here, though in smaller quantities, throughout the year.

There appears no reason whatever to doubt that golden ore is homogeneous to the soil in the mountains and hills of Malabar, and even many elevated spots in the valleys of Nilambúr and Moorkoorty and the immediate vicinity of Devála and the Koondah and Nilgiri mountains; whilst that which is found in the beds of rivers and other mountain streams is fortuitously brought down by the monsoon rains.

Though a very extensive search has been made among the records of my office since I had the honor of receiving the commands of the Right Honorable the Governor, under date the 18th November 1828, to afford information on this subject, I regret to state that I have not succeeded in finding that any endeavour whatsoever was made by the several Collectors since this province accrued to the possession of the Honorable Company, to discover the mines or places whence the gold issues. These, however, appear to have been noticed by the Honorable Mr. Duncan, late Governor of Bombay, who enjoined the authorities then in the province, in the year 1793, to collect and submit to him every information that could be obtained on the subject; but it does not appear upon record that any scientific person was deputed to explore the places where the dust is found in order to trace the sources from whence the supplies are derived, or that any particular inquiry on the subject was set on foot, though it has been well known from the earliest period that gold is produced in the province, and the collecting of it has been farmed out in Wynaad and the Nilambúr valley for the last forty or fifty years.

Agreement between Harry Louis Hugnenin, Native of Switzerland, and the Right Honorable Stephen Rumbold Lushington, Governor of Madras and its Dependencies.

I, Henry Louis Hugnenin, do hereby engage to search for gold mines in the mountains on the Malabar Coast on the following conditions:—

1*st*.—That the search be conducted at the expense of Government and that I receive all reasonable assistance and countenance from the local authorities.

2*nd*.—That my proceedings shall be under the superintendence of such controlling authority as the Government may be pleased to appoint.

3*rd*.—That I shall receive one half of the gold I may assist in finding and raising during the next twelve months and the same proportion of all gold I may collect from the mountain streams, &c., by washing. It shall, however, be optional with the Government to take my share of the produce at the market-price of gold and to renew this privilege in my favor for another year if they shall think fit.

(Signed) H. L. HUGNENIN,
Horloger.

Dated 16th February 1831.

By order of the Right Honorable Stephen Rumbold Lushington, Governor of Madras.

(Signed) H. CHAMIER,
Secretary to Government.

Witnessed.

(Signed) J. LUSHINGTON,
Private Secretary.

(A true Copy.)

(Signed) H. CHAMIER,
Secretary to Government.

DEVÁLACOTTAH,
18th April 1831.

FROM

LIEUTENANT W. NICOLSON,
49th Regiment, N.I.,

To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—In obedience to the orders contained in your letter of the 12th instant at Ootacamund, I have the honor to acquaint you, for the information of Government, that I met Mr. Hugnenin at this place on the 16th instant, and that, after all due consultation with him and minute inquiries from the natives into the causes, times, and places of fever about this part of the country, I am of opinion that nothing whatever is to be apprehended on that score until the setting in of the heavy rains in June, and scarcely even then if proper precautions are taken to prevent it.

The country in our immediate vicinity is entirely free from jungle with the exception of a few hills presenting nearly the same features as some parts of the Nilgiris. The thermometer ranges between 71° and 82° in the 24 hours. There does not appear at present to be any unhealthy symptoms among the natives, nor are there any to be feared by their accounts during the *heaviest rains*, but merely at their commencement and ceasing, that is, during the months of June and September. The monsoon, however, is the most favorable time for the collection of gold dust in consequence of its being then brought down in large quantities by the mountain torrents; for during the rainy season the quantity washed by one person daily varies from the value of 3 to 6 rupees, and during the dry season scarcely from 1 to 2 rupees, so that justice can scarcely be done to the undertaking if the possibility of the rains affecting the health of those employed be considered an objection to it.

I now beg to inform you that there are three mountains near this in which Mr. Hugnenin is confident of finding quantities of gold. The one which he intends commencing is called Chulimally by some, and Vellimally by others, of the natives; it contains the sources of several streams flowing into a branch of the Beypoor river near Carcare in which streams a great quantity of the gold dust of this district is collected. In Arrowsmith's Map this place is marked Diencote, about 12 miles from Goodaloor, a little to the southward of the main road to Manantoddy, and the mountain in question is about three miles further south. There is nothing however in the shape of a road, nor even a path to be found towards it, and from the abruptness of the intermediate hills and rocks the way is in some parts utterly impassable for cattle, so that in the first instance a practicable path must be cut for the supplies of a bazaar, as there are no provisions to be found even in this village, which scarcely contains a dozen huts.

I have the honor to enclose a list of workmen which will be required to place all things in readiness for commencing operations immediately. In the first instance I have the honor to submit that I conceive thirty men at least requisite to carry on the work with certainty and expedition, the whole to be employed at first in hutting themselves and making a practicable pathway to the mountain, and afterwards 15 as miners and 15 in washing the sand and searching for gold dust in the rivers. I also beg to to add that, if an intelligent native officer was detached with the party, he would be of the greatest assistance to me in overlooking one party while I am with the other, &c. These circumstances, however, will of course remain for your consideration and decision.

I have the honor to be,
Sir,
Your most obedient humble Servant,

(Signed) W. NICOLSON, Lieut.,
49th Regiment, N.I.

List of Workmen required.

One bricklayer for the construction and repairs of smelting furnaces and reverberatories.

One carpenter for the construction and repairs of wooden washing bowls and all wood work required for the mining implements, &c.

One smith and one bellowsman.

Two wood-cutters for the supply of the reverberatories and smelting furnaces.

(Signed) W. NICOLSON, Lieut.,
49th Regiment, N.I.

DEVÁLACOTTAH,
18th April 1831.

DEVÁLACOTTAH,
22nd April 1831.

From

LIEUTENANT W. NICOLSON,
49th Regiment, Native Infantry,

To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—I have the honor to acknowledge the receipt of yours of the 20th instant, and, in reply, beg to state that the tools required for the men will depend entirely on the number of men sent. I consider that the chests of mining tools should be allowed at least six men each, and that a spade, a momety, and a pickaxe will be required for every man beyond that number with a supply of baskets for carrying earth, observing at the same time that the more hands available, the more expeditious will be our operations.

I have now the honor to acquaint you, for the information of Government, that Mr. Hugnenin and myself proceeded yesterday for the third time to the Chulimally mountain for the purpose of searching for an old mine which, it seems, was worked long before the Honorable Company obtained possession of this part of the country, the fearful probability of which event, it is said, induced the Rajah of that day to abandon the mine for the time being from a dread of losing it altogether, and, making the business a State secret, he issued orders that no one on pain of death was to approach the mountain, on which, I am here told, he let loose as many wild beasts as he could procure. How far this account may be true is difficult to say. We have not as yet, however, succeeded in persuading a single villager to accompany us to the mountain in consequence of the above belief.

I now proceed to acquaint you that yesterday, after cutting our way for several hours in the thickest part of the jungle on the mountain, we came upon the mine in question, consisting of three shafts about five feet each in diameter and 10 from each other, forming an equilateral triangle, the deepest of them extending to about 70 feet, since a stone dropped in took about 4½ seconds to reach the bottom; the depth, however, has no doubt greatly decreased by the effects of rotten vegetation, &c. On further search we soon found that this mine was not the only one, for, having penetrated as far as we possibly could through the jungle towards the *summit* of the mountain, we discovered no less than 27 shafts, all sunk in the same manner and forming a chain of triangles as before described, the disposition of which with regard to each other leads me to suppose that they have all subterraneous countershafts communicating with each other and probably extending to a large main shaft which, I trust, may be discovered on the arrival of the pioneers. How these mines could have remained so long a secret appears surprising; however it is certain that had not a descendant of the above said Rajah mentioned all these circumstances to Mr. Hugnenin and made the contract herein enclosed, which he was unable to fulfil for want of sufficient capital, the mountain would of course have still remained unknown. I have the honor to forward a few specimens of minerals which I found on the surface near the shafts, as also a small quantity of gold dust, the result of Mr. Hugnenin washing the earth for a few hours on the same spot.

I now beg to conclude by stating that I am perfectly satisfied in my mind that any *labor* or *expense* whatever that may be incurred in this undertaking will be most amply repaid hereafter.

I have the honor to be
Sir,
Your most obedient humble Servant,

(Signed) W. NICOLSON, Lieut.,
49th Regiment, N. I.

This morning I came accross the new road to the Nilgiris.

The Moorkooty hills bear from hence east-north-east about 12 miles; Paratmala hills north-east 30 miles; Munoor ghat east-south-east, 40 miles. The Cherrunhoya is *navigable even now* 10 miles beyond Oorumpooum, from which place I have just now come down in a dhony.

Yours, &c.,

(Signed) W. NICOLSON.

Karcatode is about six miles south-east of Manjury on the bank of the river.
Mr. Hugnenin joined me on the 10th all right.

MADRAS,
27th September 1831.

EXTRACT.

THESE minerals are of a class so generally known and understood that I have only to give them their proper designations, and you will find them described at length in any mineralogical work you may happen to have in your possession.

The mineral marked "copper mica" is what mineralogists usually call "mica." It is found very abundantly in India. It separates into many thin laminæ, and in that state is transparent and is the article with which the natives form those lanthorns that are exhibited in their festivals. It forms one of the component parts of the stones called granite and gneiss and constitutes a considerable portion of the bulk of the globe.

The component parts of this mineral have been so frequently ascertained by the first chemist in Europe that I conclude the Right Honorable the Governor would be disposed to rely more on their analysis than mine.

One by Dr. Ure is as follows:—

Silix	47
Alumina	22
Oxide of iron	15·50
Oxide of manganise	1·75
Potash	14·50
	100·75

The two other specimens are likewise sub-species of the same mineral and are both called chlorite by mineralogists. Although of different colors, they are of the same sub-species. I have examined both these minerals and have found them so nearly the same that I am rather inclined to ascribe the difference to some slight inaccuracy in the process (arising chiefly from a want of a proper apparatus for this purpose, and perhaps also in some degree to a want of tact on my own part in conducting the process) than to any considerable difference between them.

My analysis is as follows:—

Silix	36
Alumina	38
Oxide of iron	6
Maker	12·5
Potash, Oxide of manganise, Magnesia	7·5
Loss	100

The last three substances I have not the means of collecting and ascertaining with precision, but I have no doubt that their proportions are in the order in which they stand. Potash most, manganise less, and magnesia least of all; indeed of the last there was only a trace.

Thus briefly to recapitulate:—

1. The mineral marked "copper mica" is the ordinary mineral called "mica" and does not contain any copper.
2. The earth marked "mineral gum paint" is chlorite, a sub-species of mica. This and the following earth you will find described in books under the name of chlorite; "mineral gum paint" or the paint called "mineral gum" is a pigment derived from copper and is an artificial, and not a natural production.
3. The earth marked "metallic clay" derives that shining and metallic appearance from the undecomposed mica it contains. It is another variety of the same sub-species as the last mineral chlorite. It contains neither verdigris nor arsenic. The smell arising from these earths is common to all earths of this kind.

I should have acknowledged the receipt of your letter and of the minerals immediately after they came to hand, but in consequence of indisposition I had gone as far as Porto-Novo for change of air, and, hearing then that the Governor had left the Hills, I did not know where to address a letter that was likely to reach you before you arrived at Madras. I hope you will consider this a sufficient apology for the delay.

(Signed) W. BARNISTER.

(True Extract.)

(Signed) R. CREWE, Major.

NADGHAINEY, CARCOOR PASS,
16th November 1831.

From LIEUTENANT W. NICOLSON,
49th Regiment, Native Infantry,

To MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—I have the honor to report that the Havildar's party of pioneers under my orders arrived here on the 7th instant and are as yet employed in hutting themselves, with the exception of two or three, who take their daily routine of duty on learning the method of washing for gold in this district, as I have obtained for that purpose from a ryot in the neighbourhood the services of the head Kuroombar in his employ during the absence of Mr. Hugnenin, from whom I have not yet heard.

I trust ere long to have the honor of seeing you here, as it is almost impossible to give you any adequate idea on paper of the nature of the work requisite and of the small number of men I have to perform it with. Gold there is in all directions—*every nullah in the neighbourhood contains it*—and I have no doubt we shall collect a good quantity as soon as the washing trays, &c., arrive from Calicut, as I have only been able to procure one tray from the natives to teach the pioneers with.

I have to add that a direct road to Chulimally from hence cannot be made without an excessive loss of time at present, particularly as I find there is little or no water on the mountain just now, without which the work cannot proceed, and during the dry season should at any rate be confined to the big rivers and nullahs.

No sickness has as yet made its appearance in the detachment.

I have the honor to be,
Sir,
Your most obedient and humble servant,

(Signed) W. NICOLSON, Lieut.,
49th Regiment, N. I.

CAAPUL GOLD MINES,
NERR MOMBOATANGADY,
3rd January 1832.

From

LIEUTENANT W. NICOLSON,
Superintending Gold Mines,

To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—I have the honor to report, for the information of Government, that, having arrived at Carcatode on the 10th ultimo, we continued our researches for the most lucrative places for gold in that neighbourhood until the 24th, when it became evident from the daily average of work that it was not worthwhile remaining there, at any rate at this season. The place seems famed for gold in consequence of the *superior touch* of the small quantity found there, a circumstance which greatly affects the nominal value of the metal to be found elsewhere, a great deal of which is sold by the natives as Carcatode gold. The nature of the work in that direction will be found in the detailed reports I shall duly have the honor of forwarding.

I have now to add that with the view of pursuing the search throughout the Nilambúr Valley we arrived at this place on the 26th ultimo and were not a little surprised at finding a regular set of mines worked by five or six hundred Moplahs, who (if their headmen could be believed), are obliged to give one barley corn weight of gold *per man* to the Zemindar per day, by which a direct daily tax of about twenty rupees is levied by him without his paying anything to Government. On our arrival the whole of the Moplahs made off; but, in consequence of my issuing proclamations that in continuing their work they should meet no molestation, a great number have returned to the mines. These works are very extensive; the shafts are generally from ten to fifty feet, and the deeper they are the greater is the quantity of gold to be found, the only impediment to the work being the continual accumulation of water which they have no idea whatever of raising, but by assembling in great numbers with chatties. We could easily employ bamboo syphons for this purpose; but, as our work would be overlooked by the Moplahs, they would not fail instantly to apply the syphon to all the other mines in the neighbourhood to our great disadvantage hereafter. Therefore, until we have a sufficient number of workmen and are sufficiently strong in pioneers or others to place guards over the mines, we cannot work them to any great advantage.

It will at once appear evident that when five or six hundred men find it worth their while to work with the miserable and slovenly apparatus they possess, and with which the very least each man can possibly find is the weight of the third of a gold fanam per day, which trifling day's work *very seldom* happens (as the quantity found by one man daily varies from that just mentioned to the weight of ten gold fanams, on which occasion the mud is always taken from the deepest shafts); it will then, as above mentioned, appear evident that, were these mines systematically worked on the European principle, the quantity of gold to be had would be very considerable. But situated as I am without the above means and with so small a party, we can do little more than as many of the natives, and can only for the present continue the search for the most lucrative mines in the district and for those places where it may be worth while for Government to keep up regular mining establishments, amongst which number these mines

may most undoubtedly be classed. The pioneers have collected nearly an ounce of gold during the week they have been here, and, had I the regular European apparatus, this *ounce* would, I have no doubt, have been a *pound*. This will be duly forwarded to yourself or the Collector as you may desire.

I have the honor to be,
Sir,
Your most obedient servant,

(Signed) W. NICOLSON, Lieut.,
Superintending, Gold Mines.

CAREMBAT JUNGLE NEAR CARCOOR,
25th January 1832.

From

LIEUTENANT W. NICOLSON,
Superintendent, Search for Gold Mines,

To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—In continuation of my reports for the information of Government, I have now the honor to acquaint you that the Moplahs at the Coopal mines having commenced a system of devastation in filling up the shafts, &c., I have been under the necessity of applying to the Collector for a Havildar guard, on the arrival of which at Coopal (having heard that the same system of depredation was going on in the mines in this direction for the purpose of giving us every possible difficulty and impediment in our search), I immediately left half my party at Coopal under the command of the Pioneers' Havildar with the necessary orders for protecting the works, &c., while I am continuing the search and endeavouring to prevent injury being done to the mines in this neighbourhood, which are said to be very numerous and much richer than those at Coopal. As yet, however, we have only come upon one which is in a mountain called "Combalamally," one of the Chulimally range close under Nellialum.

The average quantity of gold to be found in this mine may be taken at about a gold fanam weight per man daily, but in consequence of the constant search we are making in the jungles for the best mines we have no time for gold washing.

I take this opportunity of a party returning to Ootacamund, who have brought pay for the detachment, to forward to you by them the gold which has been found by the Pioneers up to this date in searching the Nilambúr Valley. The situations of the richest mines I shall duly have the honor to forward in a rough map.

In now again submitting for consideration the necessity of my party being increased, I trust I may not be accused of presumption in suggesting the expediency of teaching the whole corps of Pioneers the methods of washing for gold and furnishing them with trays accordingly, a system which, if well followed up, would no doubt lead to the discovery of many valuable mines, particularly in the Koondar and Moorkooty hills, *to which we have fairly traced the strata which contain yold in that direction.* It may be as well to remark *en passant* that the above-mentioned trays are very light, and with a little ingenuity would form a much more comfortable and useful covering for the head for men who are exposed to the sun the whole day than the cap they now possess. The quantity of gold sent herewith is as follows:—

From the Coopal mines three ingots weighing thirty-nine new gold fanams and seven barley corns (touch 9).
From the Killarkumpoya and Poonapoya rivers, Nilambúr Valley, three ingots weighing thirty new gold fanams, five barley corns (touch 8½).
From the Kakatode and Cherrumpoya rivers under the Moorkooty hills one ingot weighing thirteen new gold fanams (touch 9½).

Total sent eighty-three new gold fanam weight; a small quantity of gold dust remains, but as it is not melted and therefore very liable to be lost I have not sent it.

I have the honor to be,
Sir,
Your most obedient servant,

(Signed) W. NICOLSON, Lieut.,
Superintendent, Search for Gold Mines.

No. 37.

FINANCIAL DEPARTMENT,
Fort St. George,
3rd February 1832.

From

THE HON. H. CHAMIER,
Chief Secretary,

To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—I am directed to acknowledge the receipt of your letter of the 7th ultimo, and to transmit to you the report of the Mint Master's Assayer on the three specimens of gold received from Lieutenant Nicolson.

The specimens were sent to the Mint without any communication of the cost of the several pieces as noted in the card attached to each, but with orders to report both as to the touch and real value of each. You will perceive from the memorandum given below that the value of each is greater than the cost, and if you are satisfied that the cost is correctly reported, it is obvious that the purchase at the prices specified will be advantageous to Government, especially of the gold from the Coopal mines :—

Specimens.	Weight.	Fineness.	Touch.		Value as stated by the Assayer.	Cost as stated by Lieutenant Nicolson.	Gain in Value.	Value of an Ounce of Gold of this fineness.
1	2	3	4		5	6	7	8
	DWTS. GRS.	C. GRS.			RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
No. 1, Coopal Mines ..	2 14	B 1 3¼	Gold	99·22	5 9 5	4 4 0	1 5 5	43 4 6
			Silver	0·78				
				100 0				
No. 2, Nilambúr Mines ..	3 4	B 0 2¾	Gold	94·53	5 8 6	5 12 0	0 12 6	41 4 0
			Silver	5·47				
				100·0				
No. 3, Devála Mines ..	3 2	W 3¼	Gold	90·88	6 1 10	5 0 0	1 1 10	39 10 6
			Silver	8·86				
			Copper.. ..	0·26				
				100·0				

You will be pleased to preserve carefully the assayed specimens herewith transmitted and communicate with the Principal Collector of Malabar on the subject of the best mode of obtaining the gold on account of Government, which he will be fully qualified to state when he shall have ascertained in whom the ownership of the several mines is vested, and what claims require to be satisfied before undisputed possession of the mines or their produce can be obtained. A copy of the letter addressed to him under this date is herewith transmitted for your information.

I have the honor to be,
Sir,
Your most obedient servant,

(Signed) H. CHAMIER,
Chief Secretary.

ARECOTE,
24th February 1832.

From

LIEUTENANT W. NICOLSON,
Superintendent, Search for Gold,

To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—For the further information of Government I have now the honor to report our return to the Coopal mines after having duly searched as much of the Nilambúr Valley as the jungle has permitted us to penetrate, and I am happy [redacted] ve been as successful as could be wished. The mines in that direction are innumerable [redacted] incipal ones are, however, in the thickest part of the jungle immediately under the Wynaad hills and near the following villages belonging to the Teroopad of Nilambúr, viz., Carembat, Katchapara, Moondairy, and Maneecoote. The Carembat jungle is mined throughout wherever the ground will admit of water being supplied from the neighbouring rivers, this being the only thing requisite, as the whole of the soil under the hills contains gold, the quality of which is much the same as the specimen I have had the honor to forward labelled "from the Nilambúr Rajah's mine." This you will perceive by a small specimen herein enclosed (weight six new gold fanams) cost 2 rupees 4 annas.

I now beg to state that, in consequence of an intimation from the Collector of Malabar requesting to see me respecting further operations, I am proceeding to Calicut, where I shall have the honor to await your further orders.

I have the honor to be,
Sir,
Your most obedient servant,

(Signed) W. NICOLSON, Lieutenant,
Superintendent, Search for Gold.

CALICUT,
3rd March 1832.

From

LIEUTENANT W. NICOLSON,
Superintendent, Search for Gold,

To

THE PRINCIPAL COLLECTOR OF MALABAR.

SIR,—In reply to yours of the 1st instant, and with reference to the communications therein contained from Government, I have the honor to state that my having obtained at such low prices the specimens of gold lately forwarded to Government arises from my having purchased them from *the gold-washers themselves* previous to their getting into the hands of the Swookars, whose customary profits would have otherwise made them much dearer; but it appears that a slight inadvertency has occurred in consequence of my not having had the means of determining the exact proportion of each specimen to an ounce, which circumstance has caused a slight overcharge of the specimens from Nilambúr and Wynaad, and an undercharge of the specimen from Coopal. This, however, does not affect the cost of the whole, viz., Rs. 15, nor its value according to the Mint Master's report, viz., 18-3-9; and if people were stationed at the several mines to purchase the gold on account of Government, they could obtain it at the following rates :—

	Per Ounce.	Value according to the Mint Master's Report.
	RS.	RS. A. P.
In Wynaad	32	39 10 6
In the Nilambur Valley	34	41 4 0
At Coopal and Kakatode	36	43 0 0

If required to be melted into ingots four annas per ounce must be added for goldsmith's hire and borax, so that the purchase of Wynaad gold will yield a profit of upwards of 23 per cent., Nilambur gold 20 per cent., and Coopal gold 19 per cent.

I have the honor to be,
Sir,
Your most obedient servant,

(Signed) W. NICOLSON, Lieutenant,
Superintendent, Search for Gold.

CANNANORE,
28th *March* 1832.

From

LIEUTENANT W. NICOLSON,
49th Regiment Native Infantry,

To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—In further continuation of my reports for the information of Government, I have the honor to acquaint you that another severe attack of jungle fever shortly after my arrival at Calicut rendered it necessary, in the opinion of the medical officer, that I should be removed to this station in order to be in readiness to meet the probable necessity of my being obliged to embark on a long sea voyage for England for the recovery of my health.

With regard to the gold mines which we have already discovered, and the best means of obtaining the greatest possible quantity of gold on account of Government, I beg to observe that it appears to me—

1*st*.—That the only people who can be employed with advantage on account of the insalubrity of the climate are those who are resident at the several spots where the mines are situated and who have been accustomed to the work.

2*nd*.—That these people may be overlooked and controlled by trusty natives and peons stationed at the different mines and placed under the general superintendence of a European officer, who might visit them occasionally.

3*rd*.—That from the application of machinery to the mines, such as pumps, stamping mills, washing troughs, &c., Government might reap the greatest possible advantages, as these would enable the mines to procure a much greater quantity of gold than they now do, when Government might not lay only a heavy tax on the workmen without distressing them, but also have an opportunity of purchasing a larger proportion of gold at the rates which I have already had the honor to submit.

Whether the machinery required could be made up in this country so lasting or so cheap as in England may be considered doubtful. I would therefore beg to suggest that, under existing circumstances, I may be permitted to proceed at once to England for the purpose of procuring such machinery as may be requisite, a measure which would not only facilitate the end in view, but would also tend so much to the restoration of my health as to enable me to continue the researches so successfully commenced.

My present state of health not admitting of my drawing out of a plan of the situation of the different mines already discovered, I have marked them out in map belonging to the Principal Collector in Malabar and Canara, which is all I am at present able to do, being confined to my bed and not able to put pen to paper further than to sign my name, and I am indebted to a friend with whom I am living for drawing up what I have now the honor to forward.

In conclusion I beg to bring to the notice of Government that the allowances which I have hitherto drawn as a Pioneer Officer have been far below the outlays I have been put to in order to obtain the information I have already had the honor to forward to Government, having not only had to contend with every imaginable difficulty that could be thrown in my way by the natives (and which could scarcely ever be overcome without heavy bribes, presents, &c.,) but also having been put to considerable expense for guides, coolies, stationery, servants, horses, &c., for which I trust that Government, with their usual liberality, will deem it expedient to grant me an increase of allowances from the date of my appointment, or such other remuneration as they may think fit.

I have the honor to be,
Sir,
Your most obedient, humble servant,

(Signed) W. NICOLSON, Lieutenant,
49th Regiment Native Infantry.

OOTACAMUND,
17*th July* 1832.

From

LIEUTENANT W. NICOLSON,
Superintendent, Search for Gold,

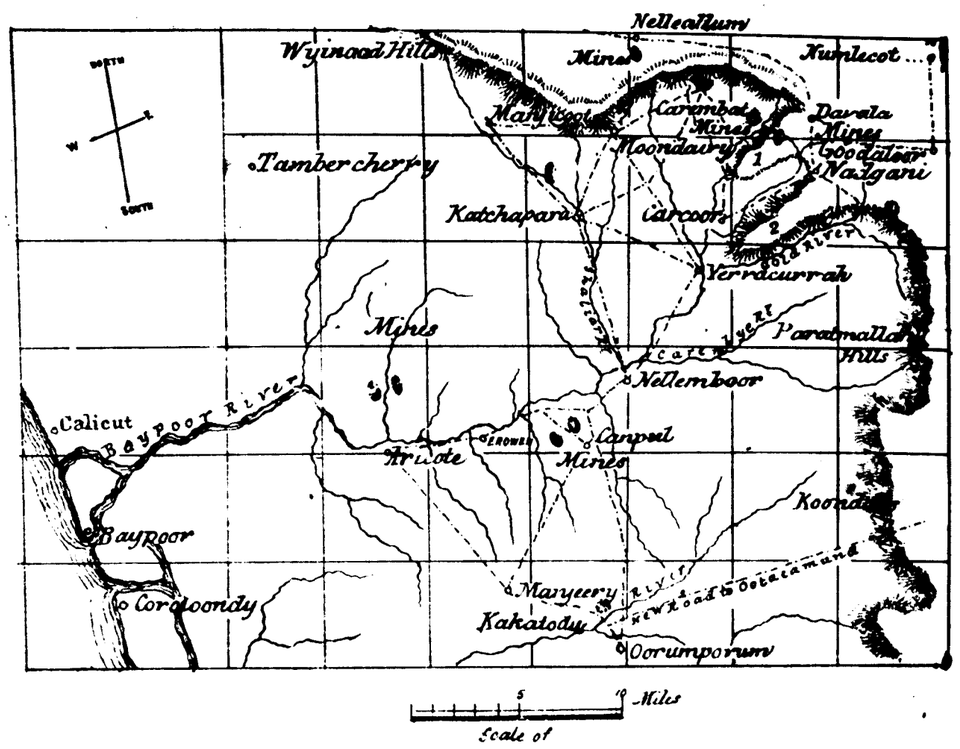
To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—I have the honor to acquaint you, for the information of Government, that having sufficiently recovered my health during my voyage round from Cannanore to Madras, I have

The largest mines are at Coopal and Carembat. All the rivers produce gold, and wherever the *gold ink* has been used mines have been discovered.

(Signed) W. NICOLSON, Lieutenant.



Paths through the jungle.
1. *Chulinally.*
2. *Carcoor Cherrum.*

The gold fields shewn in gold ink by Lieut Nicolson are marked in this tracing by blue dots.

15th July 1832.

Surveyor Genl's Office
Madras Dec. 1832

returned to the prosecution of my duties in the search for gold, on which subject I now beg to forward the following communications.

During my progress to the hills by the Salem road, the first place that I could get any tidings of gold being found at was Dharmapuri at the foot of the Shevaroy Hills, afterwards Satyamangalam, Denkanikota, Addivaram or Stremogay, and Mettapoliem, in the neighbourhood of which there are, I am informed, *now* about *thirty people* employed in gold-washing. It is therefore to be hoped we shall meet with the same success as heretofore on situations and at such elevations amongst the hills as will preclude our being again laid up with fever.

I have now to observe that in all large bazaars where there is a great demand for gold its *commercial value* far exceeds its real value as reported by the Mint Master; for instance, gold of 9 touch is generally sold in the Madras bazaar at 15 rupees for the weight of one rupee; which is at the rate of 50 rupees per ounce (troy), since that quantity weighs 3⅓ rupees, while its value as reported by the Mint Master is only Rs. 41-4-0. Now the original cost at the mines being 34 rupees (for 9 touch), per ounce, it follows that the profit to be obtained in a *commercial point of view* is nearly 50 per cent., while the real value of the metal at the Mint only gives a profit of about 23 per cent. on the prime cost, thus showing the infallible advantages that must accrue to Government from their monopolizing the sale of gold, wherever it is to be found, by purchasing it *direct from the miners* before it can possibly get into other hands.

The method of carrying such a monopoly into effect *you* will, of course, be the best judge of. From the experience *I* have now had, however, I am of opinion that it will be impossible for Government to procure the whole or even half of the gold that is actually found unless the utmost vigilance is kept up by small detachments at the different mines to prevent the gold being smuggled or purchased by the native merchants, who are always on attendance for the produce of every day's work, and for which they *never pay the workmen in coin*, but in articles of food, raiment, &c., on which *again* they charge a very great percentage, so that their profits must be enormous; and as they are in the habit of using false weights, such as introducing lead into the grains of paddy with which the gold is weighed, and various other modes of extortion, the gold brought by these Swodkars does not probably cost them more than half what *I* paid for it. The whole of the miners appeared to be entirely at the mercy of these merchants, and were obliged to give them over every rupee they received from me. It is therefore to be supposed that if these merchants had nothing to say to the miners, the gold would be sold at a much cheaper rate than that at which *I* purchased it.

What may be the actual quantity to be daily procured it is impossible to say until Government take means for preventing the metal from having *any* other outlet from the miners than Government servants stationed there to purchase it. It must be nevertheless evident that a little machinery would greatly increase the quantity to be procured; for instance, their present mode of crushing the ore is by breaking one piece against another until there is a sufficient quantity of dust to fill a tray, which slow mode of working does not allow them to wash more than three or four trays full per man in the course of the day, whereas with pumps and stamping mills they might probably wash ten times that number. No fear can reasonably be entertained of the mines *failing* or becoming *exhausted*, since the whole country for a circle of nearly fifty miles *immediately under the ghats* contains gold.

In addition to the profits I have above enumerated there is also that of the tax which appears to have been hitherto raised by the Zemindars of districts unknown to Government authorities. This tax varies from one paddyweight of gold per man to one paddyweight of gold for three men, according to the produce of the mine. At Coopal it is a paddycorn weight per man daily. I have had the honor to forward a small map of the situations of the mines as yet discovered, which I can make out on a larger scale if required; and in conclusion I beg to forward a memorandum of the extra expenses and losses I have sustained during the search, and to solicit the consideration of Government for my future allowances and instructions for my future proceedings.

I have the honor to be,
Sir,
Your most obedient, humble servant,

(Signed) W. NICOLSON, Lieutenant,
Superintendent, Search for Gold.

OOTACAMUND,
1st *October* 1832.

From

LIEUTENANT W. NICOLSON,
Superintending Gold Mines in Malabar,

To

MAJOR R. CREWE,
Commanding Nilgiris.

SIR,—With reference to the Minute of Council of the 31st August last respecting the gold mines in Malabar, I have the honor to request you will be pleased to signify my most grateful acknowledgments for the readiness and liberality with which Government have repaid my humble endeavors, and I now beg to forward a few suggestions for the future management of the mines. With regard to the choice of mines, those at Coopal would seem, all things considered, to be as good as any for commencing operations on; but although the party and tools which were furnished me last year *were sufficient for searching the country*, I have already had the honor to state that nothing can possibly be accomplished *on a grand scale* without the common machinery requisite for working any mine in the world, viz., *pumps* for raising the water out of the shafts, *cranes* for craning up the ore and earth, *stamping mills* for crushing it, troughs for washing it, and (if the metal is required in bars) apparatus for melting it. All the other implements requisite are contained in the mining chests of tools forwarded by Government, of which, however, a much greater number will be now necessary in order to furnish the miners with them; and I should think that in addition to the two chests already sent from Madras if *ten more* be now despatched to Coopal they will not be found too many. Carpenters and Smiths (for the repairs of these articles and the construction of scaffolding, &c.,) will of course be necessary. Three-inch cylinder pumps may be procured at Mr. Law's depôt on the Mount Road at 250 rupees each (the price in London is, I believe, £10.)

Cranes I understand may be made up at Palghat, to which place Mr. Hugnenin and myself are now proceeding, but the greatest requisites are *stamping mills* and *steam engines*, neither of which I fear can be made up in India unless at enormous expenses, and they could never of course be compared to those of English manufacture.

Without the articles above mentioned all that can be done in the present state of the mines is to see that the whole of the gold that is found be purchased on account of Government instead of its going to the Nairs, &c., as hitherto; and this circumstance will greatly depend on the strict *honesty* and *trustworthiness* of the native civil authorities attached to the party in counteracting the tricks, obstacles, and difficulties continually thrown in our way by those who have hitherto shared in the profits of the mines, and who will now find themselves obliged to give up these profits to Government. I have now to add that it is of the utmost importance that quarters rendered secure from the night air and dews should be erected for those employed at the mines, without which it is next to an impossibility that the climate can be withstood *for any length* of time by any but the natives of the district in that neighbourhood; it is, I presume needless to say that the Revenue Officer who attends on the party should always be provided with a sufficient sum for purchasing daily the quantity of gold found in the mines by the Moplahs.

In conclusion I most respectfully beg to submit that a sight of these mines would do more than all I can write on the subject, and I therefore humbly beg to suggest that a committee of such competent persons as Government may deem fit may assemble at Coopal with a view to the full consideration of the circumstances I have above-mentioned and of the plans which I have now the honor to submit for the future management of the mines.

I have the honor to be,
Sir,
Your most obedient, humble servant,

(Signed) W. NICOLSON, Lieutenant,
Superintending Gold Mines in Malabar.

OOTACAMUND,
6th *October* 1832.

From

MAJOR R. CREWE,
Commanding Nilgiris,

To

THE CHIEF SECRETARY TO GOVERNMENT,
Fort St. George.

SIR,—As relates to the Minutes of Consultation, under date 31st August last, the purport of which was duly communicated to Lieutenant Nicolson, I now beg to enclose a communication from that officer connected with the labors of the approaching season at the Coopal mine

and I take the liberty of respectfully submitting for the consideration of the Right Honorable the Governor in Council—

That from past experience and from all information to be arrived at without pumps for the removal of the water out of the shafts it would seem impracticable adequately to prosecute the work; in the outset two might be sufficient, but after a short time, as the shafts become deeper, two additional ones would be requisite, making a total of four, and which, if Lieutenant Nicolson's information is correct, are procurable from Mr. Law's depôt of building materials at the Presidency.

2. Cranes and troughs I calculate on being able to have prepared at Palghatcherry and I shall take measures to this effect.

Stamping mills are much to be desired. In the last report a model of one was stated to be in preparation at Calicut under Mr. Hugnenin's superintendence; every thing shall be done in order to having one prepared, but if unsuccessful some preparation of granite in the shape of pestle and mortar, or even sledge hammers, may serve as substitutes, and under any circumstances the work can progress without the two former, though not to an equal extent.

The melting the ore I do not immediately see the necessity of, but this equally with the purchase of gold at the mines. The selection of trustworthy persons for such purposes, as also for the supply of coolies and superintendence of all local matters, are duties devolving, I conceive, on the Principal Collector in Malabar, who alone possesses means adequately to provide for their performance.

3. A further supply of chests of mining tools I would also recommend, and should they and the pumps be sanctioned, I beg to suggest their early despatch to Calicut by sea, as well from motives of economy as to carriage, as from the important object of their reaching their destination in sufficient time to be brought into use as required during this season.

4. Smiths and carpenters for the construction of scaffolding and repairs of various tools in use will also, I conceive, be supplied on the spot under the orders of the Principal Collector.

5. As relates to the insalubrity of the climate, and fevers contracted during the two former seasons, in part from want of adequate protection against the heavy dews, I beg to sugggest the practicability of the construction of a temporary range of sheds on an appropriate site near to the mines of palmyra and cadjan leaves by the inhabitants of the country, the expense of which I presume would be most trivial.

6. In furtherance of these duties Lieutenant Nicolson will leave Ootacamund for Palghatcherry on the 8th instant *en route* to Calicut, where he will commence preparations in communication with the Principal Collector in Malabar, and there await the receipt of further instructions, with which I beg to be honored the above points.

I have the honor to be,
Sir,
Your most obedient servant,

(Signed) R. CREWE, Major,
Commanding Nilgiris.

FINANCIAL DEPARTMENT.

No. 257.

Extract from the Minutes of Consultation, under date 12*th October* 1832.

Read the following letter from Major R. CREWE, Commanding Nilgiris, dated 6th October 1832.

RESOLVED that the Military Board be instructed to purchase two 3-inch cylinder pumps at Mr. Law's depôt and forward them with eight chests of mining tools to the Principal Collector of Malabar, at the earliest practicable moment, for delivery to Lieutenant Nicolson. If these articles cannot be sent by sea before the monsoon, they should be forwarded direct to Lieutenant Nicolson at Pálghat.

Resolved that authority be given to Major Crewe to cause the requisite number of cranes and troughs to be made up at Pálghat.

The Principal Collector of Malabar will cause a sufficient number of carpenters and smiths to be supplied to Lieutenant Nicolson, and a trustworthy Native Revenue Officer to be

in attendance; he will also cause a range of temporary sheds to be erected for the protection of the party at night.

(A true Extract.)

To Major R. Crewe, (Signed) H. CHAMIER,
Commanding Nilgiris. *Chief Secretary.*

for information.

(A true Extract.)

(Signed) R. CREWE, Major.

(A true Copy.)

Ootacamund, (Signed) W. NICOLSON, Lieutenant,
31st October 1832. *Superintending Search for Gold.*

Ootacamund, 26th October 1832.

From

Lieutenant W. NICOLSON,
Superintending Search for Gold.

To

Major R. CREWE,
Commanding Nilgiris.

Sir,—With reference to your letter and its enclosure of the 8th instant, I have now the honor to acquaint you that I arrived here on the 18th, and having made every inquiry as to materials and workmen for manufacturing machinery for the Coopal mines the following have been the results:—viz.

(1.) That the only substantial article to be procured is wood.

(2.) The iron and all other requisites are of the coarsest possible [illegible] and would therefore be continually breaking and getting out of order.

(3.) No workmen can be found expert enough to put them *cleverly* and *substantially* together, being all carpenters of the most ordinary description without the slightest idea of mechanical powers or proportions, *even if models were placed before them.* Troughs and rakes are therefore the only articles to be furnished on here, and under these circumstances we must, I fear, be reduced to the only alternative of looking to the Presidency for assistance, although from all inquiries I made there in *May* last I could not hear of any workmen competent to the task, as they are mostly ignorant of those principles of mechanics without which no sound machinery of any sort can possibly be constructed. The opinion here is that we should be more successful at Cochin. I beg to add that as soon as the Principal Collector of Malabar has informed me of all preparations being in readiness at the mines for the construction of quarters, &c., the Pioneers will march for Coopal to assist in the work; in the meantime I beg again most respectfully to submit the expediency and necessity that exist for assembling a committee at Coopal of such persons as may be thought the most competent to form an opinion on the present state of the mines and their future management, as well as of the propriety and advantages of sending to England at once for machinery; and with this view I take the liberty of mentioning the names of the following gentlemen, viz., Mr. Brown at Tellicherry, Mr. Caldecott at Alippy, Mr. Fischer at Coimbatore, Mr. Lettardy at Ootacamund, all I believe men of known genius and general information, who, with the Collector and Engineer of the district, would form a body whose opinions on this subject would, I presume, prove most satisfactory to Government.

I have now the honor to state that there is at at this moment a very large quantity of gold for sale at this place and at Coimbatore at prices within, although much higher than at the mines (in consequence of having passed through several hands), are by *some strange anomaly* still actually under the intrinsic value of the metal, as reported by the Mint Master last season, and its intrinsic value at Madras may generally be reckoned at about 20 per cent. *below* its commercial value, so that it would still yield a good profit in the Madras market if bought up on account of Government. Enclosed I beg to forward a small piece, the price of which in the bazaar is at the rate of 39 rupees and a half per ounce; its touch is about 95. I would therefore beg to request that you will be pleased to solicit permission for me to draw upon the Principal Coimbatore for the price of any quantity of gold I may be able to [illegible] same being deposited in their respective treasuries. Under all further instructions as to my immediate proceedings.

I have the honor to be,
Sir,
Your most obedient and humble servant,

(Signed) W. NICOLSON, Lieutenant,
Superintending Search for Gold.

Palghatcherry, 10th November 1832.

From

[illegible] NICOLSON,
Superintending Search for Gold.

To

Major R. CREWE,
Commanding Nilgiris.

Sir,—Until the receipt this day of your's of the 14th instant in answer to mine of the 26th ultimo, I have to inform you that I could not know whether the purchase &c., had been [illegible] and by sea to Calicut, or for orders to me at this place by land. I have been obliged to [illegible] here for that information, and I am now proceeding without delay to Calicut *via* Coopal [illegible]

[illegible] that my purchasing gold would not in any way interfere with my duties as [illegible] purchases might be effected by natives placed under my orders; and have been authorized, I have reason to think that I could already have procured about fifty thousand [illegible] yielding a high profit to Government.

I have the honor to be,
Sir,
Your most obedient and humble servant,

(Signed) W. NICOLSON, Lieutenant,
Superintending Search for Gold.

Ootacamund, 14th November 1832.

From

Major R. CREWE,
Commanding Nilgiris,

To

Lieutenant W. NICOLSON,
49th Regiment, Native Infantry.

Sir,—Adverting to your letter of the 26th ultimo, which would have met with earlier reply had not indisposition prevented it, I can only now urge upon you the absolute necessity of giving up your attention to what I consider to be the present main object, viz., that of applying all your means to the working of the Coopal mines, in order that we may this season arrive at a probable knowledge of the returns to be expected from such labors, the degree of efficiency afforded by the tools, &c., already supplied, and any further implements or machinery desirable, in the event that any further prosecution of these labors should hereafter be deemed expedient.

A list of pumps, &c., despatched for this service I have the honor to give cover to, and I hope to hear that by this time you will have reached Calicut in furtherance of your arrangements there with the Principal Collector, and I shall also be glad to hear of the state of Mr. Hugnenin's health, and if any and what was his success as to the preparation of a model of a stamping mill long since commenced on under his superintendence.

The purchase of gold in the bazaar of Palghatcherry or Coimbatore would in my mind be a misappropriation of your time, as your superintendence and science will be so much more advantageously disposed of at the Coopal mines.

I have the honor to be,
Sir,
Your most obedient servant,

(Signed) R. CREWE, Major,
Commanding Nilgiris.

(True Copy.)

(Signed) R. CREWE, Major,
Commanding Nilgiris.

COCHIN,
20th December 1832.

From

LIEUTENANT W. NICOLSON,
Superintending Gold Mines,

To

THE PRINCIPAL COLLECTOR OF MALABAR.

SIR,—In compliance with the request contained in your letter of the 7th instant, I have now the honor to acquaint you that I arrived here on the 12th, and having made the necessary inquiries as to materials and workmen at this place, I find that machinery for the gold mines can be made here, but I fear it would be far inferior to what might be manufactured in the Mint or brought out from England, while the expense would most probably be much greater; to avoid delay, however, I am collecting materials for a windlass crane of elephant power for the main shafts at Coopal, the expense of making and setting up which will cost (as far as I am at present able to calculate) between six and seven hundred rupees; and although several of these are required, *one alone* will, I have no doubt, suffice to prove the advantages to be derived by Government from such machines.

2. With regard to pumps, wooden ones can be made, but not iron ones; these, however, unless on the *forcing principle*, can only answer for a short time, and I am given to understand there is no such thing as a forcing pump in Madras.

3. A stamping mill for crushing the ore if made here will take up much time, and will cost (with its necessary requisites) about a thousand pagodas.

4. In addition to the above iron wire sieves for sifting the pounded ore, troughs for washing it, rakes, &c., may probably come to one thousand rupees more, so that an outlay of about five thousand rupees altogether would, I should think, suffice to prove to Government the advantages to be derived from working these mines on a very extensive scale.

5. A reservoir for water should be built at Coopal immediately of brick and chunam, as there is no water near at hand but what comes from the shaft, and which, from the want of a reservoir, runs now to waste.

6. With utmost deference I now do myself the honor to submit the following opinions; but those of a *special Committee* would, I presume, be far more satisfactory to the Right Honorable the Governor in Council.

7. How long these mines have been worked and what their average produce has been are questions involving the interest of the natives to answer, and it therefore becomes a very difficult matter to ascertain the truth; their appearance, however, together with the slovenly mode of work adopted by the Moplahs, lead me to suppose that they have been worked for at least a century.

8. The Hon. Mr. Duncan, late Governor of Bombay, recommended a search for gold mines (according to Mr. Sheffield's Report) as far back as 1793.

9. And the bare fact of one mine supporting five or six hundred men and their families with the *commonest native tools* may reasonably be considered a sufficient criterion of its value.

10. Although the Coopal mines are the largest we have as yet discovered, it is not to be supposed that this circumstance arises from their particular situation or quality; it is because there is a dense and comparatively enterprizing population of Moplahs in their immediate neighbourhood, and there can be little doubt that, being guided by similar mineralogical appearances on the surface (and these occur almost everywhere under the ghats in that direction), innumerable spots exist, as we found last year, where, if shafts were sunk to the same extent as at Coopal, similar, if not much greater, benefits would

11. In the present promising state of the undertaking the despatch of boring apparatus along the foot of the ghats under efficient and competent persons must assuredly be worthy the consideration of Government; to obtain such persons, however, appears to be the grand difficulty, and to strike at the root of it it would appear expedient to suggest some mode of supplying the service with persons conversant with these duties, either by establishing a school for mines or transferring one of the Honorable Company's home establishments to some mining country where their officers might obtain a thorough practical knowledge of mining and of such branches of mechanics as are therein required, with which, and being obliged to pass examinations in Mineralogy and Metallurgy, they would arrive in India with competent information to prosecute researches and make discoveries which certainly appear to promise, at no very distant period, the most advantageous results to the Honorable Company.

12. The East India Depôt at Chatham, for instance, would not, I humbly presume, cost more in Cornwall than in Kent; yet this simple change of bounties (with the same facilities of embarking troops, &c.) and a good Professor of Mineralogy would, no doubt, suffice for the attainment of the object desired.

13. In the meantime, however, if the Moplahs who have hitherto worked the mines were embodied on regular pay and officered from the line, Government would no doubt immediately derive such benefits from the undertaking as would do away with all doubts as to its success. The employment also of such men from the European Regiments as have seen anything of the sort at home would probably be attended with great advantages, for the natives, *one and all*, whether in *Government employ or not*, continue by every means in their power to thwart our views and impede our progress; they will not even sell *to us* more than a very small quantity of the gold daily found, knowing if they sold us the whole of it we could very shortly come to some correct estimate of the value of the mines.

In conclusion I beg to observe that there does not appear to be any danger of fever at Coopal or its immediate vicinity, *for the present at least*, as the Pioneers have been at work there for the last two months, and no case of fever has yet occurred amongst them.

Finally, with regard to machinery there can be no doubt that it may be brought out from England, of a far superior quality, at a much cheaper rate, and in less time than it can possibly be made up in this country.

I have the honor to be,
Sir,
Your most obedient and humble servant,

(Signed) W. NICOLSON, Lieutenant,
Superintending Gold Mines.

COCHIN,
27*th December* 1832.

From

LIEUTENANT W. NICOLSON,
Superintending Gold Mines,

To

THE PRINCIPAL COLLECTOR OF MALABAR.

SIR,—I have the honor to acknowledge the receipt of your letter of the 24th instant, in answer to which I beg to state I am fully aware that until the sanction of Government is obtained any disbursement of funds that I may make in order to ascertain the capabilities of the workmen of this place must be at my own risk.

2. I beg to add that I hold myself in readiness to make any further communications and answer any questions that the Committee ordered by Government may require of me.

3. In the meantime the following details may probably be of service in determining the value of the mines.

4. The only work that I have hitherto been able to rely upon (in endeavouring to ascertain what quantity of gold can be daily found by one man) is that of the party of Pioneers placed under my orders, by whom the average quantity of gold daily found may be considered at about half a gold fanam's weight per man. It must be recollected, however, that these men are complete novices at the work, and that a Moplah who has been in the habit of gold-washing for years must find a much greater proportion of the metal. Allowing, however, that this may not be the case, it is evident that a Moplah must find at least as much as a Pioneer, and consequently when six or seven hundred Moplahs are at work they must find from three hundred to three hundred and fifty gold fanams' weight of gold, or about four ounces (each weighing eighty new gold fanams) per day, of which quantity the Revenue Officer sent by you to Coopal

can only obtain twenty or thirty gold fanams' weight from the Moplahs per day, who would thus endeavour to mislead us as to the value of mines.

I have the honor to be,
Sir,
Your most obedient and humble servant,

(Signed) W. NICOLSON, Lieutenant,
Superintending Gold Mines.

COCHIN,
2nd *February* 1833.

From

LIEUTENANT W. NICOLSON,
Superintending Gold Mines,

To

THE PRINCIPAL COLLECTOR OF MALABAR.

SIR,—I was duly honored with your's of the 30th ultimo, in reply to which I beg to state, with regard to the mines hitherto discovered, that I have already made every possible inquiry in my power on the spot and made myself as well acquainted as I possibly could with their localities, &c., as will be seen in a small map which I forwarded to Major Crewe in June last.

2. To the several details, however, I have already had the honor to forward I beg to add the following :—

As connected with all the mines that are worked by Moplahs, I have repeatedly tried to get these men to work for me on monthly pay, having offered them five rupees per man, but they have always refused, giving as their reasons for doing so that, if they worked for me, they would be obliged to work *every* day, whereas in working on their own account they could often find enough gold in *one*, *two*, or *three* days to support them for *a week* without working at all.

As connected with the mines in the Nilambur Valley, which are worked by Curoomba slaves belonging to the Tirooapad and for which he pays a yearly nigiddy of 1,000 Rs. from different circumstances which occurred last year, together with the universal opposition to our search which we invariably experienced, and several complaints in Malialam against the Tirooapad which were brought to me by a man called Beganad Nair, copies of which were forwarded to Mr. Hudleston and Major Crewe, I have every reason to think that the Tirooapad must make enormous profits on these mines, particularly since some Moplah merchants who came to me last year offered to throw a certain number of miners into the Nilambur Jungles upon each of whom they were willing to secure to the Circar a monthly nigiddy of from 10 to 12 gold fanams' weight of gold if authority had been obtained to that effect, which, they said, would be extremely difficult in consequence of the influence of the Tirooapad and of a man called Kinra Menon, a Sheristadar in the Cutcherry at Calicut, whom they accused of being in league with the former to keep Government in ignorance of the mines.

3. As connected with the mines in Wynaad, as far as I could learn, the Rajah of Nilambur, Numbilicottah, and other parts employ Chetties to superintend their slaves in working the mines, giving them a commission on the quantity of gold found. I should add that all these slaves are most inhumanly and barbarously treated, their daily pittance being one or two seers of paddy in the husk ; while the slightest deficiency in the quantity of gold they are daily expected to deliver up is visited with the most unmerciful floggings and crushing their limbs in a kind of vice to such a degree and so repeatedly that they are sometimes disabled for life and often left in this state to die of starvation.

4. In reply to that part of your letter in which you suggest that I may visit any part of the district in which, from my past experience, I may suppose that mines are to be found, I have the honor to acquaint you that I have every reason to think that there are many more mines to be discovered on the Coondah and Moorcooty Hills, as you will perceive I mentioned in my letter to Major Crewe, dated Carombat Jungle, near Carcoor, 25th January 1832, and I am about to proceed in order to carry on the search in that direction.

I have the honor to be,
Sir,
Your most obedient and humble servant,

(Signed) W. NICOLSON, Lieutenant,
Superintending Search for Gold.

APPENDIX C.

EXTRACTION of Gold and Silver from Copper Pyrites.

***Fred Claudet, Annales de Chimie, Quatriéme Serie November** 1872, T. XXVII., p. 407, being an Appendix to the Report of the Victorian Board on the Treatment of Pyrites.*

English manufacturers draw the greatest part of the pyrites they employ in making sulphuric acid from Spain and Portugal. As they all contain more or less copper, the residues, after the extraction of the sulphur, are sold to the copper smelters, who, on account of the large quantity of oxide of iron they contain, employ them as a flux for silicious copper ore. In the operation they recover the copper from the pyrites, but all the iron passes into the slags. The extraction of copper from minerals by the humid method first practised by Longmaid, and since applied by W. Henderson to the treatment of pyritous residues, does not give rise to this loss of the iron of the pyrites. This mode of treatment is now much used in consequence of the increasing importation of these pyrites, which has risen to 400,000 or 500,000 tons annually and continues to increase. The pyrites are sold according to the amount of sulphur and copper they contain. The manufacturers, who only buy them for the sulphur they contain, sell the roasted mineral to works at which the copper is extracted. Such an establishment has been founded by F. Claudet and J. A. Phillips at Widness, near Liverpool.

Spanish and Portuguese pyrites vary little in their composition. The following is a fair average from the mines of San Domingo, which furnish about half the pyrites used :—

Sulphur	49·00
Arsenic	0·47
Iron	43·55
Copper	3·20
Zinc	0·35
Lead	0·93
Lime	0·10
Water	0·70
Quartz residue	0·63
Oxygen and loss	1·07
	100·00

In the last item (1·07) are comprised traces of a great number of metals.

These pyrites, after being roasted in the manufacture of sulphuric acid, form the material treated for the extraction of copper. They contain, with slight variations,—

Sulphur	3 76
Arsenic	0·25
Iron	*58·25
Copper	4·14
Zinc	0·37
Cobalt	Traces.
Silver	Traces.
Lead	1·14
Lime	0·25
Insoluable residue	1·06
Water	3·85
Oxygen and loss	26·93
	100·00

The traces of silver amount to from 20 to 28 grammes per ton according to assay, and can be extracted with profit by the process now to be described.

The pyritous residues are first pounded and sifted and are then roasted in a reverberatory furnace, at a very low temperature, with chloride of sodium. The oxidation of the metallic sulphides and the decomposition of the chloride of sodium which follows give rise to the formation of sulphate of soda and soluble chloride of copper. When it is found by assay that the mineral has been sufficiently roasted and has become cool enough, it is placed in a large wooden tub with a double bottom forming a filter, and is several times washed with water slightly acidulated with hydrate of chloride until the copper is removed. The insoluble residue

* Representing 83 of Fe_2O_3

remaining in the tub consists almost entirely of oxide of iron and has about the following constituents according to analysis :—

Sesquioxide iron	96·20 = iron 67·35
Sulphate of lead	0·86
Copper	0·18
Cobalt	Traces.
Alumina	0·45
Lime	0·46
Soda	0·10
Phosphoric acid	0·00
Arsenic acid	Traces.
Sulphuric acid	0·49
Sulphur	0·16
Chlorine	0·03
Silica	1·22
	100·15

This oxide of iron, on account of the uniformity of its composition, is sold to the iron workers, where it is used with advantage to line the puddling furnaces. The washings from which the copper has to be recovered are poured into other tubs previously supplied with pieces of iron. Chloride of iron is thus formed and metallic copper precipitated, taking with it the small quantity of silver contained in the liquid. The precipitated copper is then melted and refined to bring it to the state of merchant copper. The liquid from which the copper has been separated still contains salts of iron and the alkalies which are lost, but in the subsequent operations adopted in our works we obtain on the one hand sulphate of soda nearly absolutely pure, and on the other oxide of iron in a state of very fine division suitable for polishing glass. The liquor before the precipitation of the copper by the iron contains, as stated, silver dissolved in the state of chloride. This cannot be extracted by precipitation with metallic copper; for the silver being soluble in a mixture of chloride of sodium and bichloride of copper, the precipitation cannot take place until all the bichloride is reduced to the state of protochloride by the metallic copper added. Then the most minute quantity of silver is wholly precipitated by the excess of copper, but also with some protochloride of copper which the chloride of sodium is no longer able to hold in solution. It is necessary, therefore, to have recourse to a further separation, the cost of which more than absorbs the value of the silver. This process is of no economic value. There is another method of separating the silver from the copper, which consists in converting the precipitate into sulphate of copper; but, as the market for this is limited, this method is only applicable to a limited extent.

After much research I have arrived at the following mode of separation. It is founded on the fact that iodide of silver is nearly soluble in solution of chloride of sodium at ordinary temperatures.

The mineral roasted with common salt undergoes, as has been before stated, several successive washings, but only the first three waters contain a notable quantity of silver.

We have found by experience that the two first waters contain about 80 per cent., and the three first 95 per cent., of the total quantity of silver dissolved. According to analysis of one of these waters marking 1·24 on the areometre a cubic metre of this liquor contains—

	Grammes
Sulphate of soda	144·171
Chloride of sodium	63·914
Chlorine (in combination with other metals)	66·143
Copper	52·855
Zinc	6·857
Lead	0·571
Iron	0·457
Lime	0·743
Silver	0 0437
	335 7547

Minute quantities of arsenic, bismuth, and other minerals are omitted in this analysis. The above is only given as an example, for the silver here given as 43·7 grammes varies in our operations from 25 to 75 grammes to the cubic metre, according to the richness of the mineral and the degree of concentration of the liquors. We only employ the three first washings; these are poured into a wooden cistern and allowed to remain till the solid matters in suspension settle, and, in order to employ the quantity of iodide absolutely necessary, we commence by deter-

mining the quantity of silver contained in the liquid. For this purpose the liquor is filtered and diluted with water, a little hydrochloric acid is added to retain the copper in solution; then a weak solution of iodide of potassium is added drop by drop, which converts the soluble chloride of silver into insoluble iodide; at the same time, by the addition of a solution of acetate of lead, we throw down a heavy plumbic precipitate which entangles all the silver. This precipitate is dried and melted with a flux with addition of metallic iron. The resulting lead button is cupelled and the quantity of silver held in the liquor thus determined. The clear assayed liquor is then run into another vessel, where the quantity of iodide of potassium shown by the assay to be required is added diluted with a quantity of water equal to about one-tenth of the cupreous liquor. The whole is then agitated and afterwards allowed to settle for 48 hours. The supernatant liquor is then clear. This is drawn off, and the vessel again filled for a fresh operation, and so on (the iodide of silver not being quite insoluble, about 5 grammes to the cubic metre remain in solution and pass into the copper). After every fiftieth charge the accumulated deposit is collected. It consists principally of sulphate of lead, iodide of silver, and salts of copper. The latter are easily separated by a washing with weak hydrochloric acid. The deposit thus freed from copper is decomposed by metallic zinc, which in presence of water rapidly and completely reduces the silver with the formation of soluble iodide of zinc. The following are the products :—(1st) soluble iodide of zinc, which is filtered off, and, after "tritration," is used instead of iodide of potassium in the subsequent operations to precipitate fresh quantities of silver; (2nd) a deposit, rich in silver, composed in great part of lead in the state of metal and of sulphate of lead besides several other substances. The following assay of a dried sample will give an example :—

Silver	5·95
Gold	0·06
Lead	62·28
Copper	0·60
Oxide of zinc	15·46
Oxide of iron	1·50
Lime	1·10
Sulphuric acid	7·68
Insoluble residue	1·75
Oxygen and loss	3·62

This analysis shows that all the iodine of the iodide of silver has combined with the zinc and become soluble since the deposit does not contain any or only traces. The gold appears here for the first time. It must have existed in the mineral, and it would appear that in the operation of roasting chloride of gold is formed, which, rendered more stable by the presence of chloride of sodium, is not reduced at the low temperature of this roasting. This chloride therefore enters into solution with the silver, and is precipitated with it by the iodine. It is now easy to separate from these products the precious metals by the ordinary processes of fusion for matters containing gold and silver.

During 1871 we operated on 16,300 tons of roasted pyrites, from which we extracted gold 3,172 grammes, silver 333,242 grammes, being a little more than 20 grammes of the precious metals to the ton, which produced 80,800 francs after deducting cost of melting and refining. The special expense of separation of the precious metals is about 10,400 francs; in this is included 137 kilogrammes of iodine, representing the loss of this substance, and 1,900 kilogrammes of zinc. It is remarkable that the gold which is not present in the mineral in weighable quantity should be sufficient, nevertheless, to cover all the cost of the operation. The cost of the iodine, always high, has become much more considerable by the abnormal increase of the cost of this substance. This has called my attention to the use direct of the washings of the "varech" ash instead of iodide of potassium, and recent experiments in this direction have answered our expectations. Not only are we able by this means to utilize all the iodine contained in this varech, of which a great part, as is well known, is usually lost, but also these trials have suggested the idea of an inverse operation, on which I am engaged, for manufacturing iodine, which consists in precipitating this metalloid from the washing of the varech ash by means of a salt of silver. This separation of 20 grammes of precious metals to the ton of burnt pyrites is doubtless small; but, when we reflect that in England alone the operation can be applied to 340,000 tons of mineral and produce thus, with a proportionally increased profit, 7,200 kilogrammes of precious metals of a value of 1,700,000 francs, we shall see that such an annual result should not be neglected. The above process can also be employed for various cupreous minerals capable of treatment by the wet method, and we are beginning to apply it to the copper ores of Cornwall, which contain generally more silver than Spanish pyrites, and which at present are only worked by the dry method and for the extraction of their copper only.*

* "The results obtained by this process at the Widness Metal Works show that 0·65 ounces of silver and 3 grains of gold may be extracted from each ton of ordinary Spanish pyrites at a total cost, including labor, loss of iodide, &c., of 8*d.* per ton, or 12·3*d.* per ounce of silver produced. If from this amount be deducted the value of the gold, the expense of working a ton of ore is reduced to 2*d.*, thus leaving a profit of about 3*s.* on each ton of ore treated."
Elements of Metallurgy by J. Arthur Phillips, pages 681-2.
Mr. Miller, of the Melbourne Branch of the Royal Mint, is of opinion that, should the process prove available in this colony [Victoria], it would give rise to the formation of a new industry in the manufacture of iodine from the sea weeds of the coast.

APPENDIX D.

List of Specimens of Quartz with Gold visible for the Museums of Madras and Calcutta.

Madras Museum.

Wright's Level	99
Wither's Reef	2
Rosedell Reef	4
New Reef—Prince of Wales'	1
Waterfall Reef	1
Hamlin's Reef	1
Cavern Reef	3
Bear Reef	1
Etucull Reef	2
Dawson's Reef, Elizabeth Estate	6
Reef on Bolingbroke Estate	2
Button of gold got by Korumbars	1
Reef on Trevelyan Estate	1
Reef near Magazine, Alpha Works	4
Reef, Phœnix Estate	1
Reef, Adeline Estate	2

Calcutta Museum.

Wright's Level	88
Wither's Reef	3
Rosedell Reef	4
New Reef—Prince of Wales'	2
Nedukani Reef	1
Hamlin's Reef	2
Cavern Reef	3
Bear Reef	2
Etucull Reef	2
Dawson's Reef, Elizabeth Estate	6
Bolingbroke Estate	3
Reef near Wither's Estate	1
Reef on Trevelyan Estate	1
Reef near Magazine, Alpha Works	5
Balcarres	1
Leader, Trevelyan Estate	3
Reef, Adeline Estate	2

APPENDIX E.

eld of Gold from Quartz and Pyrites sent from Reefs near Devala as ascertained by Analyses made by J. Cosmo Newbery, Esq., B. Sc., Melbourne, Victoria, Australia.

On the 3rd December 1878 specimens of quartz and pyrites were forwarded to J. Cosmo ewbery, Esq., B. Sc., who has the control of the Laboratory and Technological Museums in elbourne, and the yields as reported by him are as follow :—

	Yield of Gold per Ton.		
	OZ.	DWT.	GRS.
1. Pyrites, adit below Wright's Level	2	12	16
2. Pyrites, Cavern Reef	1	16	0
3. Pyrites, Wright's Level	1	6	10
4. Pyrites (auriferous), Wright's Level	(Assay lost.)		
5. *Skull Reef Quartz and Pyrites (the yield of silver in addition was from this sample at the rate of 37 oz. and 6 dwts. per ton)	49	10	0
6. Cubes of pyrites and limonite near the Alpha Mine	3	1	19
7. Quartz near Alpha	6	4	3

* Mr. Cosmo Newbery states that there was a little free gold in this sample, the most of it enclosed in the pyrites. is report is dated 10th June 1879.

The more important localities where rocks have been collected during the progress of the survey of the gold fields in the Wynaad.

1. Wynaad Prospecting Company's area.
2. Pookote, South Wynaad.
3. Hills east of Harewood.
4. On road to reef west of Alpha Mill.
5. Adit below Wright's Level.
6. Westbury below Seegur Ghât (Mr. C. R. Dawson).
7. Carcoor Ghât.
8. Sheardale.
9. Devála.
10. Eddacurra.
11. Downham.
12. Iron ore, Harewood.
13. Nundhutty.
14. Trevelyan.
15. Sandhurst.
16. Karambaut.
17. Etucul.
18. Richmond.
19. Gadbrook.
20. Hamalade.
21. Needle Rock.
22. Near the Hospital, Devála.
23. Elizabeth.
24. Nanjanad.
25. Marlimund.
26. Avalanche.
27. Simla.
28. Sispara and Sispara Ghât.

NOTE.—In some cases a large number of specimens were collected from the abovenamed localities.

APPENDIX G.

THE more important districts or localities in the Madras Presidency where auriferous quartz veins occur, or where there are abandoned gold workings, or where gold-mining operations are now carried on are as follow :—

1. Devála.
2. Pandi River.
3. Nelliallum.
4. Choladi.
5. Charambadi.
6. Moopenard.
7. Vytheri.
8. Karambaut.
9. Kellakumpoya and Caracoorpoya.
10. Eddacurra.
11. Nilambúr.
12. Nanjanad Valley.
13. Avalanche towards Sispara.
14. Coonoor and near Wellington.
15. Palghat Valley.
16. Toodakull River.
17. Arliparambur Rivulet.
18. Arnakyem River.
19. Carcatode Stream.
20. Sea-beach from Parparangady to Caraloondy and thence to Beypoor.
21. Kutchambara on the bank of the Coodarapoya.
22. Carumpoya and Poonapoya.
23. Mijar and Karkal in South Canara.
24. Támbraparni.
25. Godávari.

APPENDIX H.

Table showing the yield of Gold per Ton of Samples of Quarts taken from Reefs in the Wynaad, Carcoor Ghât, and Nilgiris as determined by Assay.

(Compiled for convenience of reference.)

The letters show by whom the assays were made—

(*a.*) W. King, B.A., Deputy Superintendent of the Geological Survey of India.
(*b.*) R. Lindon.
(*c.*) Johnson and Sons, Assayers to the Bank of England and Her Majesty's Mint.
(*d.*) W. Maylor.
(*e.*) R. Brough Smyth.
(*f.*) J. Cosmo Newbery, B.Sc., Superintendent of the Laboratory and Technological Museums, Melbourne, Victoria (Australia).

NOTE.—The samples marked (*e*) contained no gold visible to the eye unless so stated in the column of remarks.

No.	Letter.	Name of Reef.	Proportion of Gold per Ton. OZ.	DWT.	GRS.	REMARKS.
1	(*a*)	Skull	0	11	0	Mr. King gives the highest proportion as 25 dwts. and the lowest as 2 dwts.
2	(*a*)	Do. 1st Foot	0	2	0	
3	(*a*)	Do. 3rd ,, ...	0	2	12	
4	(*a*)	Do. 5th ,, ...		...		None.
5	(*a*)	Do. 7th ,, ...		...		Amalgam lost.
6	(*a*)	Do. 10th ,, ...	0	5	4·32	
7	(*a*)	Do. 12th ,, ...	0	19	10·56	
8	(*a*)	Do. 13th ,, ...	1	5	22·08	
9	(*b*)	Wright's Level (picked specimens).	25	13	0	
10	(*b*)	Wright's Level	11	13	0	No gold visible.
11	(*b*)	Skull Working	0	6	16	
12	(*e*)	Wright's Level	0	11	6	
13	(*e*)	Do.	2	16	1·6	
14	(*e*)	Do.	56	13	19·5	A little gold to be seen in the stone.
15	(*e*)	Do.	204	11	16·7	Gold visible in the stone.
16	(*e*)	Do.	0	3	23·04	
17	(*e*)	Skull Workings, No. 1 Section.	0	0	16·19	
18	(*e*)	Do. ,, 2 ,,	0	0	9·92	
19	(*e*)	Do. ,, 3 ,,	0	1	2·20	
20	(*e*)	Do. ,, 4 ,,	0	2	2·21	
21	(*e*)	Do. ,, 5 ,,	0	0	4·25	
22	(*e*)	Skull Workings	1	4	5	
23	(*e*)	Adit, Wright's Level	2	11	18·5	
24	(*e*)	Do.		...		Fine specks of gold.
25	(*e*)	Wright's Level	0	1	11	
26	(*e*)	Skull Reef	0	16	20·9	
27	(*e*)	Do. Wright's Level Quartz.	0	12	9·4	
28	(*e*)	Wright's Level	13	9	1·4	
29	(*f*)	Adit, Wright's Level Pyrites.	2	12	16	
30	(*f*)	Do. do.	1	6	10	
31	(*f*)	Do. do.		...		Auriferous assay lost.
32	(*f*)	Skull Workings ... ... Auriferous Quartz and Pyrites.	49	10	0	The yield of silver in this sample in addition to the gold was at the rate of 37 oz. 6 dwts. per ton. There was a little free gold in this sample; the most of it enclosed in the pyrites.
		Skull Reef.				
33	(*f*)	Wright's Level Cubic Pyrites.	3	1	19	
34	(*f*)	Wright's Level Quartz	6	4	3	
35 & 36	(*e*)	Reef west of Wright's Level...		...		Two samples which gave only minute specks of gold.
		Prince of Wales' Reef—				
37	(*e*)	No. 1 Section		...		Button not weighable.
38	(*e*)	No. 2 ,, ...	0	0	1·91	
39	(*e*)	No. 3 ,, ...	0	2	4·40	
40	...	Average of 3 Sections, 4th Experiment.	0	1	8·03	
41	(*e*)	New Reef near Prince of Wales.	0	17	11·77	
42 & 43 & 44	(*e*)	Do. do.		...		Minute particles of gold.

No.	Letter.	Name of Reef.	Proportion of Gold per Ton. oz.	dwt.	grs.	Remarks.
45	(e)	Wither's Reef		...		Specks of gold. Several specimens showing free gold were collected, but none of these were tested.
46	(e)	Cavern Quartz	0	2	21·8	
47	(e)	Pyritous Quartz, the proportion of pyrites being large.	4	19	3	
48	(e)	Pyritous Quartz	0	10	2·59	
49	(e)	Do.	0	11	4·90	
50	(e)	Do.	0	8	5·60	
51	(e)	Do.	0	14	11	
52	(e)	Quartz	0	11	15·5	
53	(e)	Cavern "Casing"	0	11	16	Small particles of gold were seen in this Casing.
		Cavern Reef—				
54	(e)	No. 1 Section	0	1	10·94	A portion of this amalgam was lost.
55	(e)	No. 2 ,, ...	0	0	17·47	
56	(e)	No. 2 ,, ...	1	15	17·47	
57	(e)	No. 3 ,, ...	1	0	9·88	
58	(e)	No. 4 ,, "Casing" ...	0	1	10·94	
59	(f)	Cavern Reef Pyrites	1	16	0	
60	(a)	Koorumber	0	4	0	Mr. King gives the highest proportion as 7½ dwts. and the lowest as ½ dwt.
61	(d)	Do.	4	13	4·8	
62	(c)	Do.	0	2	12	The silver in addition 2 dwts. per ton.
63	(b)	Do.	0	15	13	
64	(b)	Do. Estimated ...	0	2	0	
65	(b)	No. 1 Leaders...		...		Traces of gold.
66	(b)	Koorumber.				
		No. 2. Do. Leaders	2	6	16	
67	(b)	No. 3. Do. do.	1	3	8	
68	(e)	Quartz	1	0	1·15	
69	(b)	Bear...	0	4	0	
70	(b)	Do....	1	11	0	
71	(b)	Do	0	15	13	
72	(b)	Do	0	11	16	
73	(e)	Do		...		A few minute specks of gold.
74	(e)	Do		...		No gold.
75	(e)	Do	1	6	5·88	
76	(e)	Do	0	5	19·76	
77	(d)	Hamlin	0	16	8	
78	(e)	Do.	1	0	9·88	
79	(e)	Etacull Pyrites	2	1	8·11	
80	(e)	Quartz	0	16	0·82	
81	(b)	Monarch	0	11	16	
82	(e)	Do.	0	2	17·55	
83	(e)	Nadukani Reef	0	5	2·29	
84	(a)	Hamsluk	0	3	0	Mr. King gives the highest proportion as 7 dwts and the lowest as 1 dwt
85	(a)	Hamslade (Waterfall)	0	11	0	Mr. King gives the highest proportion as 1 dwts. and the lowest a 3 dwts.
86	(c)	Hamslade (Waterfall)	0	3	0	The yield of silver in addition was at the rate of 2 dwts. per ton.
87	(e)	Do.		...		Minute particles of gold.
88	(a)	Hamslade (Middle)	0	10	0	Mr. King gives the highest proportion as 12 dwts. and the lowest as 8 dwts.
89	(c)	Do.	0	8	18	The silver in addition 8 dwts. 18 grs. per ton.
90	(c)	Kings'	0	3	18	The yield of silver in addition 3 dwts. 18 grs. per ton.
91	(e)	Reef behind Harewood... ...	0	1	19·68	
92	(e)	Do.	0	2	4·41	
93	(e)	Do.	0	0	17	
94	(e)	.....		...		Good show of gold. Button not weighable.
95	(e)	Reef northern boundary of Strathern Estate Pyritous Quartz.	0	4	21·81	
96	(e)	Do. do. ...	0	5	19·77	
97	(e)	Main Reef, Elizabeth Estate...	0	2	21·88	
98	(e)	Dawson's Reef do. ...	0	10	13·56	
99	(e)	Do. do. ...	1	1	20·82	
100	(e)	Do. do. ...	0	4	17·56	
101	(e)	Sandhurst Reef	0	3	15·35	
102	(a)	Balcarres...	0	3	0	Mr. King gives the lowest proportion as ½ dwt.
103	(e)	Dunbar Reef		...		A little gold. Free gold was found in this reef when Mr. King visited it.
104	(e)	Rosedell Reef	1	3	8	
105	(e)	Do.	0	4	8·82	
106	(e)	Parcheny Hill Reef	0	1	6	
107	(e)	"Casing"	0	13	20·41	
108	(e)	Do. ...		...		Specks of gold.
109	(e)	Pyritous Quartz		...		Do.
110	(e)	Phœnix Estate Quartz		...		Less than 4 grains per ton.
111	(e)	Battery Road near Charrambaddi Pyrites.		...		Minute particles of gold.
112	(e)	Reef Vythery (Mr. Yonge) ...	0	1	10·99	
113	(e)	Bolingbroke Reef	0	3	15·1	
114	(e)	Pyrites and fine soil	0	5	20	
115	(e)	Quarts and sand	1	1	3·35	
116 & 117	(e)	Do. pyrites...		...		Do. do.
118	(e)	Breakfast Reef, Nedukal ...		...		No gold.
119	(e)	Do. do. ...		...		Do.
120	(e)	Do. "Casing"		...		
121	(e)	Karambaut.				
122	(e)	Quartz	0	9	11·13	Specks of gold.
123	(e)	Do. ...		...		
124	(e)	Do. ...	0	17	23·38	
		Do. ...	1	4	1·4	
		Murada Reefs...		...		A few minute specks of gold.

No.	Letter.	Name of Reef.	Proportion of Gold per Ton.			Remarks.
			oz.	dwt.	grs.	
125 & 126	(e)	Stream Reef		...		Two samples minute particles of gold.
127	(e)	Reef east of Stream		...		Minute specks of gold.
128 & 129	(e)	Edacurra Reef		...		Do. do.
130						
131						
132	...	Quartz Avalanche		...		Do. do.
133						
134 & 135						
136	(e)	Nanjanad (old workings) ...	0	6	13·47	
137	(e)	Do. do. ...	0	5	12	A portion of this amalgam was lost.

The following Assays (Wynaad Prospecting Company's Work) form an Appendix to Mr. King's Report—"Record of the Geological Survey of India," No. 3, 1878.

	oz.	dwt.	grs.
Catch-pits not burnt	0	6	7
Do. burnt	0	3	21
Blanket not burnt	0	4	20
Buddle, burnt	0	4	18
Reverberatory Furnace, hand ground	0	11	16
Do. do. not ground	0	3	8
Do. do. hand ground	0	6	3
Blanket Tailings, English Assay...	0	1	7
Catch-pit Tailings, do. do.	0	1	5
Average of 200 ton heap, English Assay	0	9	0
Same stuff, Wither's Assay	0	9	8
Do. do. Koorumber's Assay	0	2	9
Koorumber's Assay, Bear Reef, No. 2	1	3	0
Do. do. do. ,, 1	0	10	0
Do. do. Sand from trials	0	2	12
Do. do. do.	2	5	0
Do. do. do.	1	0	0

Mr. Lindon in his report to the Southern India Alpha Gold Mining Company gives the following as the results of some assays of "Tailings" of various description :—

	oz.	dwt.	grs.
Burnt Tailings from works	1	3	8
Tailings packed up in river	0	15	13
Do. from outflow to tyes	1	11	0
Iron pyrites washed out from sand in outflow launder ...	2	6	16

Assays of Tailings and sand from the Alpha Work were made by me: sand from the Reverberatory furnace yielded at the rate of 9 dwts. 11·36 grs. per ton; and Tailings from the catch-pits gave at the rate of 3 dwts. 15·36 grains per ton.

Assays were made by me of five samples of stone forwarded from Estates near Vythery by Mr. J. L. Yonge and gold was found in all; but one only gave a weighable button.

Two samples of stone sent from the Chumberra Estate by Mr. R. Lamb; twelve collected near Charrambaddi and Vallerymulla; one from the Grange Estate sent by Captain Ponsonby Watts; one from the Eagle Estate sent by George Salmon; two from Teriott and Glenmary Estate sent by Mr. Percy Batty; two from Cheppa Toda; and three from the Glenlee Estate Manantoddy, sent by Mr. J. H. Anderson, were tested and gold was found in minute particles in fourteen.

The quarts crushed by the Alpha Company from first to last was 779½ tons; and the yield of gold per ton was 2 dwts. 8·43 grs.; the quarts crushed by the "Prince of Wales' quartz Reef Gold Prospecting Company" was 322½ tons and the average yield of gold was 10 dwts 12 grs. per ton.