REPORT ON THE DEN HILL GOLD DEPOSITS.

Government Geologist's Office,
Launceston, 10th October, 1902.

SIR,

As instructed, I visited the Den Hill, near Lefroy, on the 3rd ult., where Mr. Anderson has for many years been carrying on mining operations in search of the lodes which shed the gold formerly won in the alluvial flat at the base of the hill.

The Launceston-Lefroy road is left at the 21-mile (the Piper turn-off), and the Den reached by road and track three miles east-north-east. The present official name is the Glen. The hill in question is a low spur in a north-westerly and south-easterly direction, rising to a height of 500 feet above sea-level. It consists of slates and quartzites, running in the same course, and dipping generally south-west, though in one instance I observed a south-easterly dip. A bed of hard grey quartzite forms the axial line, or back-bone, of the hill. At the south end the spur sinks to a flat of four or five acres in extent, which was the scene of the old Den diggings, giving employment for a short time to a considerable number of men. This field must not be confused with the new Den further to the north, on the west side of the same range. I have been told that the diggings were in full activity 35 years ago. Mr. Thureau, in 1882, mentions that gold was found in the alluvium more than 20 years prior to that date, which throws back the discovery to 1862, at least. Very little information is now obtainable as to the results, but the yield is said to have been fairly good, and Mr. Anderson says that he has heard of one party winning 400 ozs. Old residents say that a good many worked along the line of these deposits, including both the old and new Den fields. The alluvium is from 8 to 10 feet in thickness, and yielded coarse gold; but the area is circumscribed, and the field could not hold out very long.

Gold has been traced to the hill and up its slopes. For 50 feet up the hill Mr. Anderson has put down holes in all directions in the hill-drift, which is simply detritus derived from the hill, and consists of angular quartz, slate, and quartzite, carrying also gold in non-payable quantities. Most of the quartz turned out from these holes is of a white, barren variety. The clay bottom, which is the top of the

underlying slates, was struck first at a depth of 11 feet, higher up at 7 feet, then at 4 feet, the detritus becoming thinner as the hill-side is ascended. The firmly-held idea has always been that the alluvial gold was derived from the spur, and this is not surprising, as the configuration of the land suggests and supports the theory.

A good deal of work has been done under the influence of this belief, but the result has been very disappointing. The fact that both the detritus on the top of the hill and the cappings of the existing veins are not appreciably gold-bearing is strongly adverse to the supposition that the hill reefs contributed any considerable quantity of gold. Either the gold won in the flat country did not amount to much, or the main supply probably came from lodes concealed below the alluvium.

The alluvial deposits at the new Den somewhat further north, occupy a similar relation to the Den [illegible]nge, and gold there, too, has been traced up the hill in the same way without finding parent-reefs.

Three tunnels have been driven into the hill. The lowest and longest is at the bottom of the spur at its southern end, starting from just north of James Shegog's 50a. 1r. 17p. lot, and running north-west and north for about 600 feet to meet another tunnel driven south-west from the opposite side of the hill for a distance of 400 feet. The latter tunnel is about 50 feet higher than the southern one, and its end appears to have overlapped it.

In cutting the approach to the south tunnel, boulders of gold-bearing quartz were met with in the clayey overburden. Some of this stone is stated to have been worth up to 1 oz. gold per ton. Samples of it, however, which I took, were assayed by the Government Analyst, and did not contain any precious metal. The quartz has a favourable look, but it has not been identified with that of any known reef on the hill, and its source can only be guessed at. I did not see any lode from which these boulders may be assumed to have come, and can only suggest that the clay in the approach be cut down to the bedrock, in order to see whether the latter exposes any quartz-capping underfoot.

After driving 60 feet, a vein was cut, consisting of rubbly quartz and pug, with a central parting. This has been driven upon 10 feet east and 12 feet west. In the east drive the vein thinned, and showed no gold. In the west drive it was 2 feet wide. A little gold was shown, but confined to the hanging-wall portion. The lode is bearing a little south of west, and is the same as that cut in the 60-feet shaft, where the gold-bearing material on the hanging-wall was 15 inches wide. Some gold was visible in stone which

I was told had been broken in the west drive in tunnel, and the Government Analyst's assay of samples which I took was 1 dwt. 15 grs. gold per ton.

At 300 feet in the tunnel a lode formation 6 feet wide was intersected. This carries a seam of pug on the footwall, but the formation itself is ill-defined. It has been driven upon east and west. The east drive extends 42 feet, but the lode has contracted to 2 inches of quartz. The pug marks an evident plane of movement, and the strata are disturbed on each side. The west drive has followed the lode for 70 feet, showing some good-looking quartz, which, however, never yielded any gold. In the end the lode consists of pug and rubbly quartz, only 3 or 4 inches wide.

Half a chain further in the main tunnel is a small quartz-vein, which gave prospects of gold. Towards the end small veins of quartz occur, with spurs of copper carbonate and oxide, and pyrites, between the laminæ of the slate strata, and the ground here is wet. In the end of the tunnel the slate beds (containing iron pyrites) dip to the north-east, a contrary direction to that of the tunnel above. This appears to be merely a local flexure.

The northern tunnel (dry tunnel) is on the north-east side of the hill, and has been driven S. 20° W. for about 400 feet, so that the spur right through has been accounted for. Mr. Anderson is a little doubtful as to whether a reef may not have passed between the overlapping ends of the two tunnels. I am of opinion that this has not taken place. The approach to this tunnel is in red clay, dipping south-west, and succeeded at the mouth by soft grey greasy slates. A sample of the red clay was analysed by Mr. W. F. Ward, with a view of testing its alumina contents, and the result was as follows:—

	Per Cent.
Silica	77·00
Alumina, oxide of iron, &c. ...	18·80
Moisture and combined water...	4·20
	100·00

It consequently comes nowhere near bauxite, which averages 50 to 60 per cent alumina, 2 to 7 per cent. silica, and 10 to 30 per cent. water. The alumina and water contents of the Den clay are, in fact, those of ordinary clay slate; the silica, however, is somewhat higher than in typical slate.

In this tunnel there are five small veins of quartz, 1 inch in width, and these are said to be the only ones seen on this side of the hill. Towards the end flat seams of quartz tra-

verse the country, and these pass below a band of jasperoid quartzite in the face of the tunnel. This tunnel is dry, and the country passed through has an unfavourable appearance for mineral-bearing reefs. No gold has been seen in it.

Not far from the top of the hill, on its west side, a surface north and south trench has cut through a lode of broken quartz, 2½ to 3 feet wide, bearing N. 70° E. No gold has been found at the outcrop, but some colours were obtained in a shaft sunk close by. The shaft was sunk to 57 feet, and at 50 feet, I am informed, the formation was 2½ feet wide, but barren.

A chain further north-east, and higher up the hill, a trench has been cut across the outcrop of the same lode. Flat spurs of laminated quartz and iron oxide extend south along the walls and floor of the trench. Some colours have been obtained from the gritty matter on the hanging-wall of the lode.

A long trench further east failed to pick up the lode, which would seem to be a short make of quartz. East of this trench a shaft has been put down 23 or 24 feet in metamorphic slate, and some arsenical pyrites was met with. The ground became too hard, and work was discontinued.

A No. 3 tunnel has been driven north for about 150 feet, to intersect the east and west lode trenched for as above. Three unimportant quartz-veins were intersected in this tunnel. A ferruginous formation running north and south was cut half way in, and then the direction of the adit was changed to the north-east, so as to bring it below the arsenical pyrites shaft; but the prospects are not at all alluring, as the pyrites only showed by assay something over a trace of gold; and where pyrites is poor, it is generally found that the stone is poor also.

Boulders and fragments of white-buck quartz follow the crest of the range, but no reef from which they might have been derived has been met with in the heart of the hill. They are probably the residues of local makes of stone in the country-rock.

All the gullies on the south-west side of the range have been worked, but only a little gold has been found. No reefs crop out at surface, and the bedrock on the hill is for the most part hidden below a few feet of soil. There is some very hard rock in this hill, and from experience this is an unfavourable indication. The softer rocks seem more favourable for gold, and as these occupy the low country which has been worn down by denudation, the low ground is more likely to repay prospecting than the high ranges.

A significant fact is that there is a dearth of small gold-bearing veins in the hill; on the other hand, the gold won

in the flat has to be accounted for, and it seems to me that the most probable source is some reef or formation at the base of the range, or in the flat itself. I am inclined to think that the gold in the hill-drift was derived from a different source, and represents metal set free by the waste of rather poor formations in the hill. At the same time, the proving of the spur by tunnelling has been justifiable, and, in fact, is what an inspection of the ground would at once suggest as necessary, though the way in which the work has been laid out could be improved upon.

The only work which appears to me now advisable is to cut down the approach to the low tunnel to the bedrock, and see whether the boulders of auriferous quartz can be traced to a concealed reef. There is no inducement to continue any of the tunnels further, and the lode cut at 60 feet in the low tunnel is not promising enough to invite further expenditure. It is possible that the deep shaft, if sunk further, might reach a payable horizon; but the work would be too speculative for investors of small means.

The strata in a north-westerly direction from here consist of the auriferous series of slates and sandstones, in which more thorough prospecting will certainly disclose more gold-bearing stone than is known at present. In a south-easterly direction the slates are concealed under the basalt area of the valley of the Piper. The flat country at the base of the western slopes of the Den ranges deserves better prospecting than it has had. Prospectors visit the field, spend a day or two there, and then depart discouraged. This is not the spirit in which explorers in the western part of the Island have doggedly followed the indications of mineral, and laid the foundations of the industry on that coast. The same perseverance and thoroughness of search applied to the Lefroy and Den belt of country are the best remedies for the depression which hangs over the field. It is the height of absurdity to believe that the gold-bearing reefs in this belt have been worked out, and that no gold chutes have been left behind. There appears to be a barren zone in the reefs of the Lefroy field below the critical level, but above this is an unexhausted productive zone, and below it gold no doubt exists at a depth as yet undefined. The result of work in the barren zone has been unfortunate, and is a deterrent from deep trials, causing many to believe in the final disappearance of the gold at a depth. Some day, I doubt not, a deep mine in this field will pour confusion on these timid theories. Meantime, shallow work ought not to be abandoned. The gold which has been taken out of the reefs is, it may be safely said, only a portion of the metal still contained in them. The failures in the

past have tended to indispose investors to risk further outlay at and near Lefroy; but it is certain that, without putting money into this ground, nothing will be taken out. Despite the deplorable depression which at present damps mining ardour there, I believe the undeniable promise of the field will ensure a revival sooner or later, and probably fresh investors will be found to relieve those who have for a long time been contributing their fair share towards providing for the exploration of the ground.

Phosphate rock.—On the hill-slope east of the Den spur, a few boulders of slate rock occur, having a somewhat brecciated aspect, and containing (rather abundantly in places) spherules of greenish-white wavellite (hydrous aluminium phosphate—alumina 38 per cent., phosphoric acid 35 per cent., water 27 per cent.). Where broken across, these spherules appear as small discs with radiating structure, implanted on the surface of the slate. Although only these boulders are seen on the surface, there would appear to be a line of this country, as the same mineral has been found further north; and the richness of the soil in Mr. Anderson's paddocks is noticeable. The question arises, whether the rock could be turned to commercial account as a manure. It must be remembered, in the first place, that the wavellite is confined to certain parts of the rock. If the mineral were phosphate of lime, it would, if in sufficient quantity and purity, have been utilisable in the manufacture of superphosphate (or acid phosphate, as it is called, *i.e.*, the product obtained by adding sulphuric acid to the raw phosphate rock, and converting some of the lime (CaO) into sulphate of lime ($CaSO_4$), which is soluble in water). But a rock containing phosphate of alumina only, although it may have a good percentage of phosphoric acid, is not acceptable to the manure manufacturer; and, if used raw by the farmer, will only decompose slowly, and consequently compare disadvantageously with the purchased superphosphate, which will begin to dissolve in the earth directly, and make its effects felt on the next crop. European buyers of phosphate of lime rock tolerate only 3 per cent. of oxides of aluminium and iron, and make a proportionate deduction in price for any excess, because, in the process of making the soluble product, these oxides combine with phosphoric acid, and form a phosphate insoluble in water. In America phosphates have been produced soluble in citrate of ammonia (acting in the soil), and by this process raw phosphate rock, containing a good deal of lime, can be mixed with one deficient in or devoid of it, and containing even 7 per cent. or 8 per cent. of alumina and iron oxides,

though it is still desirable to keep the latter down as much as possible.

The increasing use of Thomas' slag as a manure has affected the phosphate rock trade. This slag contains 60 per cent. lime and 17 per cent. phosphoric acid, and these are combined in a form easily soluble in water, and readily assimilable by plants. It is called basic or Thomas' slag, because Mr. S. G. Thomas conceived the idea of substituting a basic lining of dolomite for the silicious lining of the Bessemer converters, and adding lime for the purpose of eliminating the phosphorus from phosphoric pig iron. The phosphoric slag has come into great use in England as an artificial manure for clay soils. It can be bought in Launceston at £4 17*s.* 6*d.* per ton, and imported Florida superphosphate at £5 5*s.* per ton. A brisk demand has sprung up here lately for both articles.

In Tasmania the conceivable sources or matrices of phosphates would be:—

(1) The older gneissose and crystalline eruptive rocks of the north-west, and possibly in the south-westerly parts of the Island. It is true that none of the characteristic occurrences of apatite have been noted so far in any of our ancient rock-systems, but this does not exclude possible discovery, for much of the Island is still practically unknown.

(2) The Tertiary clays and sands, which may here and there enclose phosphatic layers and nodules, though it must be admitted that hitherto the organic remains found in these strata have not been abundant enough to suggest a likelihood of much phosphate being discovered. The Launceston Tertiary basin, the Swansea Tertiaries, the islands in Bass Straits, and isolated sediments of Tertiary age in different parts of the State, are possible areas for the occurrence of such deposits; and indications should never be neglected.

I have the honour to be,
Sir,
Your obedient Servant,

W. H. TWELVETREES,
Government Geologist.

W. H. WALLACE, *Esq.*,
Secretary for Mines, Hobart.

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.