REPORT ON THE TIN MINES OF THE BLUE TIER, COUNTY OF DORSET.

Government Geologist's Office,
Launceston, 7th December, 1901.

SIR,

I HAVE the honour to report having, in accordance with your instructions, visited the Blue Tier Tin District, in August last, devoting from the 16th to the 27th of the month to its examination.

The productive mines at work were the Anchor, the Australian, the Liberator; the Crystal Hill was preparing for active work; the Laffer, below Lottah, was searching for its lode; at Beale's show, at Mt. Michael, sluicing was going on. Work was not proceeding at the Cambria, the Moon, Haley's Lease, nor the Lottah. Since my return, I have heard that a little sluicing is going on at the Lease.

The Blue Tier is the mountainous boss, or range of granite, which occupies that part of north-eastern Tasmania situate between the Ringarooma River and the East coast line. It rises to a height of 2585 feet above sea-level. The top is comparatively flat or undulating, and covered with timber, alternating with open stretches of moorland. I may say the heights given in this Report are from aneroid readings only, but appear to correspond, approximately, with some of those cited by other visitors. I give the following stations:—

	Feet above sea-level.
Crown of Tier, just above Poimena ...	2585
Poimena Township	2435
Liberator Mine, top of face...	1700
Cambria shaft	1700
Crystal Hill Camp...	1460
Liberator battery	1340
Crystal Creek Bridge...	1280
Laffer Mine	1000
Anchor Mine battery...	850

The Tier has been examined by former Government Geologists, Mr. G. Thureau and Mr. Alex. Montgomery, M.A., and their instructive reports should be consulted. The titles of these are:—"Report on the Blue Tier Mining District and its Tin Deposits, Feb., 1886, by G.

Thureau" ; "Report on the Blue Tier Tin Field, Nov., 1889, by Alex. Montgomery" ; "Report on the Tin Mines at the Blue Tier, County of Dorset, Jan., 1893, by Alex. Montgomery."

This year, Mr. K. L. Rahbek was deputed by the Government to examine the Tier, and report upon the possibility of conserving water for the supply of the large mines in the district. He has reported that, by constructing a large power-reservoir on the Wheal Tasman flat, on the top of the Tier, or, rather, just on the edge of the northern fall, with a water depth of 30 feet at weir, a water spread of 200 acres, and a capacity of 134,000,000 cubic feet, 13 sluice-heads (one Tasmanian sluice-head = 24·168 cubic feet per minute), giving 375·4 actual horse-power, can be continuously supplied, first, to the four mines, the Moon, the Australian, the Crystal Hill, the Liberator, and then re-collected and forwarded to the Anchor (unmixed with any water used for dressing), giving that mine 187·2 actual horse-power. The cost of construction of the power-reservoir, with feeder reservoirs, races, and auxiliary works is estimated by Mr. Rahbek at £94,000.

I understand that the principal object of my examination of the Tier this time was to supply you with information as to the extent of the deposits of tin-ore, for consideration in connection with the above water scheme. Before giving the results of my inspection of the different mines, I invite your attention to the following brief description of the geology of this mountain range.

The granite of which the Tier is composed is that which, with textural and slight mineralogical variations, is the basement rock of the whole of the East Coast of Tasmania. At the close of the Silurian period it consolidated upon intrusion, at great depths, into the Silurian slates and sandstones. The extent to which the latter have been metamorphosed and mineralised by the invading granite can be well studied along the zone of contact, near St. Helens.

At the Tier it is a rather coarse-grained porphyritic granite, with large crystals of felspar, an inch in length, scattered through it; grey, white, or pink in colour. Its mineral constitutents are felspar, quartz, dark magnesian mica (biotite), and a little silvery potash mica (muscovite). Sometimes the white mica is quite absent; its abundance seems to depend upon the presence of tin-ore. At George's Bay, the granite contains a larger proportion of quartz and less felspar than upon the Tier.

The first element to crystallise was the mica, then the felspar, finally the quartz. This is shown by crystals of mica occurring enclosed in the felspars, and by the residual silica filling the interstices or spaces between the well-formed crystals of felspar. So far, all are agreed. The differences of opinion begin when we consider the portion of the granite which carries the tin-ore. This is not coarse as the ordinary granite; it is more even-grained, and is not porphyritic. The dark mica goes through a series of changes into silvery and greenish-white mica, muscovite (non-pleochroic). The change is first into a dark bronzy mica, and, finally, as the iron becomes gradually abstracted, into the white potash variety. This alteration can be observed under the microscope in one and the same crystal, which is partly iron-magnesia and partly potash. Often the felspar decays to kaolin, and the rock becomes softer, or there is extreme silification, and the rock grows much harder. The magnesia liberated in the decomposition of the dark mica is re-deposited as talc, which gives a greenish tinge to much of the tin granite; the felspathic material remains behind, to some extent, as kaolin. The new minerals developed in this variety of granite are cassiterite, wolframite, scheelite, fluorite, molybdenite, galena, copper pyrites. The iron pyrites may be original. No axinite has been yet found at the granite contact; this is no doubt owing to the absence of lime. Tourmaline is rare. Sapphires and topaz are found in the stanniferous gravels, and have probably been released from pegmatitic veins.

This tin-bearing granite has been labelled with different names, such as quartzose porphyrite, aplite, and, most frequently of all, quartz porphyry. Parts of the mass correspond with some varieties of the tin-bearing granite at Altenberg, in Saxony, called zwitter-rock, or stockwerk porphyry, only the latter usually has a good deal of topaz in it. Zwitter-rock is sometimes a greisen (quartz + mica), with very finely disseminated tin-ore; sometimes the mica is absent. The mica itself is a greenish fluoric potash-iron variety, which, together with topaz, has replaced the felspar. At other times the rock is nearly all quartz, and dark in colour, resembling the more quartzose varieties of the Blue Tier tin-granite. Typical zwitter-rock contains—quartz 50 %, mica 37 %, topaz 12 %, cassiterite 0·40 to 0·5 %. Varieties without mica consist of 70 % to 71 % quartz, 27 to 28 % topaz, and 1·4 to 1·5 % cassiterite. Zwitter is essentially a modified granite, resulting from a process of greisenisation, which has started from cracks and fissures.

Mr. Thureau and Mr. Montgomery looked upon the Blue Tier tin-bearing rock as an intrusive dyke traversing the country granite. Prof. Ulrich, on the other hand, regarded it as a stockwork or mineralised zone of the granite mass. When able men differ like this, it may be taken as certain that there is something to be said on both sides of the question.

The most dyke-like occurrence which I saw was on Haley's Lease, on the old Blue Tier Company's ground, not far from Mr. Ogilvie's camp. In the race a dyke-like band of tinstone is exposed for a width of two chains, running through the porphyritic country granite, from which it is separated by a small pegmatitic vein. Further east a smaller band of soft tinstone, 1 foot wide, traverses the granite, and has quite sharply-defined boundaries. Still further east, a wider vein of tinstone is seen, also separated from granite by a pegmatitic facing. I have alluded to this stanniferous variety of granite as tinstone, but am not sure that it is the best term, as it is also used elsewhere for cassiterite, the ore of tin. The above occurrences cannot be considered as conclusive, for they are associated with pegmatite veins, which may have been the mineralising channels.

The two strongest objections to the dyke theory are:—
1. The irregular boundaries of the tin-bearing granite;
2. Its occurrence in the form of floors.

1. By referring to the annexed map, a fair idea may be formed of the shapeless development of the tin-bearing rock-mass. At the Anchor Mine it disappears to the N. and E., under a capping of country dark mica granite, a very singular thing if it is a dyke. To the N.W. and W. the Anchor stone extends to the Crystal Creek, passing under some country granite on the E. side of the road bridge; then, W. of the creek, the altered granite, at first non-stanniferous, and then tin-bearing, continues west through the tin properties of the Crystal Hill and Liberator Companies, merging into ordinary country granite at the Working Miners' Creek, on the western boundary of the Liberator. Again, from the Crystal Hill, a narrow strip of tin granite extends at right angles to its previous direction, due north through the Australian sections and Haley's Lease, across the Wyniford to Beales' sections at Mt. Michael, spreading out like a fan as it approaches the Wyniford, and, apparently, connecting with the Moon property on the east. In the middle of the Crystal Hill sections, some of the unaltered country granite has survived. The

irregularity of the contour of the formation seems irreconcilable with a dyke origin, and, in addition, the general structure of the stone differs from that of elvan dykes. The latter are generally coarsest in the middle, and finer-grained near the sides.

Apart from elvans, wide granite dykes often traverse granite masses, but in the present case there is no parallelism of the sides of the formation—no walls, nor anything to suggest that the tin stone is the filling of a fissure.

2. There is a very striking indication of floors in the Anchor Mine. The tinstone in the old eastern workings lies under the barren country granite, which ascends the hill thence to Lottah (see Fig. 1, at the end of this Report); a flat seam of quartz and bronzy mica, with a few large felspars, forms a horizontal floor separating the tin-bearing stone below from the coarse (here decomposed) granite above. A face of about 30 feet of the latter is exposed at this bench. Just below the seam is some white quartz and coarse tin, and, within six inches of it, I noticed a large felspar crystal quite enclosed in the tinstone; this was evidently due to the influence of the dividing seam. We have here a good example of a horizontal boundary or floor. Practically the same phenomenon is repeated in the top workings of the mine, where dark mica granite rests upon the tinstone, and has to be stripped before the latter can be worked. This granite overburden may be expected to decrease towards the west, and increase towards the east. I infer this from the fact that the modified stone rises about 400 feet to the road in a north-westerly direction, while northwards it is hidden beneath the huge granite mass which ascends from Lottah to Poimena. On Haley's Lease, at the old McGough's tunnel-pit, 1400 feet above the Anchor face, the country granite (also decomposed) occurs overlying the tin-rock, as shown in Fig. 2, at the end of this Report.

All over the field fluorite is associated in small quantities with the tin granite, colouring and facing joint-planes, as well as permeating the substance of the rock. There are large patches of this violet mineral in the rock at the Liberator. I found it also in the stone at the Anchor and Australian Mines. We know that there are good reasons for believing that tin ascended as a fluoride, and, if so, the resulting fluorine compounds formed powerful agents in the decomposition of granite, and its conversion into the modified rock, which carries the tin-ore. It is not surprising, therefore, to find the granite silicified, its mica

altered, secondary talc abundant, chlorite also present derived from liberated magnesia, and fluorine minerals developed. In the No. 2 trench at the Crystal Hill Mine, there is an interesting development of pale green fluor-apatite in prisms, in hard reddish tin granite.

If the fluoride ascended through the channels afforded by the jointings of the granite, and was in quantity sufficient to permeate the rock for some distance on each side, or on one side only, as the case might be, altering its constitution, and depositing the tin-ore, the origin of the present stanniferous deposit may be realised without resorting to injected or intrusive material. A proof of this process, to some extent, is the nearly universal incipient greisenisation of the granite wherever it is tin-bearing, and the restrictions of the tin-ore to greisenised granite. As a rule, the greisenisation is not complete; there is generally more or less felspar undergoing alteration into muscovite. Completed greisenisation consists in the elimination of the felspar from the granite, accompanied by a silicification of the rock, and a large development of muscovite and lithia mica. As mentioned, there is a notable accession of such minerals as tin, tourmaline, fluorite, &c. The change is brought about by vaporous (pneumatolytic) "after action" of cooling granite, the vapours and solutions ascending through crevices, &c., into the already cooled upper zone of rock, and slowly pervading and corroding the whole mass, and modifying its nature, as described above.

This conversion of country granite into tin granite, in certain zones, produces an appearance of the latter being an intrusion, but, upon the above theory, while the introduction of the tin was subsequent to the formation of the granite, the latter is still in place, and has not been subjected to any movement or disturbance.

The frequent occurrence of veins and druses of pegmatite, *i.e.*, segregations of large crystals of intergrown quartz and felspar, accompanied by crystals of mica and coarse tin-ore, also illustrates the "after action" of the granite involved in the deposition of tin. These pegmatites may be seen everywhere, *e.g.*, on Haley's Lease, at the summit of the Tier; in the face at the Liberator Mine; notably at the Laffer Mine; at the Anchor Mine; and on the hill-side going down from Lottah to the Laffer.

While, for the present, I think that the theory of intrusion lacks the support which the greisenisation theory possesses, I consider the question of permanence in depth is unaffected by either hypothesis. The solutions carrying

tin and its associated vapours have ascended from unknown depths, and, within the zone of deposition, there is no known reason why concentrations should not be equally rich at one horizon as at another. The deposition may be assumed to have been governed by the physical conditions existing at the time. We know that the tin granite on the Tier is 1500 feet higher than that at the Anchor, and 1100 feet above the Don face at the Australian; and this ore zone may be safely reckoned upon as descending beyond the depth accessible to mining.

Dykes.—There are a few dykes of eruptive rock, which traverse the granite. These are basic, and have usually been taken for Tertiary basalt, which they greatly resemble. Microscopical examination shows them to be dykes of diabase. [Constituents = plagioclase felspar + augite, the latter greatly chloritised: structure = diabasic. No olivine.] There is a dyke of this kind, about 50 feet wide, in the granite, crossing the road S. of Lottah at the Horseshoe bend, between Lottah and the Anchor manager's house, and said to be traceable eastwards for 3 or 4 miles. Stones belonging to the same dyke are seen on the track near the office at the Anchor Mine.

I saw a wide dyke of similar stone on Haley's Lease, a little north of Ogilvie's camp. There is another one on the Lease about 30 chains further north. These dykes are all roughly parallel, taking a N.E.-S.W. direction. They are of Mesozoic age, consequently younger than the deposits of tin-ore, and have no bearing whatever upon its deposition.

Distribution and Grade of Ore.—The quality of the tin-ore from the Blue Tier mines is excellent. The average of the whole district is about 72%, some of the produce reaching a higher figure. The ore is remarkably free from iron; in some of it, however, traces of copper are present.

There seems to be no rule for making use of the distribution of the ore in the tin-granite (*Germ.* Zinngranit). I could see nothing to show whether the tin has been concentrated in the middle of the formation more than towards the margins, or *vice versâ*. The patches are quite irregular, and will, I believe, be found to be more dependent upon the natural fissuring of the rock than upon any law of segregation. In some places the stone is rich and heavy; elsewhere, practically barren. Taking the formation as a whole, the probabilities are that the ore contents will range from a shade under $\frac{3}{8}$ to about $\frac{5}{8}$ of 1% black tin. An average of $\frac{1}{2}$% ought to be expected from most of the mines.

The percentages ruling at the different mines are:—At the Anchor, about $\frac{3}{8}$%, passing all stone through the mill; Australian, $\frac{3}{4}$ to nearly 1%; Liberator ranges from $\frac{1}{2}$ to nearly 1%, averages $\frac{5}{8}$ to $\frac{3}{4}$%; Haley's Lease used to yield $\frac{3}{8}$%; the Moon, $\frac{3}{4}$ to $1\frac{1}{4}$%. At the new Crystal Hill Mine, now being opened out, I took samples from each face indiscriminately, without picking or seeing whether any tin was visible or not, and the total assay was 0·6% metallic tin, or (at 70%) 0·85% tin-ore. Large deposits of $\frac{3}{4}$% stone undoubtedly exist, but then, again, poorer areas come in to reduce the average, which, from all appearances, is in the neighbourhood of $\frac{1}{2}$%, taking the Tier as a whole.

The Anchor stone appears to be the lowest on the list, and in the district it is generally considered the poorest stuff. I fancy this is largely owing to the fact that the mine is being operated upon a large scale, and that the stone is not selected, but broken down from the faces and passed through the battery just as it comes. It is certain that if the other mines commenced to clear away the whole of their formation without selecting promising places at which to attack the deposit, the per cent. yield would be somewhat reduced.

Anchor Mine.

This is the most important and best equipped mine in the district. It is situated just to the S.W. of Lottah, on the slope of the hill above the Groom River. It was reported upon by Mr. Thureau in 1886, and again by Mr. Montgomery in 1889 and 1893. Work has been carried on here for over 20 years intermittently, but until the present management took the mine in hand, imperfect and costly methods have been the rule. Prior to the end of 1892, 30,734 tons were crushed, returning 288 tons tin-ore, equal to ·937%, but, with work on a larger scale, the average yield of the stone has decreased. For the 21 months ending June, 1901, 111,167 tons stone have been crushed for 434 tons tin-ore, equal to 0·39%. The company's ground covers 315 acres, but the actual work of winning ore is, so far, confined to an area of about 12 chains square, which is being slowly enlarged as the upper face advances north into the hill. The formation, or matrix, of the ore is the tin-granite described above. Generally, the felspar of the granite has not been wholly removed, and the rock is not very hard. In the Pentridge face, however, the rock is quartzose, and excessively hard; so hard that it has been taken for lode-stuff.

It belongs, however, to the same formation as the other. This eastern face carries good stone, of a quality near 1%. Twelve feet below it, 100 tons of tinstone were taken out by Mr. Mitchell, yielding 2% tin-ore. A tunnel has been driven 150 feet into this hard rock, and 75 tons of stone, taken out for a trial, gave 1% tin-ore.

The faces now being worked are 10 or 12 chains west of the above workings, and extend up the hill for a vertical distance of about 200 feet. No. 1, the lower face, forms a crescent 300 feet in length by 55 feet in height. The whole of the rock is broken down and trucked to the stone-breaker without selection, for all of it contains tin. Green mica and talc give a greenish tinge to the rock. A little fluor-spar accompanies quartz leaders; no bismuth or galena has been observed, only a little copper pyrites. Special concentrations of ore may be seen in floors of the greisenised rock and in nests. The principal joints and seams run E.W. and N.S.; minor ones traverse the rock in all directions. Tin is always looked for in and near the seams.

No. 2 face is about 150 feet above No. 1, and No. 3 is 50 feet above No. 2. I ought to say that 35 feet below No. 1 a tunnel has been driven for 250 feet, and 50 tons of stone were taken out and raised by horse-power to the stone breaks, and returned a good yield at the battery. It may be added that in the No. 1 face the stone on the whole keeps the same in quality from top to bottom, with, of course, richer and poorer patches occasionally.

No. 3, the uppermost face, has more stripping than the others, and the tin formation is covered by about 18 feet of country-granite, of which there is only a little in the N.W. corner of No. 2 face, and none at all lower down in No. 1 face. The tinstone in the upper face is of the usual character, except that it carries more leaders of stanniferous quartz.

A new epoch in the history of the mine commenced when the present general manager, Mr. R. Mitchell, took charge of the work, and readjusted the dressing plant. New faces were opened, and the property was prospected, both by tunnels and boring, with the diamond-drill. In 1899 nine bores were put down, five of which are in advance of No. 1 face, three being near the old eastern workings, and No. 9 600 feet further north. As a general result, the bores show that the rock is variable as a tin-carrier. The ground to the north of the upper face has not been tested by boring, as, before starting there, the drill was required by the Government.

The dressing-sheds contain two 50-head batteries, with 1000 lbs. stamps and accompanying classifiers, jigs, vanners, settlers, and buddles; the dressing is automatic and efficient. With full water supply, the 100 stamps will crush 100,000 tons of stone a year; but, unfortunately, for want of water, the 100-head have never run for long continuously, and the average number running last year was only 34. The management claims that when in full work the ore can be raised and treated for 2*s*. 6*d*. per ton of stone. The average hands on the pay-list for the past twelve months have been 112, and for full work not more than about 30 additional would be required. It is easy to see how desirable it is to obtain water-power sufficient for driving the complete plant. I was told that the question of transmission of power by electricity had been considered, with unfavourable conclusions.

The company have water-rights for 43 head, and, if that amount of water could be obtained, there would be no difficulty in driving the whole of the crushing and dressing plant. The new race, when completed, will extend 39 miles to the South George River; the first section goes 26 miles to the North George, tapping Waratah Creek, &c., on the way, and the remaining 13 miles to the South George will be constructed subsequently. In this way, it is hoped that ample power will be provided; whether this hope will be realised remains to be seen.

From the above, it will be seen now that the thing needed to make this property a success is an assured water supply at all seasons; provided, of course, that the tin-contents of the stone do not fall to a percentage which can no longer be extracted profitably. The manager assured me that he can pay expenses with 50 head of stamps; and, if this be so, it not only speaks volumes for the economical handling and efficient treatment of the material, but is also suggestive of the return which may be anticipated when the full 100 head are running continuously. What is done here may also be done at other mines in the district if the same care and skill are exercised.

Assuming the grade of ore to continue, and it seems safe to do this, the quantities necessary for success may be reasonably considered as existing. The ground for some depth below the lowest face and between the lowest and the top faces has been proved by the diamond-drill to be tin-bearing. Of course, in this area there are poor patches as well as good ones, but there is no doubt of the tin-bearing formation existing continuously north and south between

the faces for a total horizontal distance of 8 chains, and I think it may be legitimately accepted that the per cent. value of the stone for that distance will not be less than that shown by the battery returns the last few years, viz., 0·39%. The width of the formation has been proved for about 12 chains, but there is a good deal of broken ground, and, in my calculation of quantities which may be reckoned upon, I have confined myself to the width of the present workings, viz., 4 chains, leaving on one side the eastern ground, the value of which cannot be easily estimated. The eastern ground will probably swell the total output, but I am stating a minimum for the information of the Department, not a maximum for the gratification of shareho'ders. The proved block of stone to be taken out will then measure 8 chains long by 4 chains wide by 0 to 200 feet high, which (with a sp. gr. 2·67 × 62·425 = 166·67 lbs. per cubic foot) will total 1,037,142 tons, or, allowing 20% for barren interspaces, 829,714 tons tin-bearing stone. This quantity will suffice to feed 100 head of stamps continuously for eight years, and the tin-ore contents at 0·309% would be 2563 tons. This output can be increased by the produce of the eastern workings, but most of all by the advance of the faces into the hill north of the present upper workings. The eastern workings cannot be extended far to the east without coming under a heavy cap of country-granite; still, the ground explored up to date there will give a large output. Again, in the principal workings every additional chain of width taken in the face means nearly 200,000 tons more of material, or a couple of years' more work between the levels of existing faces.

A question of interest is whether the tin-granite will rise with the hill, or the overburden of barren granite increase, as the work advances. From my examination of the country surrounding the workings, I am led to believe that the overburden will be heavier east and north of the present works, but that it will decrease towards the west and north-west. Tin-granite is seen on the road N.W. of the mine and 500 feet above the lowest face, and I believe the future development of the mine will disclose a continuous vertical section of 500 feet; but whether it will all be payable stone cannot be ascertained beforehand, except partially, by use of the diamond-drill. The tunnel below the lowest face has also shown that very good tin-bearing stone is going underfoot. The full quantity of stanniferous rock existing on the property cannot be estimated without making as-

sumptions unverifiable in the present stage of development. It is not known, for instance, how far the percentage of tin may fall in the zones of rock which have not yet been proved; and, without further boring, it is not absolutely certain that concealed floors of barren granite may not interrupt the continuity of the formation here and there. But if, after extending the present faces right across the property, the ground throughout proves good enough to send to the battery, then, I estimate, there is stone enough on the company's sections to keep the mill going continuously for between 40 and 50 years.

The present low-grade of the stone treated, compared with crushings in previous years, is just sufficient to cause some anxiety as to the future; but I believe it will bear a further slight fall in the percentage, and still pay. Such fall would possibly be met by a correspondingly slight reduction of mining cost in handling full quantities of stone. The tin-market, too, must be considered; the last two years it has been favourable, and there are no signs of any serious permanent fall, but an unexpected change might dislocate working results for a time.

The other mines on the Tier will do well to note the experience of the Anchor. One lesson to be learned is that mining, or, as it is here, quarrying, must be accompanied by properly-arranged dressing plant and efficient dressing. The saving of the ore is as important as its mining.

If the new race fulfils the hopes which are formed of its capacity, then the Anchor Mine will be in an independent position as regards water supply; but experience with long partly-flumed races has invariably shown that great loss of water takes place, and it may be that the 187 horse-power promised in Mr. Rahbek's distribution scheme will prove a welcome addition. One thing is very clear. Unless the Anchor gets the full power necessary to drive its machinery (estimated by Mr. Rahbek at 275 h.p.), it will never pay dividends. It appears to possess enough ore-bearing stone to utilise any quantity of water that can be brought to the mill. It occupies an important position among the surrounding mines, and, if it can be brought to a dividend-paying state, the field will receive a great stimulus.

Australian Mine.

Australian Tin-Mining Company, No Liability.—The battery is about 1¼ mile W. of Lottah, and the property extends up the hill northwards to a height of 1000 feet.

above the creek at its base. The old upper face, the Puzzle, is about 600 feet above the battery; the lower, the Don face, which is the one now being worked, is a little lower than the mill, with which it is connected by a tram 23 chains in length.

The formation is the tin-granite, a continuation of the Crystal Hill stone on the south, and connects with the same rock on the summit of the Tier, running through Haley's Lease and across the Wyniford to Mount Michael. From its apparent narrowness, it has been surmised to be a dyke of intrusive rock, but I have already explained my reasons for regarding it as a zone of altered granite. At the base of the hill it expands into a J. shaped mass, one arm of the J. extending W. to the Liberator, the other arm to the Anchor, a form incomprehensible on the dyke theory, but natural enough on the supposition that the permeation of the rock proceeded from joint planes. To explain the expansion, it used to be supposed that a lode runs E. and W. through the formation.

There is no essential difference between the formation at the Puzzle face and that at the Don. No systematic work has been done in the way of testing the ground between the two faces. The probability is that all the intervening rock is tin-bearing. Why it has not been prospected, and faces opened up, is incomprehensible.

The two faces at the top of the hill (Puzzle) have been abandoned since 1899 in favour of the Don workings at the bottom. The rock at the Puzzle faces is a greenish micaceous variety of the tin-granite merging into a more felspathic kind. It contains some iron and copper pyrites, and nests of crystals of mica, and some of it is very hard. The faces are about 60 feet high. When work ceased here, the published accounts show that the stone was returning $\frac{3}{4}$% tin-ore. The first returns were $1\frac{1}{2}$%, and the disappointment at subsequent crushings failing to maintain this yield serves to indicate the altogether erroneous conception of the nature of this huge stock of stone. Selected crushings are no guide to the value of the deposit as a whole.

Meantime, at the end of 1898 the Don claim at the base of the hill was taken over, after trying 25 tons of the stone in the battery, with the usual result of an abnormally-high return, viz., nearly 2% tin-ore. The next crushing, however, returned about 1%, and, during the first half-year in 1899, 2206 tons of stone were crushed for 20 tons, equal to

0·90% ore. In 1900, a poor patch of stone was encountered, which threw the average back to nearly ½%; but this year the yield has come up again, as follows:—

1st six months, to 28th February, 773 tons stone...	¾ per cent.
2nd six months, to 31st August, 1075 tons stone....	0·93 per cent.

This is a high percentage for the district, but not high enough to counterbalance the drawbacks which exist in connection with the handling and treatment of the stone at this mine. It seems safe to reckon that the Don face, as a whole, is capable of returning about ¾% tin-ore per ton of stone. I have no doubt, however, that work on a large scale, and including other parts of the property, would involve some decrease in the percentage yield. The average smelting works assay of the ore is published at 73%.

Fresh capital has been introduced into the undertaking this year, and the machinery repaired and overhauled. This work was going on at the time of my visit, when the battery, a 30-head one, was, consequently, idle. The motive-power is steam, and there was no means of substituting water-power in winter, when there is a good supply. This defect is being remedied by providing a Pelton wheel. Other drawbacks are irremediable without entirely new plant.

The Don faces are about 45 feet in height, the upper 15 feet of which are composed of rather barren rock, called the overburden. This is rejected in working, and the rest is sent to the battery. On the present restricted scale of working, only the selected stuff pays to treat, but, on a large scale, it is a question whether it would not pay to put the overburden through also, for there is no real difference between this and the lower part of the face; the latter is only richer in tin. Whether the overburden really will increase as the formation goes into the hill cannot yet be stated, though appearances point that way. On the other hand, stanniferous stone crops out higher up, towards the N.W. This "Don" formation has been proved for 4 chains in width by two faces.

On the top of the hill, good stone has been disclosed by prospecting north of the Puzzle face, and, I believe, tin-bearing rock could be uncovered all the way down the mountain-side. Mr. Rahbek's scheme provides 100·5 horse-power for the Australian Mine, and this, he estimates, is nearly double what is required for the mill.

The mine has been grievously mismanaged in previous years, but it is, nevertheless, a property which has the elements of future prosperity. The work which has been car-

ried on has failed to do justice to the property. Large quantities of stone exist, and could, with an efficient mill, be treated profitably.

I have to thank Mr. J. W. Palmer, the former manager, for showing me the faces, and Mr. Hugh Dempster, the present manager, for facilitating my examination.

Liberator Mine.

This property covers 120 acres, 6 miles W. of the Anchor. As far back as 1892, Mr. Montgomery found some prospecting work going on, in the form of surface-sluicing and shallow-shaft sinking, at the top of the hill. In 1896, the undertaking came into the hands of the Anchor Mine proprietors, who have since expended about £30,000 in developing it. Work on the present scale was started in the winter of 1898, but crushing has been intermittent from insufficient water supply; in fact, taking the whole year round, the supply is less than half what is required. In the dry season, consequently, crushing has had to be stopped. The supply is being increased by a new race bringing water 7 miles 57 chains from George Creek to supplement the quantity hitherto derived from the Groom River and its branches. When I was at the mine, about 4 heads of water were being got from the new race, and 3 from the Groom, which is about sufficient for all purposes; but the dry season will still present a difficulty.

The mine has a neat and efficient battery of 20 head of stampers, each full weight, 1000 lbs. Pelton and breast-wheels (2 feet breast, 10 feet diameter) actuate the machinery, which includes 8 jigs, 9 vanners, 2 buddles, besides electric light plant. With full water supply this battery could crush from 18,000 to 20,000 tons of stone per annum, and that is about as much as the present tramway can conveniently convey. If the motive-power for the mill were equal to this scale of work, a wonderful improvement on the present turnover would result. In 1899, only 3000 tons stone were crushed, averaging $\frac{3}{4}$% tin-ore; in 1900, 3100 tons stone were crushed, averaging $\frac{5}{8}$% tin-ore. The stone goes to the battery without selecting, and the ore is dressed up to about 73%; the range has been from 72·3 to 73·8%. Some of the rock crushes easily, but some is very hard. As a rule, the softer rock yields the most tin. To enforce how essential it is to base calculations for permanent work upon large quantities, I may instance this mine, in which a day's crushing will sometimes return nearly 1%, and the next day only $\frac{1}{2}$%. Fig. 3 at the end

of this report is a sketch of the main face. Two faces have been opened up at the top of the hill, about 300 feet above the mill. The main face is 31 feet in height, and has been worked down in benches to an enclosed floor. Exit is obtained by a short tunnel, through which the stone is trammed to the inclined-way and run down to the battery.

The stone is the same tin-granite as prevails at the Anchor, though much of it is somewhat harder. This is marked 6 in sketch. The hard stone in the lower 15 feet contains nests of tin-ore; one crystal weighing 9 lbs. has been found in it. Some molybdenite is present, and fluor-spar is often associated with it in nests, as a rule pervading the granite mass generally, and not in definite veins. Patches of flour-stained rock (C) prospect very fairly for tin. The stone is richer in the neighbourhood of seams (A); the appearances suggest the diffusion of the tin along horizontal floors rather than in vertical zones. In one of the quarries large tin-crystals are found in nests of good-sized crystals of quartz.

A third face, a little west of the others, is rather iron-stained and oxidised in the seams and joints. Fluor-spar here covers large faces of the rock, and molybdenite is freely disseminated throughout the stone in minute scales. Work had been suspended in this face from fear of contamination by iron, but, as the assays have returned 68·6% tin, it is intended to resume operations.

On the section north-east of the battery, as much as 150 tons of ore are said to have been taken from the creek in the old days.

North of the faces, for about 40 feet, the surface of the ground has been stripped to the bedrock, and prospecting-holes have been sunk. The faces cannot attain greater height, owing to their position on the top of the hill.

On the western section, about a third of the way down the hill, some prospecting work has been done in tin-granite, and the result is rather encouraging. These are called No. 4 workings, and the stone is softer than that in the upper faces, much resembling the formation at the Crystal Hill. Ten bores have been put down into the rock for 5 ft. 6 in. to 6 feet; a small pit has also been sunk 9 feet, and a drill-hole bored in the bottom for 4 feet. The prospects from the shaft go about 1%, and the average from the bores was, I am told, $\frac{3}{4}$%. It is proposed to send down the stone from here by a shoot to junction with the tramway from the Cambria Mine.

The tin-country is evidently continuous from the Crystal Hill, but none has been seen to the west of the Liberator ground beyond Working Miners' Creek. The ground between the present face and the battery does not seem to have been prospected at all, but I believe that a little work done upon it would show that faces equal to the present ones could be started much nearer to the mill. This is what is required to make the mine a success, namely, an extension of the scale of working. The stone is harder than the general run of stone at the Anchor, and the quantity broken from the face daily is about 3 tons per man, breaking and trucking; consequently, the mining cost must be higher than at the Anchor; but this could be greatly reduced by increasing the output.

At present this is a small mine, working intermittently, with a straitened water supply. The new race is expected to remedy the latter drawback, and it certainly will do this, at least partially. With increased water, the output must be raised, in order to bring the mine into a healthy condition. Mr. Rahbek's scheme provides for giving this mine 100 horse-power, which would be far beyond all possible requirements. Exploratory work must be kept up, and additional faces opened, if the mine is to lead any other than a lingering existence. It is a property of distinct promise; it is in the same great tin-bearing formation in which the Anchor, Crystal Hill, and Australian are situated. The per cent. yield of the portion worked has been equal to any of the others, and there is every reason to believe that, if it were opened out more extensively, and the necessary water were available, it would justify the hopes of its proprietors more thoroughly than it can be expected to do under present conditions. Mr. Jas. Scott, mining manager, kindly showed me around.

Crystal Hill.

The Crystal Hill Tin-Mining Company, No Liability.—This property comprises 130 acres, south of the Australian Company's Mine, and between the Liberator and Anchor properties. The hill comprised in the sections consists of the tin-granite of the district, most of which at the surface is tin-bearing to a greater or less extent. When I was there, a battery of 10 stampers was being erected, which it was intended to drive by steam-power, storing water for dressing by means of two or three dams. Mr. Rahbek's programme would supply this company with 3 sluice-heads, giving 91·2 horse-power.

The present battery is altogether too small for permanent exploitation of the deposit, as, even after making allowance for the stuff being softer than obtains at most of the other mines, I do not think the crushing-power will exceed 15,000 tons per annum.

There is a fair area of stanniferous ground, though there are portions which, apparently, would not pay to work. The main source of supply for the battery is the western hill, which, for a length of about 18 chains, has been trenched and cut into at five points, the highest about 80 feet above the lowest. The backs obtainable above the battery tramway appear to be 80 to 90 feet. The stone is very favourable for crushing. Faces can be opened easily, and there is no difficulty in conveying the stone to the battery.

Tests have been made of the quality of the stone from time to time, the most reliable results from this part of the ground being about 1%. I sampled the five faces just mentioned in a perfectly fair and indiscriminate manner, without any selection or examination of the stone, and my material, when assayed by Mr. W. F. Ward, the Government Analyst, returned 0·6% metallic tin, or 0·856% tin-ore. I feel some confidence in this yield as a fair average of the stone which is accessible. It is true that parts of the deposit will be found exceeding 1%, but poorer patches may also be looked for, which will reduce the average yield. The ground cannot be thoroughly prospected without the diamond-drill, but, so far as surface-indications go, the stone compares well with that of any of the surrounding mines. Its nature tallies most of all with the stone of the neighbouring Australia Mine. The quality will certainly vary, as may be seen already at the surface in different parts of the property, but the formation, as a whole, will not cut out in depth, and, if the undertaking is wisely managed on an adequate scale, I anticipate a prosperous future for it. I will now describe the other points which I examined.

Gaunt's Shaft Face, No. 3.—This is on a low saddle, east of the camp, and has yielded the best stone on the mine. A cut has been made into the stone about 6 feet deep, but its width has not been proved. A small shaft, between 15 and 20 feet deep, has been sunk, only a few yards ahead of the cutting, and has gone about 8 feet deeper than the latter. Water prevented my seeing the bottom, so I cannot say whether the rich stone of the cutting continues into it; but I understand the quality was irregular. The tramway can be taken round to this face, and the deposit will

certainly be found useful for mixing with the general stone, and keeping up the desired average. The quartz-leader, or indicator, here is the strongest which there is on the property. On all these mines the tin-granite is intersected by thin stringers, or veins, of quartz, running in all directions. The miner looks upon these as indicators of tin, and searches for them before breaking any ground. They may be seen very plainly developed on the Crystal Hill and Liberator sections; in fact, wherever the formation is tin-bearing.

The other workings, east of the camp, are somewhat removed from the battery, and are not available unless a cutting or tunnel is made through the saddle of the hill. For some of them a lower battery-site would have to be chosen.

Apatite Trench.—This is No. 2 of the eastern workings, and has been cut 8 feet for a length of 12 feet, yielding good specimens of tin-stone. The rock is reddish and somewhat peculiar, being a mixture of felspar (orthoclase and plagioclase) and apatite. The latter (fluo-phosphate of calcium) is abundant, in the form of pale green hexagonal prisms. Its occurrence is, undoubtedly, connected with the introduction of tin. Nothing has been done at this point beyond simply exposing the stone.

Elvan Trench, No. 1.—This is still further east, and cannot be worked to supply the present battery, but it shows that the tin-formation continues over a wide area. It has been driven about 60 feet into the hill, crossing an elvan dyke 14 feet behind the end. The dyke is composed of $1\frac{1}{2}$ feet of soft granular granite, of much the same nature as the country-rock, with about 4 feet of clay towards each side. It stands vertical, and runs E. and W. No tin was found in the trench until after passing through the elvan, and then a fair quantity of payable stone was met with. Near this trench the country has been stripped to the bed rock, exposing greisen with crystals of tin-ore. Here, as elsewhere, quartz leaders form indicators.

No. 5.—This is a small cut on the north side of the hill, above the road, opposite the Australian, in yellowish soft granite, containing a little fine tin. It had only just been opened, indications having been found while grubbing an old tree.

No. 4.—This consists of workings $\frac{1}{4}$ mile W. of the camp, and is a large formation of rather soft stone, in which an excavation has been made, 23 feet deep, and a tunnel driven. The softest part has been sluiced, and over a ton of tin said

to have been taken out of it. From the size of the excavation, I should judge that yield to represent about ¾% tin-ore. The ground worked is reported to have been irregular in quality, but tin-bearing all through.

The extreme eastern and extreme western portions of this property will probably be left alone for the present, and attention concentrated on the central part. The trial which will be given it by the small battery will test the superficial part of the deposit, and will most likely induce the owners to try more extensive work by-and-by. The mine has several good points; plenty of stone, ample timber and firewood; the stone is of easy nature for crushing, can be mined cheaply, and the main road is close at hand. The only drawback is the necessity for using steam. To develop into a permanent concern, work must be undertaken on a larger scale than contemplated at present. The stone will have to be taken just as it is, and treated for what it is worth. It will, no doubt, be found to vary in quality, the same as at the other mines on the field, but in the ore-zone there is every chance of its maintaining a payable average, even working with steam, and *a fortiori* with water, if the water conservation scheme on the Tier is initiated. I have to thank Mr. E. Hall and Mr. J. Stott, mining manager, for attentions during my visit.

Tin Properties on the Summit of the Tier.

Similar tin-bearing stone to that which is worked at the Anchor, Australian, Liberator, and Crystal Hill, is found at the top of the Blue Tier, 1700 feet above the Anchor Mine. An uninterrupted connection can be traced up the hill to the Puzzle, and then right through Haley's Lease to Beale's at Mount Michael. A similar connection cannot be made out between the Anchor and the Full Moon, as a body of country-granite caps the Anchor deposit northwards; but the Moon is apparently a higher floor of the tin-bearing stone, and has probably a lateral connection with the stone on Haley's Lease.

The tin-stone passes right through the crest of the Tier, and is worked also on the northern brow. There are three properties here which are worth attention, and form three natural groups, capable of being worked as separate mining propositions, but, from their elevated position on the watershed, they cannot be developed so easily as the mines which are lower down. Indeed, the problem of their profitable

exploitation is one for the engineer. Nevertheless, there is every appearance of a great store of tin-bearing stone upon this lofty plateau, and the means of utilising it demands consideration.

Haley's Lease.—Mr. J. Ogilvie showed me this property, which, I understand, comprises 180 acres, viz.:—Ogilvie, 80 acres; Johnston, 20 acres; Gee, 80 acres. There is a continuous run of tin-granite from the top of the Tier northwards to the head of the Wyniford River. The connection of the stone with the Australian sections to the south has been proved by the work done on the old Crowther's and Ethel sections. At surface the tin-bearing rock is not very wide. It forms a strip 1 to 3 chains wide on the Lease, and this has caused it to be regarded as a dyke. I prefer to regard it rather as granite impregnated with tin, and altered on one or both sides of a vertical joint plane. This plane is not even always vertical, and hence we cannot tell how far the tin-bearing rock may extend laterally underground. There is some evidence of such extension eastwards from Haley's Lease into the Full Moon property.

On the south section of the Lease (Ogilvie's section) we have country-granite on both the east and west boundaries, the strip of tin-stone running through the middle of the section. I saw some workings in yellow soft felspathic tinstone, to a depth of 25 feet, carrying good tin. The formation here is between 2 and 3 chains wide. Very good prospects were obtained. On the western wall, a rich seam was worked as alluvial, so long as it was sufficiently soft; when it hardened, it was abandoned. The ground here is patchy, and might possibly average anything between ½ and ¾%. Further north (south of main workings) a soft formation has been worked on the east wall, proving very good. As a rule, this upper floor of tin-granite on the Tier is more felspathic and less quartzose than the stone in the mines below. At the main workings there are two large pits excavated, the first to 30 feet; the second, a few yards further north, is 40 feet deep, from which the stuff went down through a pass to the branch tunnel below. The tin-stone comes to the surface in massive, jointed blocks. Its width does not appear to be proved at this point, and I shall not be surprised if it is found to join the Full Moon run of stone to the east. The tunnel level is 40 feet above the old battery floor; by cutting down a few chains below the camp, several feet more might be gained, and I was told that a good deal more backs could be got by cutting for nearly

half a mile further. This cutting would drain the mine to its present level, but any increase in depth will necessitate pumping. Mr. Montgomery suggested that the water pumped up might be used for dressing. If water-power is to be used, a battery will have to be erected lower down the Wyniford. Other plans of working the mine are more problematical, such as tunnelling through to the southern fall above the Australian, or connecting with the Lottah tunnel, *viâ* the Moon properties. In the old days, mining and concentrating cost 6*s*. 6*d*. per ton, and the stone, according to the company's accounts, averaged ·6486% black tin, assaying from 65·8% to 73%. With improved plant and management, the cost could now be reduced considerably, but it would not, I think, be wise to reckon on a higher percentage yield from the stone. On the contrary, with an augmented output, the tendency would be towards a diminution of the average.

The holders of the Lease properties regard the flat, a mile lower down to the N.W. (the site, I believe, of Mr. Rahbek's proposed compensation reservoir on the Wyniford fall), as the place where water could be conserved for their battery. They consider that a long low tunnel from that side would give them a hundred feet additional backs.

Just N. of the camp, a dyke of diabase (dolerite), formerly supposed to be Tertiary basalt, crosses the formation in a N.E.-S.W. direction.

The tin-stone continues without a break through Johnston's and Gee's sections to the Wyniford River, and has been trenched across at several points. On Gee's section a 30-feet shaft was sunk on what was always considered to be rich stone, but had to be stopped, owing to insufficient pumping-power. There is none of the stone left now at surface, it having all been carted away and crushed. The formation-rock is the soft greenish variety of the Australian and Crystal Hill tin-granite. A long open drive was begun from the Wyniford, and driven south, as an approach to an adit to connect with the shaft at a depth of 50 or 60 feet; but this work was never completed. It is rather singular that no ore was got from the drive.

There is, apparently, not the great mass of tin-stone on this property that there is at the mines on the southern slope of the Tier, but the average yield will be nearly the same, and there is enough ground to make the group well worth attention. I firmly believe that the underground extension of the formation is likely to be more considerable than can be judged by the development at surface.

Beales Property.—This ground is about 1½ mile north of the Wyniford River, and is worked at present on a small scale by Mr. Robt. Beales. The rock at the base and on the slopes of Mount Michael (or Macmichael, as it is sometimes called) is of precisely the same character as that of the other mines on the Tier, a soft greenish tin-granite. Little Mount Michael lies to the west, and this tin-bearing ground occupies the area between the two mounts, as well as entering into the composition of the peaks themselves. The distance between the two mountains is about ¼ mile. The tin-stone, being soft, has weathered away, and provided material for sluicing, and this is being carried on down to the hard bedrock. A shaft has been sunk over 20 feet deep, but stopped, owing to water. I saw some nice pieces of tin-stone among the rock stacked at the mouth of the shaft, but cannot report as to the nature of the ground at the bottom. Judging from the pile of stone, I should say the quality is variable—sometimes good, sometimes poor—similar to what obtains in the other mines of the district. There is evidently a fair quantity of tin-stone on the property, and every likelihood of the quality being equal to that of its neighbours. The tin-ground is wider than on Haley's Lease, and offers in that way more scope for continuous working, but the situation is more remote, being farther over the northern fall of the Tier. The ground falls on the south to the Wyniford, and on the north to Cotton's Creek. I did not visit the latter, and am uncertain how the mine could be best worked. I was told the tin-ore usually goes 72%, and has been as high as 73 and 74%.

The Moon Properties.

These are now under offer in London. The mine suspended operations on the failure of the Van Diemen's Land Bank. Mr. Kirwan kindly accompanied me round the property, which shows signs of a good deal of work having been carried on in former days. It is situated N.E. of Poimena, just outside the township, and on the north fall of the Tier. Crushing returns formerly were at first 0·75 to 3%, and finally an average of 1·25% ore, but crushing was not continued very long, as operations were not profitable. A good deal of driving was done from the 120-feet shaft. The ground at surface is granite, but tin-stone was found lower down, said to be the richest on the Tier. I am unable to say whether this stone was the massive tin-granite or quartz-vein stuff, of which a lot is seen lying about. Tin-bearing quartz-veins and leaders intersect the Moon ground,

and have been worked for tin, and the excavations in all directions on these veins look now like old races. Some of the stone resembles that of the Lottah lodes, and also carries a little molybdenite. The long drive, I was told, has gone 600 or 700 feet towards the Lottah Mine. The long level at the Lottah has been driven 900 feet; consequently, to connect the two sets of workings, 2300 feet more driving would be required, and the present idea of the Moon promoters is that the connection should be made, and the ore sent through the tunnel to a battery to be erected at the Lottah end. The lower tunnel at the Lottah is about 500 feet lower than the Moon drive, the upper one only 250 feet lower. It is hoped that the Haley's Lease Mines would also send their stone through the same tunnel, and thus supply continuous work for a large battery. I am afraid this anticipation will be found difficult of realisation. The stone will never pay to bring that distance, and the $\frac{5}{4}$-mile tunnel will not admit of steady, rapid delivery of the output of two or three mines. The Moon people, I am of opinion, would find its carrying capacity taxed to the utmost to keep their own battery regularly supplied. There are two other ways of working, each of which, I believe, is preferable, provided work is carried on upon an adequate scale. One is by steam, pure and simple. This was done formerly, but at a ruinous expense, mainly on account of the small quantities treated. The other is by electricity as a motive-power, generated by water from the Wyniford basin. It might be possible to select a convenient site for a mill, to serve both the Haley's Lease and Moon properties.

Vertical contacts of tin-stone with country-granite, divided from the latter by vein-quartz, are seen in the Moon workings, but it is also apparent that the tin-stone forms a floor under the ordinary granite. A run of stone about 3 chains wide passes S.W. to connect with the stone on Haley's Lease, and my interpretation of the occurrences is that the tin-granite exists all over the Moon and Lease area in a floor below the country-granite, the dyke-like exposures only marking vertical planes at right angles to the main floors. Upon this point, those beginning work ought to assure themselves by systematic boring. By this they would mark out definitely the area of tin-bearing stone, and ascertain whether it continues to a reasonable depth, without any serious interruption. Neglect of this precaution would be inexcusable.

The Moon ground abounds in rich patches. From first to last, the mine cannot have produced less than 1000 tons

of tin-ore, but battery work was carried on upon far too small a scale to admit of success, especially under the local conditions of steam and haulage. They worked the deposit down to a low level, and then had to lift all material to the battery.

The fact cannot be disguised that these Upper Tier properties are disadvantageously situated for work, being on the northern brow of the hill, and at such a great elevation that the backs are trifling and water supply inadequate, or, to say the least, inconvenient. In the case of each property, the method of working will require careful consideration before entering upon any outlay. As, however, the tin-stone is undoubtedly present, the claims will certainly be worked sooner or later. My own opinion is that the Haley's Lease and Beales' properties will be worked by water on the northern fall, and the Moon by steam or electricity. The success or otherwise of the mines lower down near Lottah will, without question, powerfully affect, and, perhaps, wholly determine for a long time, the fate of the upper ones.

Lottah Mine.—This is situate 500 feet above Lottah, and has been idle for a long time. It was described by Mr. Montgomery, in his 1889 report, and alluded to again by him in 1893, as a promising mine abandoned when ready to begin stoping. The lode is well-known as containing excellent ore, and it is a wonder that no further attempt has been made to test it.

Laffer Mine.—This is a small exploratory mine east of the township. Three small drives are being put into the hill-side in pegmatite dyke-rock, which has yielded some coarse tin-ore. Owing to floods, no one was working on the afternoon that I was there, and I only saw the two lower tunnels. The lower tunnel is first driven in decayed granite, and then into a dyke of pegmatitic quartz and felspar, and the upper one begins in a felspathic-clay formation containing white mica. Some tin-ore has come out of this tunnel in soft pegmatitic rock, associated with greisen; but the drive appears now to have gone through into the country-granite. Some stones very rich in tin may be picked up on the hill-side, and the endeavour is naturally being made to find their source. When this is found, I believe it will prove to be connected with the coarse pegmatite formation. Some

rich bands may be discovered, but they are not likely to be wide. The men are sticking pluckily to their little venture, and it is to be hoped that they will be successful.

Cambria Mine.—Mr. Jas. Scott also kindly accompanied me to this mine, which is on the southern fall of the Little Plain, 1 mile S.W. of the Liberator. The property is held by the Anchor Company's directors. The ground is traversed by the ravines which form the head of Waratah Creek. Lode-work was started over 10 years ago, but has been intermittent, and nothing was being done at the time of my visit.

The sections are outside the Lottah zone of tin-granite, the country being the ordinary porphyritic granite overlaid towards the north by Tertiary basalt.

In the northern part of the long section (1510) a shaft has been sunk, and short drives opened out east and west on the lode, but no stone has been crushed. Judging from the surface-pile, the lode consists of a dark-grey mica-quartz rock, containing a white quartz seam or seams. Tin appears in the quartz, but none is visible in the micaceous lode-rock. Talc and arseniate of iron give a greenish hue to parts of the rock. From here a N. and S. lode outcrops down the hill. This consists of seven or eight veins of quartz, about a foot apart, and from 1 inch to 4 inches wide, faced with very coarse tin-crystals, associated with radiating talc. The lode has been laid bare by stripping. Lower down, still on the long section, a tunnel has been driven for the intersection of the E. and W. lode with the N. and S. one. The intersection was reached, but the former lode not properly tested. Some 60 tons have been taken out and crushed at the Liberator battery, but as I understand the ore was not treated separately, results cannot be stated precisely. The yield was believed to be from ¾ to 1%. The tram connecting with the Liberator is a long one, 4¼ to 4½ miles, and the idea was that 30 or 40 tons a day could be conveyed, whereas the actual quantity was only 6 tons.

Some of the vein-stone is over a foot wide. The quartz is vitreous, and carries coarse tin, yellowish-green flakes and rosettes of talc, occasional iron and copper pyrites, and fluor-stains. The proportion of copper pyrites appears occasionally to be unpleasantly great, but it is not intimately mixed with the tin. At the intersection the lode was good, and specimens up to 10% value were obtainable, but the N. and S. lode cannot be described as payable. In the quartzose

lode-matter patches of granite occur. Probably the quartz-veins represent the fissure, and the quartzose bands are the wall-rock of altered granite, as shown in Fig. 4 at the end of this Report.

Lower down the hill, to the S.E., a good deal of sluicing has been done on the E. and W. lode. From this line of lode I was told that 500 tons of tin-ore are reported to have been won altogether. The lode is crossed at all angles by numerous veins of quartz and kaolin, which carry good tin-ore. The line of soft ground along its outcrop has been sluiced away, leaving a deep cutting 20 to 25 feet. Continuing E. on surface, the lode is 3 feet wide, with veins of quartz, as represented in Fig. 5 at end of Report. A little further N. is a lode outcropping 18 inches to 2 feet wide, N.W.-S.E., which will cross the others. A little E. is another parallel lode. The whole series of lodes cross each other, the most important intersections being somewhere near the shaft. The rich patches of ore will almost certainly be found at the intersections, and from the tin already won by washing and other trials, there would seem to be a good number of such concentrations. Whether the concentrations are numerous enough to pay for underground mining can only be proved by more extended trial. I would advise that the tramway be improved, and the E. and W. lode be given a thorough mining trial before incurring any expense for the provision of a battery. A moderate amount of judicious expenditure will soon show whether the lode is payable, and, if it proves to be so, there are fair facilities for milling. I think, however, that for a long time to come, it will be found more feasible to tram the stuff to the Liberator battery, notwithstanding the distance.

There are good facilities for adit-driving, and deep work will be required to prove the mine thoroughly, for the ore concentrations will have to be followed down, if the mine is to be a permanent one.

Russell's Wolfram Mine.—I visited this small mine, which had been started on Russell's section, between Lottah and Poimena, about 500 feet above the former township. It is reached by ascending the Poimena Road from Lottah, and then striking west into the bush a little way.

I saw three openings into the lode, at intervals of 6 and 15 chains. A tunnel was driven, about 20 years ago, for tin-ore, and at over 100 feet intersected the lode about 25

feet from the surface. A drive N.E. for 15 or 20 feet has followed the lode, which consists of reef-quartz 3 to 6 inches wide, containing scattered patches and crystals of wolframite (tungstate of iron and manganese), with which iron and copper pyrites are associated. Some tin is said to occur in the lode, but I did not find any. The crystals of wolframite are often faced with azurite and green carbonate of copper, and extensive azurite-staining is seen on the footwall of the lode in the drive. The quartz is the clean vitreous variety usual in the tin-fields. The country-rock is porphyritic granite.

This tunnel is driven into a hill-spur, and levels on the course of the lode would come under diminished backs, and southwards would, in fact, emerge into daylight. There is no use whatever in extending the present level.

Fifteen chains further N. a trench about 6 feet deep has been cut across the cap of the same lode. The detritus from the softened and disintegrated capping yields, by washing, small lumps and grains of wolfram from the size of a pea down to that of coarse tin-ore. The lode outcrop, including 4 inches of hardened wall-rock, is about 15 inches wide, dipping south 1 in 6 or 7. Section of this is shown in Fig. 6 at end of this Report.

Six chains further N.E. the lode has been exposed again by a cut about 7 feet deep. The outcrop is in soft decomposed granite; on the footwall side, an inch or two of quartz is visible, and in the middle is soft decomposed lode-stuff, which, when washed, showed a few grains of wolfram. The cut is not deep enough to expose the lode properly.

From the tunnel I took samples fairly representing the quality of stone which one may expect to meet with, *i.e.*, of wolfram-bearing stone. These were assayed by Mr. W. F. Ward, the Government Analyst, who reports:—Wolfram contents, 5%; analysis of wolfram, tungsten trioxide, 62·2%; manganous oxide (MnO), 5·4%.

Tungsten trioxide (WO) is known as tungstic acid, and the selling value of wolfram-ore is based upon the percentage of acid which it contains. Recent quotations are £28 for 72% ore, and at the time of my inspection it was understood that 70% ore would realise £20 per ton; but a vein averaging only 3 inches, with only 5% of wolfram, will not pay to work, besides which objectionable elements are present, such as accessory copper pyrites, and the reported tin-ore.

If the mine were to be worked, a low tunnel would have to be driven about 100 feet below the open cut, and ex-

tended 200 feet, to cut the vein, and open out on same N. and S. The work is purely speculative, the indications are not encouraging, and I should not like to hold out hopes of success.

ST. HELENS DISTRICT.

Stony Ford Mine.—This is a small tin-mine, about a mile W. of St. Helens, owned by the Anchor Company. At the time of my visit an open crosscut drive had just reached the lode, which is of a singular nature—one not observed hitherto elsewhere in the State. The mine is just south of the Golden Fleece Rivulet, and in the angle formed by the road and rivulet. The country is granite, of the type prevalent round St. Helens, with dark mica and much quartz, and on either side of the lode it is converted into a dark quartzo-felspathic capel or wall-rock. This wall-rock is about 3 feet wide on the east side of the lode; a little of it exists also on the W. side. It merges gradually into the granite, with no clean wall of division, and appears, in fact, to be altered granite. The tin-bearing rock cannot be described as a lode, but was not exposed fully enough for me to be quite sure as to its relations to the encasing granite. It is a band of quartz-chlorite rock, charged with pink garnets, iron pyrites, a little blende and copper pyrites occasionally, and tin oxide. I took a bag of samples from the different ore-heaps, and the result of assay by Mr. W. F. Ward, Government Analyst, was 2% metallic tin. Sketch of the section of the lode is given in Figure 7 at the end of the report. There is a line of this garnetiferous schist (the rock is sometimes quite schistose) running through the granite-country east and west. I was told that some eight years ago 3 tons of similar lode-stuff was sent away for crushing, and gave a high return of tin-ore.

There is some, I believe, south of Jason's Gates, and some on Houston and Miller's section east and adjoining Stony Ford, and Mr. Henry Grant took me to a couple of exposures of it in the granite alongside the main road, on Lord's property, ½ mile E. of the St. Helen's Bridge. Here the green schist is thoroughly encased in and mixed with the country-granite. The two exposures were 100 feet apart. (See Figure 8.)

The most feasible explanation of the occurrence is that it is in the contact zone of the granite with the slates and sandstones of the neighbouring Silurian country. Crossing the Golden Fleece Rivulet, a chain or two north of the mine, a contact of granite with quartz schist occurs, and

in the drive itself there are twisted pieces of hornstone in the country-granite east of the "lode," making it pretty clear that the phenomena are those of contact, as might be guessed from the garnet. The granite in the drive is seamed and faced and mixed with hornstone contact-rock, grey in colour, dense, and of flinty aspect, often in large massive heads. It may be imagined that the contact-line formed a channel for the ascent of the stanniferous solutions which deposited their contents in the schist, the granite being altered at the same time on each side to the hard "capel," or wall-rock.

A long open drive has been driven 120 feet to cut the lode, which had just been reached when I visited the mine. Surface stripping had exposed the lode for 250 feet to the west. Just where the drive impinged upon the lode, a shaft had been sunk 27 feet from surface, but was not empty. At the bottom the garnet rock is said to be 4 feet wide; this I could not verify. Too great hopes must not be entertained of this deposit descending regularly to any great depth, as it is not a main contact, but looks more likely to be torn off and included fragments of schist a little distance off from the general line of granite contact. This, of course, does not exclude the existence of small connecting-channels between the different patches of schist, but it may form a drawback to economical mining.

Westwards, on the other side of the little creek, another shaft has been sunk 22 feet in soft granite, to cut the lode on its underlie, but has been discontinued in favour of stoping the lode from the surface down to 24 feet, all along its course as far as the shaft. In this way all the easily-accessible lode-stuff will be removed, but no greater depth can be gained without sinking. Shaft-sinking is absolutely necessary, both for proving and working this lode. As said above, the chances are that the deposit is an irregular one, varying in width, perhaps pinching out for a time. If this occurs, it must be followed down to a greater depth; a timid policy will be out of place in developing this mine. The indications at present are good, and the percentage of ore is very fair and encouraging. The proprietors have an undertaking here which is a legitimate opening for enterprise. Before putting up a battery, I would advise deeper work in opening out the mine.

Silver Echo Mine.—This mine near St. Helens has been recently reported upon by Mr. G. A. Waller, Assistant Government Geologist, and it is unnecessary for me to do

more than confirm his account generally. I am afraid that at present it is more interesting geologically than important from an economical point of view.

The lode is in metamorphosed Silurian slate, running N. 20° E., and is of great width. The whole of it has not been uncovered, and the width is, consequently, undefined. A width of 50 or 60 feet may be assumed. Its composition is peculiar. The footwall portion for about a foot is granite-porphyry dyke-rock (porphyritic felspar—orthoclase and plagioclase—dark mica and quartz. The groundmass is quartz and muscovite). This merges into quartz for 7 feet, which is then replaced by 6 feet of pyrrhotite, the latter developing into quartz and chlorite on its margin. To the east of this the lode consists of quartz, with pyrites for 14 feet, and then bluish-white quartz for some 30 feet or thereabouts. I give a section of the lode in Figure 9. The pyrrhotite part carries some golden (lithia ?) mica; pyrite, copper pyrites, and marcasite also figure in it. The reported 15 dwts. gold per ton is said to have come from the latter mineral. Tourmaline occurs also. A small vein crossing the approach to the tunnel is said to have given good assays in copper and up to 5 ozs. silver; and, in the tunnel, a succession of quartz-veins, with a little native copper, crosses the lode. Though tin might reasonably be expected to be present, it has not been found yet, and there is hardly any inducement to expend much in opening it up. Still, not very much is known of the real nature of the lode, and until some further work is done upon it there will always be uncertainty as to its possible value.

Conclusion.

In drawing these observations to a close, I may emphasise the fact that on the Blue Tier we have a large area of tin-bearing rock, sufficient to keep several mines going for a good many years, supposing only that the tin-stone continues a very little below already-proved depths. If it descends indefinitely, there is enough stone for generations. If the dyke theory of its occurrence be correct, there is no reason why it should not persist to a great depth; if the floor theory is the right one, it will still descend to any required depth, but is liable to interruptions from barren horizons. The different companies interested may be recommended to prove their ground by boring before launching out into great works.

Considerable portions of this area may be safely expected to yield ½% of tin-ore; experience at the Anchor end of the ground has shown that the bulk there is worth about ⅓%. If, as is claimed by the Anchor Company, such stone can be treated profitably, there is no doubt that immense quantities await extraction. It is well, however, to bear in mind that, with such low-grade material, the margin, or difference, between profit and loss is extremely small, and no engineering or mining mistakes are admissible.

The development of the mines appears to be governed by the water-power available. There is a lamentable deficiency of this. Steam makes up for it imperfectly. The real solution of the difficulty lies in an efficient scheme for the conservation of the natural supplies of water. With adequate water, the district would, without question, be a busy tin-producing centre. It is a productive district as it is, but its production is intermittent, being dependent upon the rainfall.

For myself, I entertain high hopes of the future of the Tier. It is true the ground needs testing on a large scale by boring, but it has been broken into already at several points here and there, and a good deal of it has been proved by actual work. We have good ore-ground at its base; there is also good ground at its summit, and there is every reason to believe that in the intervening space there are large quantities of similar stone. This mountain range, in my opinion, forms a practically permanent asset of the State.

I have the honour to be,

Sir,

Your obedient Servant,

W. H. TWELVETREES,
Government Geologist.

W. H. WALLACE, ESQ.,
Secretary for Mines, Hobart.

Explanation of Figures

Fig. 1.—Tinstone underlying granite in eastern workings at Anchor Mine. TG = tinstone or tin-granite; G = ordinary country granite.

Fig. 2.—Tinstone underlying granite on Haley's Lease; TG = tin-granite; G = ordinary granite.

Fig. 3.—Section of face at Liberator Mine; A = seams or joints; B = tin-granite; C = fluorite patches.

Fig. 4.—Section of lode, Cambria Mine. G = granite; V = vein-stone (quartz); WR = wall-rock.

Fig. 5.—Plan of lode, Cambria Mine. G = granite; V = quartz-vein; WR = wall-rock.

Fig. 6.—Section of Wolfram lode, Russell's Section. G = granite; WR = wall-rock; V = quartz-vein; VM = vein-matter.

Fig. 7.—Section of lode at Stony Ford Tin Mine. G = granite; L = lode, garnetiferous schist; WR = wall-rock, capel.

Fig. 8.—Section of garnetiferous schists in granite at St. Helens. G = granite; S = green quartz-chlorite schist with garnets.

Fig. 9.—Section of lode at Silver Echo Mine. SL = slate; Q = quartz; P = pyrrhotite; QP = quartz with pyrites; GP = dyke of granite-porphyry.

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.

MAP OF TIN COUNTRY ON BLUE-TIER

Scale 20 10 0 10 20 30 40 50 60 Chains

Granite

Tin granite formation

H.H. Twelvetrees
Government Geologist
7 Dec. 1901

5 cm

(34)

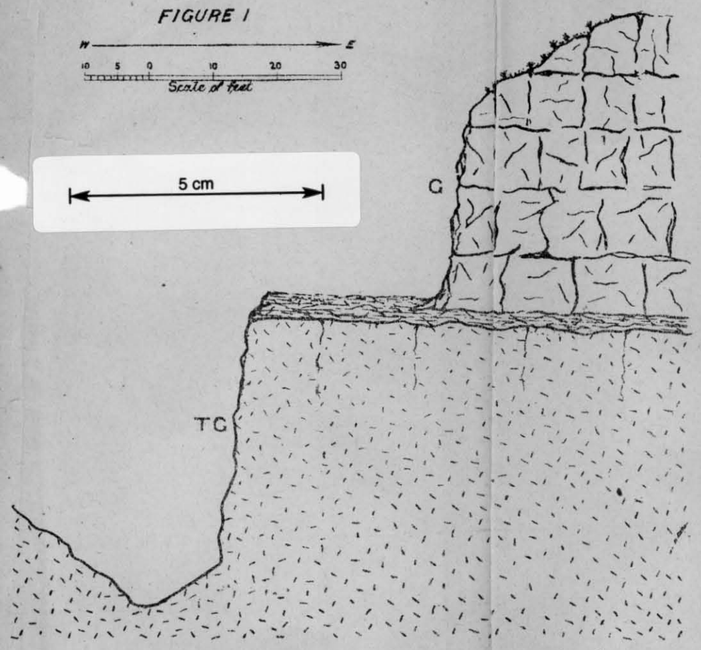
34/36

LITTLE Mt MICHAEL
BEARLES SHAFT
MOUNT MICHAEL
WYNIFORD RIVER
PROPOSED CONSERVATION RESERVOIR
PROPOSED POWER RESERVOIR
MOUNT GEORGE
SHAFT
DYKE
LODE
QUARTZ
TUNNEL
MOON
PROPOSED RACE FROM FEEDERS
PROP. FEEDER RESERVOIRS
PROP. FEEDER
POIMENA
HALEYS
MARIE LOUISE CREEK
RANSOM RIVER
LOTTAH TUNNEL
AUSTRALIAN TIN MINING Co.
WORKS
LOT TAH
CR.
H.L.T.M.Co N.L.
LIBERATOR T.M.
E. Hall & E. Gaunt
CRYSTAL CREEK
DYKE
ANCHOR T.M.
ANCHOR TIN MINE L.TD
GROOM RIVER
SHAFT
CAMBRIA TIN MINE
M'ARTHUR CREEK
P. Haley

1821

(35)

FIGURE 1



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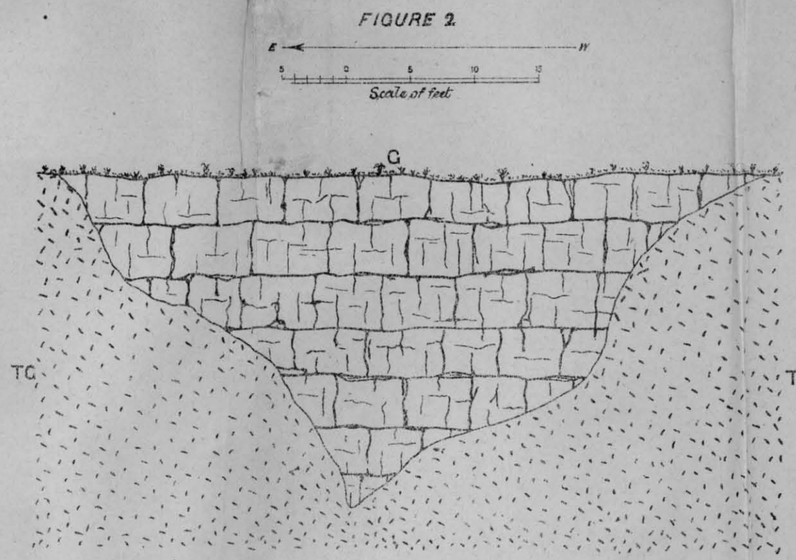

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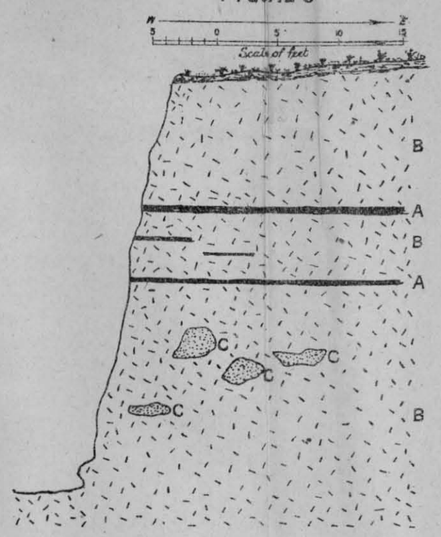

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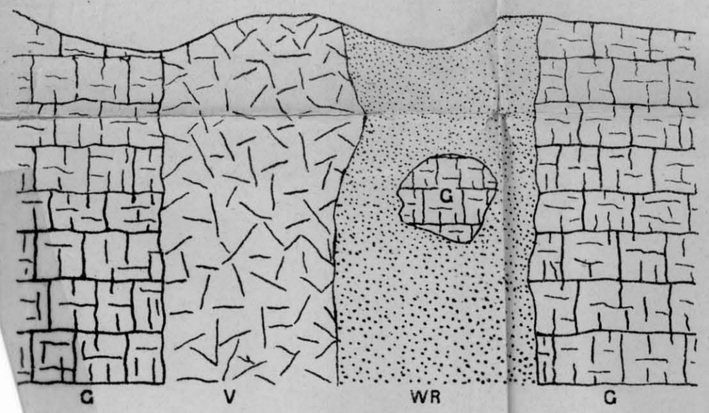

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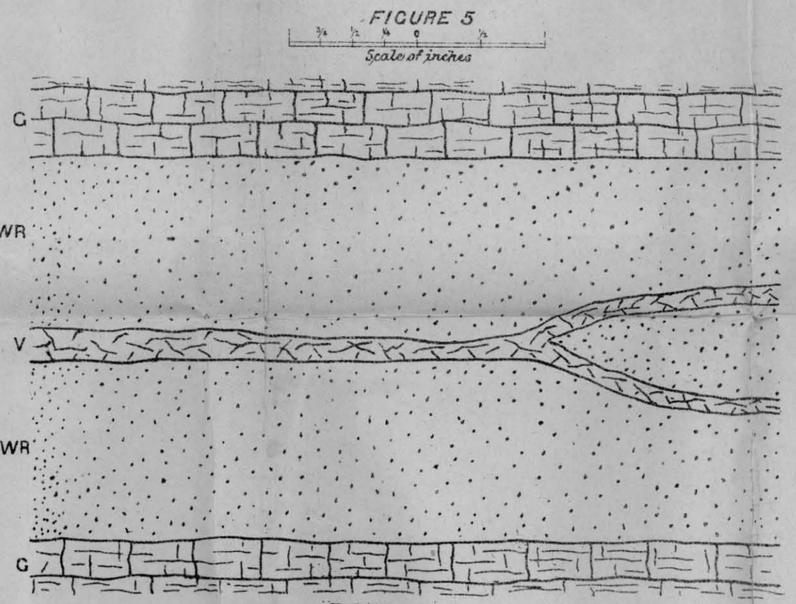

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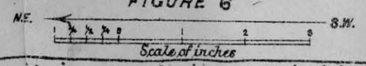

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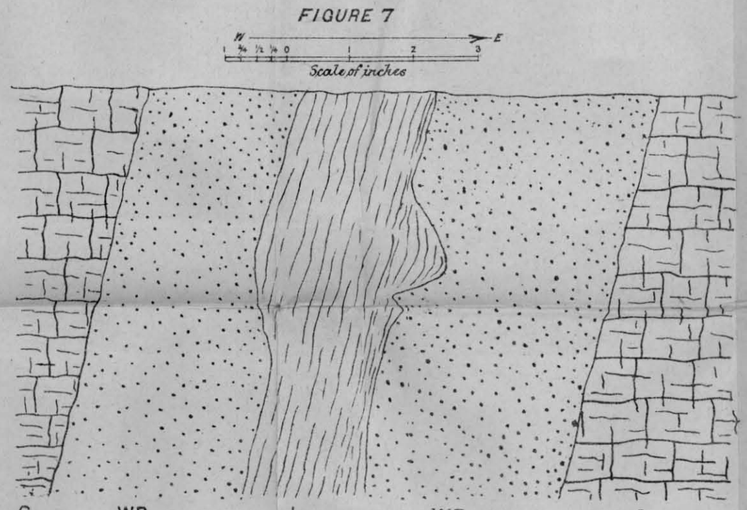

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182

FIGURE 8

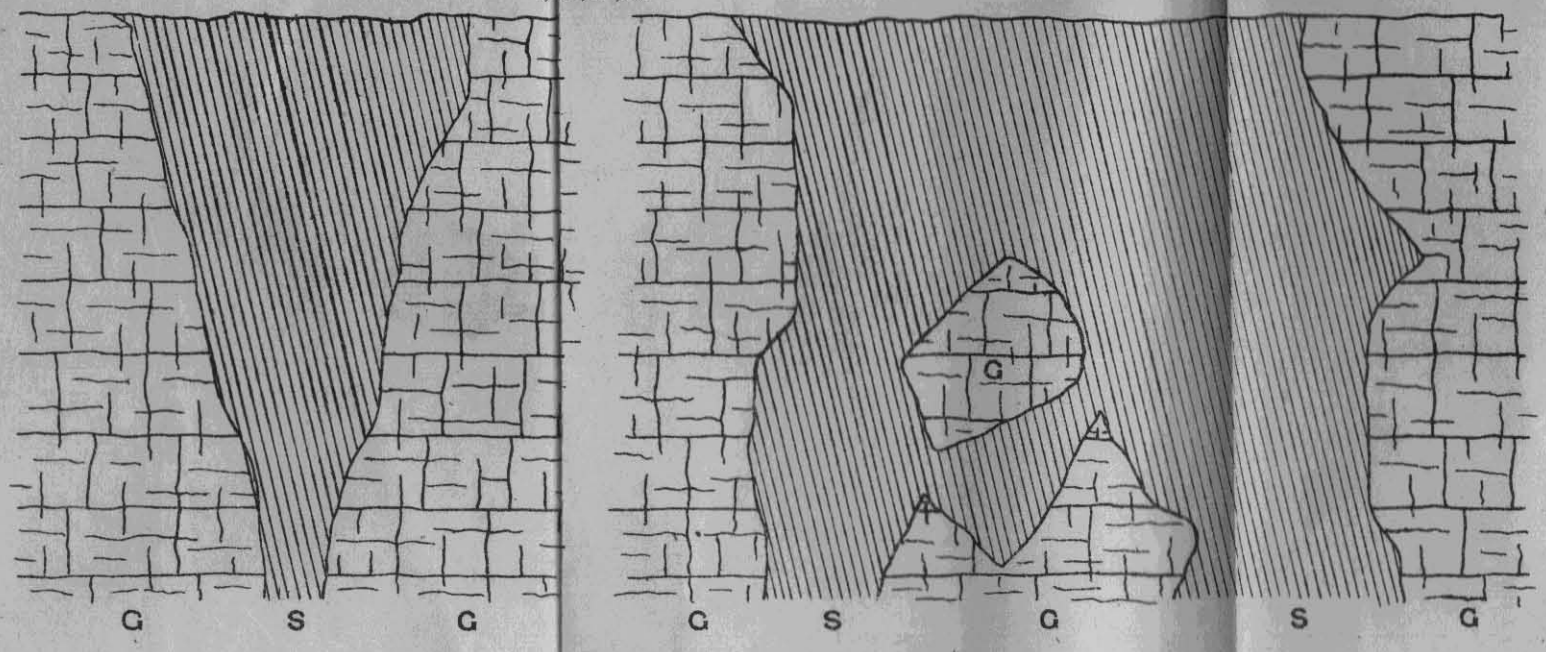
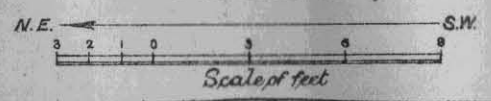
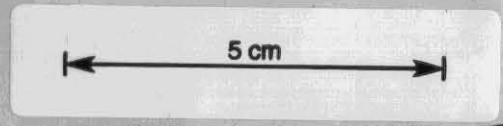
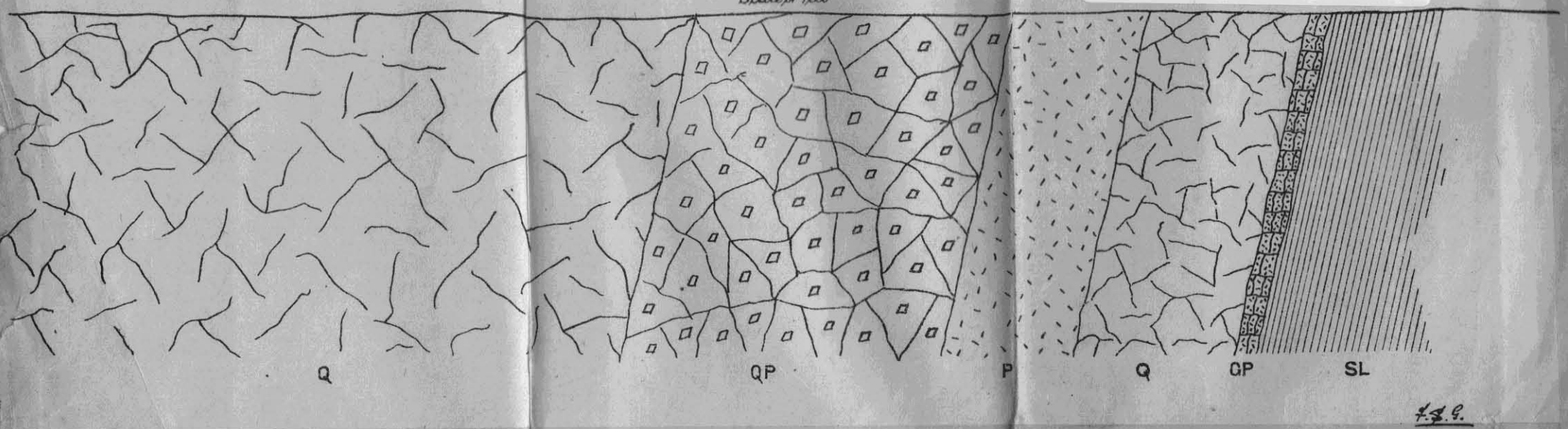


FIGURE 9







T.S.G.