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DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN

No. 38

BLUE TIER TIN FIELD

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and

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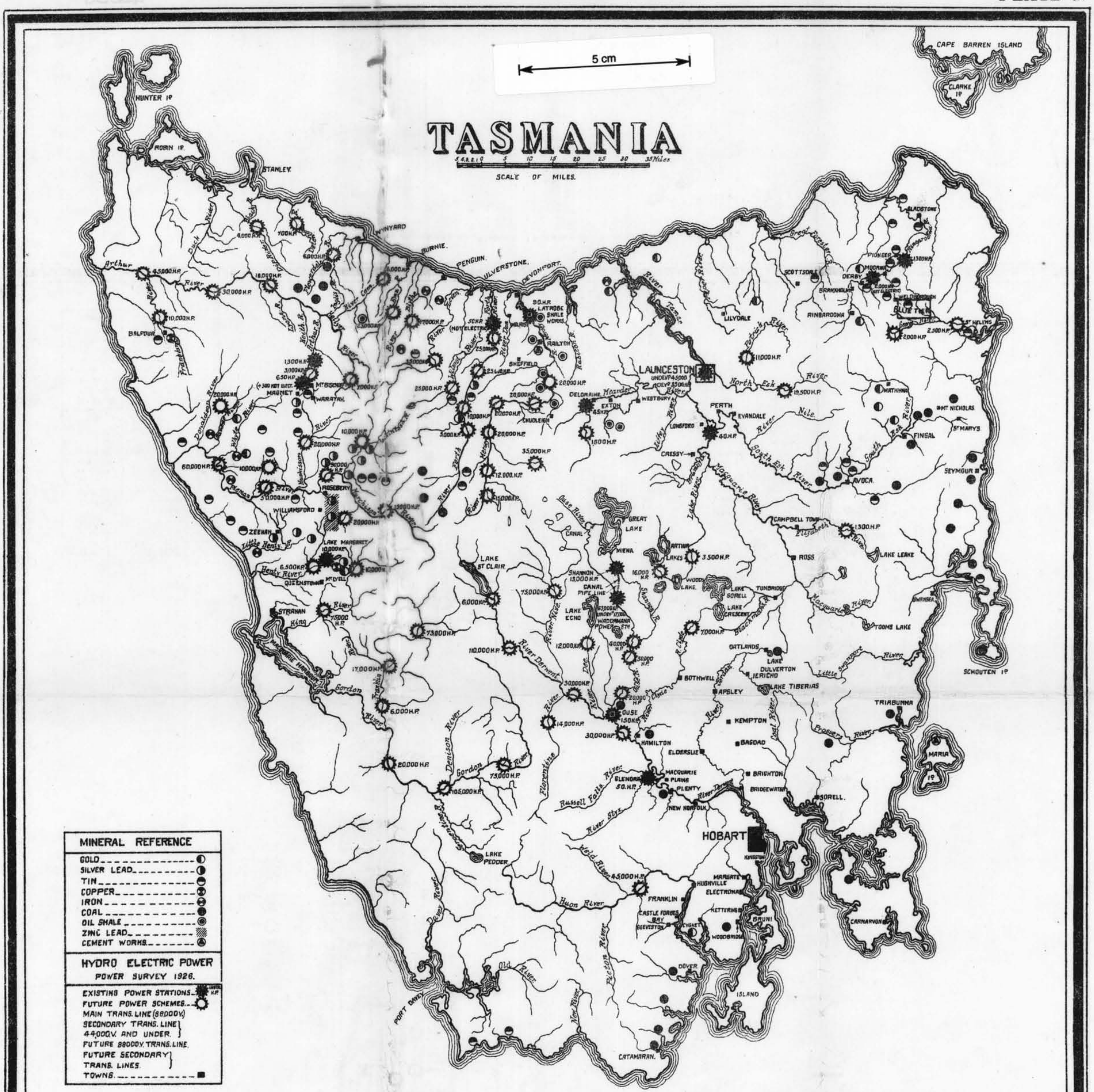
PREFACE.

OWING to the present low market rates of other base metals it is a matter of self-interest to the State that tin-mining be carried forward effectively and expeditiously. The one Government agency through which the essential support for the development and extension of the industry must ordinarily come is the Department of Mines. Aware of that fact, the officers of the Geological Survey Branch have exhaustively studied certain sections of the tin fields, and have prepared many reports and bulletins dealing with their works. Last year it was decided to concentrate attention on the North-Eastern Tin Field for the purpose of furnishing, as soon as possible, reliable information to those interested in the development of the more important ore-bodies.

This bulletin is the first result of that decision, and is the second of a new series of publications dealing with tin-ore deposits in general.



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Summary.

BLUE Tier field, from the early days of its mining history to recent time, has been an important producer of tin ore. The first stage of its development may be characterised as one of alluvial or placer operation, and the last stage as one of vein mining and rock excavation. In some places the alluvial deposits were of extraordinary richness, but none was of any considerable extent, and soon all were depleted of their reserves of tin ore. The mining of the vein-fillings and the quarrying of the tin-bearing rock formations, from which the alluvial and detrital bodies had been shed, then became a matter of necessity to the people of the district, who directed their attention to the Anchor, Liberator, Crystal Hill, Don, and Australia lines of lode in the southern part of the district, and the Southern Cross, Moon, Mount Michael, and other mines in the northern part.

Altogether it is estimated that 2,000,000 tons (long) of stone has been mined and treated for tin ore, of which the output of the Anchor amounted to 1,750,000 tons. The average yield of tin may be given as 0·2 per cent. The potential reserve of ore of that grade is high, but cannot be expressed in figures. It is proposed to thoroughly explore these bodies by means of the diamond drill.

This investigation reveals a former misconception of the nature and structure of the ore-bodies, the direct result of which may be seen at every turn and at every mine opening. On the data now available, as illustrated on the accompanying map, it will be possible to so design the lay-out of the mines that little loss will be incurred in future work. A resume of the evidence and deductions therefrom will now be submitted for the guidance of those engaged in the mining of tin ore in the district.

First, it should be noted that the tin ore accompanied the intrusion of a granitic magma into and under cover of Cambro-Ordovician sediments, now removed. Second, that the magma differentiated into two main portions: a barren porphyritic granite portion, and a younger medium and even-grained granite containing tin ore and other metallic minerals. The younger or so-called "tin" granite is intrusive into the porphyritic granite, and has a general north trend. The upper part or cupola of the younger differentiate may be described as alaskite, and is marked by planes of cooling or geoisotherms dipping gently to

the south. Underneath the alaskite cupola the mineralisers accumulated and acted upon the "tin" granite, completely transforming some of its components and converting others into secondary minerals. The gradually consolidating and contracting magma, subjected to great tension, found relief by fissuring and faulting and gravitative settling. Along these lines of fissuring and faulting the mineralisers found their way and formed the ore-bodies. By reference to the structure map it will be seen that between the lines of faulting—one passing south of Poimena and the other along Wyniford River—is an example of gravitative settlement. In this block it will be noted also the dykes of alaskite-aplite and quartz-aplite and the greisen veins have a general north-westerly trend, while those to the south and north have a general north-easterly trend. In no case has any individual ore-body been found continuing beyond those lines of faulting. North and south the outcropping "tin" granite bodies spread to their full width. As regards the ore-bodies, it is found in many cases, and in all the mines of the southern area, for instance, that the greisen veins occur in distinct groups. Thus are known:—

(1) The Anchor group;
(2) The Liberator-Crystal Hill-Don group; and
(3) The Australia group.

In these places, where the greisen veins have not penetrated far into the cover-rocks of alaskite and porphyritic granite, the arrest of the mineralisers has allowed of their permeation of the intervening granite. In that manner were formed the large bodies of tin-bearing, partly greisenised granite at the Anchor and the other mines mentioned. Where the greisen veins reach the geoisothermic plane between the cover-rock of alaskite and the containing "tin" granite, the rock is much richer in tin ore. The concentration underneath the covering of alaskite gave rise to the idea of the "floor" type of deposit. Actually these are groups of closely parallel lines of greisen veins. These veins will be found to extend to considerable depths, but the tin-bearing part of the encasing rock to not more than 200 feet.

The Blue Tier Tin Field.

INTRODUCTION.

Preliminary Statement.

During the past 50 years tin has figured as one of the chief exports of the State. Of late years, however, Tasmania has fallen from her high position on the list of producing countries. This is due in part to the great reduction in the output of the famous Mount Bischoff Mine and in part to the rapid depletion of the alluvial deposits in the North-Eastern District. Still, in the classification of the resources, tin must be placed among the metals of greatest—if not of quite the first—importance. In order to arrest the decline and, perhaps, increase the output it is necessary to direct attention again to the primary deposits, the source of the wonderfully rich alluvial gravels which contributed so much to our wealth. Early mining in this, as in neighbouring, areas was confined to the easily workable alluvial deposits. In later years attempts were made to mine and treat the tin-bearing stone from the lodes and veins. In some cases the endeavour was long-sustained, and was prosecuted with the utmost vigour, but all to no ultimate success.

The work upon which this report is based was undertaken primarily to determine the nature, extent, and value of these deposits, and secondarily to ascertain whether, under present-day conditions, a much greater measure of success might be attained by the use of modern plant, and by operating on a scale commensurate with the magnitude of the ore-bodies. In this report an endeavour is made to present an account, in as great detail as possible, of every phase of the subject that is likely to prove of interest.

The field work was performed during the period 1st September to 10th December, with interruptions amounting to three weeks. Altogether the actual work occupied 11 weeks.

General Statement.

In the presentation of the results of this survey it has been considered necessary to prepare and attach a number of maps, plans, sections, and sketches for the purpose of illustrating the geologic relations of the ore-bodies, their geographical distribution, and the design of works for their exploitation. Without such aids it is thought that the explanatory descriptions would prove rather difficult to follow.

The main part of the report is divided into three parts, dealing with—

1. Geology and geologic structure;
2. The economic geology; and
3. The mines of the area.

In addition, articles have been written on the price of tin and its stabilisation, and the status of the industry.

ACKNOWLEDGMENTS.

The writer wishes to acknowledge his indebtedness to Mr. T. Haley, Registrar of Mines at St. Helens, for his interesting account of the history of the region; to Mr. J. Hodgman, of Lottah, for the use of records; to Mr. J. B. Lewis, for information relating to the production of tin ore from the Anchor Mine; and to Mr. John Kennedy, of Hobart. Thanks are due also to Mr. D. C. Mackenzie, Mining Engineer, and to Messrs. D. Gough, G. Lawry, and J. Hall, for much useful information, and to Messrs. B. Griffin and T. Mundy for efficient help in the field.

The field work was carried out with the assistance of Q. J. Henderson, Cadet Geologist, who also prepared all the plans for the printer. In acknowledgment of those services his name appears on the title-page as coadjutor. Assistant-Geologist F. Blake assisted in the mapping of the tin-granites.

Publications dealing with this field have been freely drawn upon in the presentation of this report in all its details.

Particular reference is due to the kindness of Mr. R. M. Murray, General Manager of the Mount Lyell Mining and Railway Company, for supplying copies of plans and sections showing the results of all the work performed by that company in its extensive explorations in this area

CHAPTER I.—HISTORY OF DEVELOPMENT.

Previous Literature.

The bibliography of Blue Tier is not extensive. Although the field has been visited by officers of the Department from time to time during the past 42 years, the following publications only are recorded:—

1. Blue Tier Mining, by G. Thureau, 1886.
2. Report on Blue Tier Mining District and Its Tin Deposits, by G. Thureau, 1886.
3. Blue Tier Tin Field, by A. Montgomery, 1889.
4. Blue Tier Tin Mines, at Blue Tier, County of Dorset, by A. Montgomery, 1893.
5. The Mines of the Blue Tier, County of Dorset, by W. H. Twelvetrees, 1901

(In addition to the brief reports enumerated are two reports by K. L. Rahbek (1901-1902) dealing with the conservation of water for mining purposes in the district.)

Thureau and Montgomery regarded the tin-bearing rocks as intrusive dykes traversing the normal granites. Professor Ulrich, on the other hand, regarded the tin-bearing bodies as part of a stockwork or mineralised zone of the granite mass. Twelvetrees differed from them all in attributing the formation of the tin-ore bodies to processes of greisenisation. In this report evidence will be brought to confirm that educed by Montgomery in favour of the dyke theory, and also that educed by Twelvetrees in favour of the greisenisation theory. The writer finds that both types of deposit are well represented, and that their juxtaposition in some cases has led to the confusion of one with the other. Greisen deposits, however, are the more common, and, in the aggregate, the more important. In some few cases greisen veins traverse tin-bearing dykes, such as those of aplite and pegmatite, and thereby further complicate the issue.

An interesting account by Malcolm Moore appears in an issue of the Proceedings of the Australian Institute of Mining Engineers. The writer's observations are in some respects confirmatory of the views expressed in that account, from which extracts have been made.

Early History and Exploration.

The following account of the history of tin discovery in this division has been taken from notes prepared by Thomas Haley, Registrar of Mines at St. Helens. During a residence of 37 years he has witnessed the growth of, and taken an active part in, the tin-mining industry from the smallest beginnings to its present-day importance; and he has, during that long period, gathered much information of interest and value, and, moreover, has kept a record of it. His records of production are fractional, because such are those relating to tin ore that passed through his hands only; but those records contain the results in detail of the production of some mines, and are therefore of considerable value.

This history begins in 1874, when a prospector named S. Harrison found tin ore in the vicinity of Ruby Valley, about 4 miles north-west of George Bay. Not having any knowledge of tin ore, he sent the sample to Captain R. A. Hall, who in turn passed it on to Isaac Wright and Co., of the Old Wharf, Hobart. The sample was ultimately submitted to P. H. Wintle, then a resident of Hobart, who identified it as tin ore. Wintle later visited the area, inspected the deposits, and published a favourable report on the prospect. At that time gold-mining at Mathinna (then known as the Black Boy) was declining, and, following the published reports of the tin discovery, a syndicate was formed there to send James Hall *via* Hogan's Track, to George Bay. His instructions were to prospect *en route*. At Carter's Marsh, Upper Scamander, Hall found tin ore, and pegged the ground for his syndicate, but no sustained attempt was made to develop the deposit at that time. Hall then pushed on to Golden Fleece Rivulet, and there sluiced and concentrated the first parcel of tin ore produced from this field.

Favourable reports of the district led the more ardent prospectors of Mathinna to break camp, and quite an exodus set in. Among the first lot were Chris. Iles, Chas. McGough, and A. Waggenkneet, who, in the course of their prospecting, found tin ore in the bed of Derwent Creek. These gravels were thought too poor, so they resumed their wanderings, and ultimately arrived at Blue Tier, where they found John Clement Macmichael and James Gaylor in possession. Macmichael and Gaylor, by arrangement with Iles and party, retired from Blue Tier and went to Thomas Plains (now Weldborough), where they found very rich deposits of alluvial ground, which they leased under the name of the Union Tin Mining Company. The subsequent operations were very profitable to the shareholders. In the meantime Iles and party, who remained at Blue Tier and continued their work, unearthed the richest alluvial gravels in the district. A company of eight (including the prospectors) was formed, under the title "Full Moon Syndicate," to work the gravels. From the proceeds of their work many dividends were paid to the shareholders, one of £500 per share. So rich was the "wash" that as much as 25 cwt. of concentrated tin ore was obtained in one day as the result of the work of seven men. This company had the distinction of making the record shipment (50 tons) from George Bay. It carried on successfully for many years, and, in the course of its sluicing, unearthed the large ore-body from which much of the alluvial ore had been shed. The alluvial ground having been depleted of its store of tin ore, a company was formed, with John Scannell as manager, to attack the lode deposit. During Scannell's term, and that of his successor (Dick), shafts were sunk and crosscuts made to cut the lodes. That development work exhausted the capital of the company, and the mine was closed. Another company, with Milles as manager, reopened the mine, extended development, and erected a 10-head milling plant. Although the lode material mined and crushed was of high grade, the costs of production and transport were higher than the value of the ore, and in consequence the mine was abandoned. It has not been reopened since that time.

The Rising Sun Tin Mining Company's operations, under the supervision of Phil. Watson, were highly remunerative. The ground it worked lay north-west of the Full Moon area.

The Marie Louise Tin Mining Company (now the Southern Cross), with John Symons as manager, removed a large quantity of tin ore from the soft detrital deposits resting upon the ore-bodies. The manager at the time informed the contributor of this article that the cost of production of tin ore from these rich kaolin cappings did not exceed £9 per ton

The Wheel Tasman Tin Mining Company, under the management of the late Captain Robinson, worked some rich ground near the Rising Sun property.

The Lottah Tin Mining Company held leases on the north-eastern end of the Tier. The manager, Augustus

Simson, produced a large quantity of tin ore from the shallow surficial deposits and from some soft tin-bearing granite bodies underneath. Harder rock supervening brought to an end the sluicing operations. The company then, with John Symons (and later Tredennick) as manager, turned its attention to the greisen veins, many of which had been exposed during the removal of the detritus. Adits on the more important veins opened up narrow, hard quartz-greisen, with occasional pockets and short shoots of tin ore.

The failure of the company was due to the narrowness and poorness of the veins, their hardness, and the hardness of the containing rock.

The Blue Tier Tin Mining Company, under the leadership of Neil Turner, worked surficial deposits south of the Marie Louise Company's leased ground. The results of the operations were satisfactory.

The Planet Tin Mining Company (James Irwin, manager) stripped and sluiced the soft capping of the tin-granite dyke. These operations were of considerable profit to the shareholders.

The Crystal Tin Company held leases of ground close to Weldborough-road, about 1½ miles from Lottah. Gaylor and Blackett produced, at a profit to the company, a large quantity of tin ore. Some years later an engineer named McQueen formed a company, known as the Puzzle Tin Mining Company, to work the remaining Crystal ground and that now known as the Australia Mine. In this connection a foundry was erected at St. Helens for the manufacture of the necessary mining, milling, and concentrating machinery. Although the work of the foundrymen was good, the designs of plant were unsuitable for the purpose in view. Inefficient machinery, the low market rates of tin, and insufficient initial capital contributed to the downfall of the company.

The Anchor Tin Mine.—The original lessees, Chapman and Gaylor, were interested only in the detrital covering of the large rock bodies. During the progress of sluicing the parent rock was exposed over a large area, and at the surface it appeared to be of extraordinary richness and extent. On the data obtained from surface sampling it was decided to organise a company of large capital for the purpose of equipping and opening the mine. John Symons, the first manager, erected a crushing and concentrating plant, and a huge water-wheel, 66 feet in diameter, to drive the machinery. The result, like that of all other attempts at that time, was not up to expectation. Symons was succeeded by A. Robinson, and, under his charge, better results were obtained; but it was soon found that large scale operations only would prove profitable. In order to bring about this desideratum the first act of the shareholders was the sending of Richard Mitchell to England for the purpose of raising the necessary capital. In this Mitchell was successful. The Anchor Tin Mine Limited was formed in 1895, with an authorised capital of £70,000. Operations ceased in 1913, and the company subsequently went into liquidation. Its first manager, W. H. Wesley, reduced the cost of production to a low figure; Wesley was succeeded by R. Mitchell, and during his term of office an inquiry was made into the best means of augmenting the supply of water for motive power. Two schemes offered possibilities: one, the generation of electric-power at Columbia Falls; the other, the construction of a water-race to tap the supplies available in the North George and South George Rivers. The latter scheme appeared the better, although it involved the construction of 30 miles of water-race to a point only 6 miles in a straight line from the terminus. Ample water entered from the various streams tapped in its course; but evaporation and seepage caused a serious loss, and the only efficient section was that taking Groom and Crystal Creeks. In wet weather these provided more than requirements; in dry weather the supply from North George, Cambria, and nearby creeks was not sufficient to overcome the loss due to the great length of the race between them and the Groom. Had it been constructed 100 feet higher it would have been less than half the length, and it would have carried more water at a hundred feet greater pressure. The race passed through precipitous and heavily-wooded country, and suffered much damage from slips, wind storms, and bush fires.

At this time Lindsay Clark took charge of operations. An improvement in the earnings of the company immediately followed, and continued throughout his term of office. His successor, J. B. Lewis, had from the outset many difficulties to contend with, not the worst being the renewal of an almost obsolete plant. Further details are given in the description of the Anchor Mine in a later chapter.

The early prospectors, the majority of whom came from Mathinna, were men of long experience and splendid physique, the right type to carve a way through dense bush and unexplored country. These men carried swags, containing provisions and camp equipment, weighing 60 to 70 pounds and more. To them is due the greater part of the credit for the opening of these fields of endeavour.

It should be remembered that the period covered by the foregoing historical sketch was that of the early stages of development. Transport during the earliest stage was by pack-horse, at a very heavy rate as compared with present-day costs. But at that time the alluvial and detrital deposits only were attacked, operations having been confined mainly to the beds and banks of creeks, for which the necessary equipment consisted only of hand-mining tools. Road construction gradually followed development, and in later years came railways and motor transport. To-day the question of transport is not one to seriously exercise the mind.

Although the attempts many years ago to mine the rock, lode, and vein deposits were invariably unsuccessful, the work performed has proved of great advantage to present-day investigators. The conditions in those days are not comparable with those of to-day, therefore the potential resources may be reviewed from other standpoints.

These notes may be concluded with the statement that between the years 1875 and 1886 over 3000 tons of concentrated tin ore was sluiced from the creek beds and lode-cappings of Blue Tier.

PRODUCTION.

Data relating to the production of tin ore from this area are fractional only. Until recent times no official record had been kept of the individual output of mines, and the records of defunct companies have either been destroyed or lost. Writing in 1886, Thureau stated that over 3000 tons of tin ore had been taken from the surficial deposits. Since that time tin-mining on the plateau has continued intermittently, with a gradual swelling of the output to 5000 tons at least. In addition, the Anchor Companies produced over 3000 tons, and others in the neighbourhood about 1000 tons.

The total production, therefore, is estimated at 9000 tons.

CHAPTER II.—GEOGRAPHY AND PHYSIOGRAPHY.

Location and Area.

Blue Tier mineral field lies in the County of Dorset, in the north-eastern part of Tasmania. It is that area charted as Weldborough No. 2, and is 10½ miles from east to west, and 10 miles from north to south. This report, then, deals with an area of 105 square miles.

Population and Industries.

In the early days of this field, when the shallow alluvial and detrital tin-ore deposits were being worked, the population at Poimena and Lottah was about 1000. Since the depletion of those deposits, and the closing of the Anchor Mine, at Lottah, the population has dwindled to a few score.

Although tin-mining is the staple industry, grazing is carried on at Blue Tier, and a little timber-milling is performed. In its natural state the plateau was covered with a heavy forest of beech (*Fagus cunninghami*). Half the area of land has been denuded of forest and sown with grasses. On the pastures thus provided sheep, cattle, and horses are run during summer and autumn.

Roads and Railways.

Poimena, an almost deserted settlement on the plateau of Blue Tier, is connected by a road (3½ miles) of steep grades to Lottah, a not much larger settlement. Lottah is connected by road (18 miles) with Herrick, the terminus of the North-Eastern railway from Launceston (84¾ miles), which is the chief shipping centre of the northern division of Tasmania. Lottah is connected by road also with St. Marys (the terminus of the Fingal railway), *via* the port of St. Helens, which is situated on the shores of the shallow waters of George Bay. Trading is almost wholly through Launceston, where is situated the tin-smelting works of the Mount Bischoff Company.

George Bay, although an extensive sheet of water, is navigable for ships of light draught only.

Climate.

Blue Tier has a mild and even climate, but is generally colder and more exposed to winds than the country fringing the shore-line. The annual precipitation averages 65 inches, distributed throughout the year, but once in a decade extraordinary variations may occur. For instance, the rainfall may rise to 79 inches or fall to 45 inches. On two occasions in a period of 10 years over 24 inches fell in one month, and once 18 inches fell in 24 hours. The snowfall is very light, and melts almost as quickly as it falls; but as much as 3 inches has been recorded.

TOPOGRAPHY.

Relief.

The area is one of great topographic relief. It is an elevated plateau with low surrounding ridges and very steep flanks in all directions. The general level of the plateau is from 2300 to 2400 feet above the sea; and that of the ridges and peaks 2700 to 2900 feet (Mount Littlechild). The slopes of the Tier are very steep. For instance, between Anchor Mine (700 feet) and the ridge above Australia Mine (2500 feet), a distance of only 3 miles, the incline is at the rate of 600 feet per mile.

Drainage.

Blue Tier is the watershed of some of the most prominent river systems of the North-Eastern Division. Tributaries to Ringarooma River are the Weld, Frome, and Wyniford, flowing in a north-west direction. Great Mussel Roe River flows northward, emptying into the sea east of the Ringarooma debouchure. On the south side Anson's River receives its waters and flows north-eastward to Anson Bay. George River receives Groom, Ransom, and Laffer Creeks on the east side, and continuing in that direction, empties into George Bay. All the streams are fast-flowing.

Valleys.

In this area the valleys are deep, narrow, and v-shaped, and are highly inclined. They are all youthful, having been formed since the extrusion of basalt in Mid-Tertiary time.

Outside the area the valley floors broaden, and extensive flood-plains allow the streams to meander over a fairly wide range.

The valley floors of some of the small streams on the plateau at one time contained richly concentrated deposits of tin ore. Every stream bed on the plateau and on the flanks of the mountain has been sluiced of its store.

The Development of the Topography

The causes of the development of the present topography are many and varied. Not all of the information relating thereto is in evidence in this area, consequently reference will have to be made to the influences at work in contiguous areas, and to the geological events that led up to the present development.

First, it should be noted that at the close of the Trias-Jura sedimentation, which was continous with the Permo-Carboniferous, came the intrusion of diabase. Second, that uplift and faulting accompanied the injection of diabase, and a long period of rapid erosion set in. Deep valleys were soon cut into the lightly compacted sediments, and the greater part was completely swept away. One remnant of the basal beds only remains in Blue Tier area, but fragments form the bulk of the sub-basaltic stream gravels and drifts in the neighbourhood of Weldborough and of Pyengana. Such remains also appear in places in the terraces of George River. That cycle of erosion was arrested by the outpouring of basalt in Mid-Tertiary time. Basalt lava filled many valleys, diverted streams to other courses, and protected underlying rocks from erosion. A slight uplift accompanied the basalt eruption, sufficient to add considerably to the corroding energy of the streams. A gradual depression then supervened and continued until Recent time.

Attention is again drawn to the post-diabase faulting, because that series of movements was responsible in part for the selection of the original stream courses.

The parallelism along north-west and south-east lines of the tributary streams leading direct from Blue Tier is particularly striking. That is due in a measure to the fact that most of the greisen veins, which are as a rule much harder than the containing rocks, lie in that direction; and in part to lines of minor faulting.

CHAPTER III.—GENERAL GEOLOGY.

Geological and Structure Maps.

In order that the presentation of the results of this survey shall be made clear, a structure map has been prepared in addition to one showing the geological and physical features. As much information as is necessary is placed upon the structure map to show the relative associations and the order of intrusion of the various differentiates of the granitic stock magma. It is obvious that the deciphering of the major structural features, based largely as they are on local observations of one igneous rock type only, present a difficult problem. The interpretation, therefore, is admittedly inconclusive, yet the evidence submitted is sufficient to serve as a background upon which an understanding may be obtained of the effects produced by those forces responsible for land movement in this area. It is necessary to extend the field of investigation to neighbouring areas in order to arrive at a satisfactory and conclusive solution.

The geological map contains information relating to the physical features and the general geology of the area. In addition, the positions of the surveyed blocks of all leased ground are shown.

The map is based upon the mineral chart of the district issued by the Lands and Surveys Department.

Some features were located by prismatic compass and chain, and elevations were obtained by the use of aneroid barometers based upon the datum of Lottah. Although numerous check readings were taken, the contour lines are not likely to be correct within 50 feet, yet the topographic part of the map in the main may be regarded as a fairly close approach to accuracy, and will certainly serve to convey an idea of the relief.

GEOLOGY.

General Statement.

This field is occupied almost wholly by granitic rocks of the Devonian period. All these granites came from a common source, and they, as a whole, formed the fundamental part or base upon which succeeding formations were laid down. They may be seen intrusive into Cambro-Ordovician slates, sandstones, tuffs, and lavas (not represented at Blue Tier) in the neighbouring areas of Pyengana, St. Helens, and Mount Rattler. The sedimentary cover-rocks of the granites at Blue Tier were removed by agents of erosion before the close of the Devonian period, for the basal members (quartz-conglomerate and sandstone) of the Permo-Carboniferous formation may be seen resting directly upon the granite at Mount Littlechild, one of the most prominent peaks of the Tier. The existence of that remnant of the Permo-Carboniferous at the 2700-foot contour (the altitude of the highest peaks of granite along the Tier), a little above the general level of the elevated plateau, is important in showing that agents of erosion have not removed any great amount of the summit deposits. Their preservation has been due in part to the bulwark of erosion-resisting porphyritic granite, which completely surrounds the softer granites containing the ore-bodies; and in part to the numerous greisen veins of quartz-mica crossing the tin-granites. Other, and perhaps not unimportant, supports are the dykes of diabase and of basalt (?) that intrude the granites in groups. In addition, the south-west part is completely covered with basaltic lava, which has, since the Mid-Tertiary, provided an effective shield against the invasions of meteoric waters. An instance of this may be seen at the Cambria Mine, where the upper and richer part of the lode is seen passing underneath sheets of basaltic lava, which rest directly upon boulders of conglomerate and fossiliferous sandstone and mudstone of Permo-Carboniferous age. It will prove of interest to mention here also that the writer found at the Blue Tier Weld Mine sub-basaltic Mid-Tertiary gravels and drifts made up largely of the waste of Permo-Carboniferous rocks; and at Nesbitt's prospect, on the bank of George River, gravels and drifts of similar materials are open for inspection. It appears also that the beds of Tertiary age overlaid with Recent tin-bearing gravels and sands, composing Thureau's deep lead, are made up largely of fragments of Permo-Carboniferous rocks composed of granitic waste. This, however, will be dealt with at another time.

Stratigraphy.

The stratified rocks which occur in this area are of the Permo-Carboniferous, Tertiary, Quaternary, and Recent systems.

Older stratified rocks (Cambro-Ordovician) outcrop in neighbouring areas; but these have no direct bearing upon the main subject of this work, and have not been carefully studied, and therefore will not be discussed here.

Permo-Carboniferous.

A small remnant only, capping Mount Littlechild, remains to indicate the nature of this once extensive formation. Two members are represented in place: one, a conglomerate consisting largely of well-worn quartz, with occasional pebbles of granitic rock; the other, a siliceous sandstone composed of quartz grains, with felspathic material filling the interstices. Fossiliferous mudstone boulders and pebbles of this age compose the bulk of sub-basaltic stream gravels in this and adjacent areas.

Tertiary.

Sub-basaltic gravels and sand-drifts carrying tin ore fringe the south-western part of this area. The boulders of the gravels are made up largely of Permo-Carboniferous mudstone and sandstone, and quartz conglomerate, and the compacted sands are derived largely from soft sandstone of that system. These deposits are not very extensive.

Quaternary and Recent.

Deposits of tin-bearing gravel and drift occupying valley floors and the beds and banks of streams constitute the whole of the formation of these ages.

Igneous Rocks.

THE GRANITIC ROCKS.

One of the most striking features of the Blue Tier granites, which form part of the great batholithic body outcropping so prominently in North-Eastern Division, is the marked variation in type. That the variation is not confined to type, however, is shown in the chemical and mineralogical composition. It is quite clear that this heterogeneity has been produced as a result of processes acting within one originally homogeneous magma. Two distinct types of rock are represented, namely, those that differentiated before intrusion, and those that differentiated after intrusion. One kind of rock followed another from a common reservoir, and their order of intrusion is clearly manifested in their co-relation and in their sharply-marked lines of contact. These distinct bodies are representatives of primary differentiation; but some of the larger masses exhibit the effects of secondary differentiation after intrusion.

The sequence of intrusion at Blue Tier appears to have been:—

(1) Biotite granite passing into hornblende granodiorite to the north of the area, and with an alaskite phase eastward.
(2) Porphyritic granite consisting of oligoclase phenocrysts set in medium-grained biotite granite. This appears to have been an independent intrusion, but the observation requires further evidence of verification.
(3) Biotite-muscovite granite, of medium grain, not porphyritic but equidimensional. This is certainly an independent intrusion into the porphyritic granite (2), and is known in local centres as tin-granite.
(3*a*) Contemporaneous or slightly later pegmatite of similar minerals containing ore minerals.
(4) Pegmatite dykes, contemporaneous or slightly later than (3), of quartz-mica and quartz-veins.
(5) Greisen veins, slightly later than (3).
(6) Alaskite aplite and quartz aplite, later than (5). and barren of ore minerals.

In this and neighbouring districts there is every possible gradation between hornblende granodiorite, which probably represents the composition of the original magma, through normal biotite granites to pegmatites. The tendency for all differentiates from a common magma to be composed of much the same minerals, in different proportions, is well known. Thus, the hornblende granodiorites lying to the east of this field pass insensibly into normal granites in which the proportion of hornblende becomes less and less, and in which the acidic felspars predominate. Then we come to the porphyritic granites of Poimena. These consist of phenocrysts of oligoclase (1 to 3 inches long, with a general directional arrangement of the longer axes), set in an aggregate of medium-grained orthoclase, oligoclase, quartz, and biotite. The felspar phenocrysts, which have idiomorphic outlines, are not corroded, and probably represent the excess of the mineral over the eutectic ratio. The ground-mass of the phenocrysts is of even grain-size. The first mineral to separate was the biotite, then the felspars, and finally the quartz. This is shown by the appearance of biotite enclosed in the felspars, and by the quartz occupying spaces between the better-formed crystals of felspars.

The porphyritic granite is composed of:—

	Per Cent.
Silica	69·44
Ferrous oxide	1·16
Ferric oxide	3·29
Alumina	15·22
Titania	0·40
Lime	3·00
Magnesia	1·59
Soda	2·59
Potassa	4·11
Ignition loss	0·30

The next to be described is the most remarkable, and at the same time the most important, rock in the district, the so-called tin-granite. As its local name implies, its importance is due to association with the deposits of tin ore. In fact, it may be affirmed that almost all the commercial deposits are contained in that granite. Many of the most extensive deposits are impregnations of the rock; the richest greisen veins are contained in it; and many of the pegmatite formations are in direct association. Its importance, then, is quite evident.

As to the more extended application of the other adjective, it is remarkable because of the presence of much albite-orthoclase, and of the development of pinite and other secondary minerals in its altered parts.

The tin granite is finer in grain than the normal types; the crystals are more even, but are less idiomorphic than in the porphyritic granite; and in many places the rock has suffered greatly from the effects of mineralising agents during the process of consolidation.(1) The dark mica goes through a series of changes into silvery and greenish-white mica. At first the change is into a dark bronze-coloured mica, then, as the iron becomes gradually abstracted, into the white potash variety. This alteration is observable under the microscope in one and the same crystal, where a mica flake consists of the iron-magnesia variety in one part and the potash variety in the other. A typical specimen of the altered granite shows:—Quartz, fringed with secondary quartz; magnetite in bleached and altered biotite; topaz and muscovite pseudomorphous after felspar; felspar altering to secondary muscovite; kaolin edged with sericite.

(1) Twelvetrees, W. H.: Report on the Tin Mines of Blue Tier, County of Dorset, 1901.

Another specimen shows:—Primary quartz with vesicles; topaz and secondary muscovite after felspar; secondary quartz; felspar altering to secondary mica; pinite; topaz and secondary quartz; and mica after felspar; kaolin after orthoclase; and green biotite.

At the Liberator Mine the altered granite is studded with fluorspar (not in cracks, but in the body of the rock), yet, as a rule, the tin-granite is deficient in lime. Fluorspar, however, is fairly abundant as a coating of joint planes in the granite at the Anchor Mine, and at the Crystal Hill Mine fluor-apatite, in pale-green prisms, is found in hard reddish tin-granite. The general deficiency in lime minerals may be verified by reference to the analyses in the subjoined table:—

Table of Analyses.

Reg. No.	Locality.	Nature of Rock.	Silica.	Alumina.	Ferrous Oxide.	Ferric Oxide.	Lime.	Magnesia.	Potassa.	Soda.	Tin Oxide.	Manganese Oxide.	Fluorine.	Ignition Loss.
1553	Anchor Mine	Altered granite	69·60	14·56	2·19	3·28	nil	0·86	2·59	1·19	5·00	—	—	2·40
1552	Mt. Michael Mine	Tin-granite	74·60	16·65	1·41	1·57	nil	0·21	2·57	1·41	—	—	—	0·94
1550	Mt. Michael	Pinitised granite	75·75	15·75	1·55	1·71	nil	0·58	2·89	2·53	0·25	—	—	1·34
1548	Anchor Mine	Tin-granite	77·00	13·80	1·29	2·57	nil	0·29	1·85	1·22	0·06	—	4·38	1·68
1549	Liberator Mine	Granite with fluorspar	71·68	15·57	2·32	2·86	1·20	0·86	2·24	1·75	nil	0·18	1·36	1·98
1551	Ransom Mine	Kaolin (felspathic granite)	49·00	32·68	0·30	0·64	nil	0·14	3·59	2·79	trace	—	—	11·90
1468	Ransom Mine	Kaolin (felspathic granite)	56·83	27·85	—	2·15	nil	0·21	—	—	0·57	—	—	12·77
1472	Mt. Michael	Felspathic granite	57·18	24·24	—	1·72	nil	0 50	0·28	4·09	8·38	—	—	3·30
1474	Australia Mine	Pinite	53·40	31·10	—	3·30	0·36	0·14	5·69	1·66	—	0·40	—	4·00
	Michael Mine	Pinite	44·72	36·42	—	3·38	nil	1·08	6·36	2·43	—	—	—	5·66

One of the most striking features of the tin-granite is the constant presence of the soda-alumina felspar albite, or its monoclinic equivalent, as an admixture in the orthoclase component. As may be seen by reference to the table of analyses, the sodium compound, in some cases, is in excess of the potassium, and in association therewith tin ore is more abundant.

The liberated magnesia in the decomposition of the dark mica is redeposited as talc or as chlorite, but the common green mineral, mistaken for talc, that gives the greenish hue to the granite is neither of those minerals, but is pinite, an alteration product of topaz. Note in the table of analyses the high proportion of silica, the low proportion of magnesia, and the general absence of lime in the tin-granites from all parts of the field.

This tin-granite, in its mineralised parts, is a more or less greisenised rock in which topaz and a greenish-brown secondary mica (fluoric-soda-potash—iron variety) have taken the place of felspar in some parts, and quartz and mica have replaced it in other parts. Incipient greisenisation of the granite is evident; everywhere tin-bearing, the tin ore is restricted to the tin-granite, except those greisen veins that traverse normal granites, which veins, however, are comparatively unimportant. At the Mount Michael Mine, and in other parts, the white tin-rich rock consists of topaz, quartz, and albite-orthoclase felspar. This is contained in tin-bearing pinitised granite, not as rich as the white rock. Topaz became early one of the foremost of the accessory components, for it is found in close association with felspar, biotite, and quartz, and its alteration product, pinite, is found in similar association. There is abundant evidence, however, to show that part of the topaz—perhaps the greater part—is of later formation, and is pseudomorphous after crystals of felspar.

As a rule partial greisenisation only has taken place, as evinced by rock showing felspar undergoing alteration into topaz and muscovite. (Complete greisenisation consists in the elimination of felspar and an accompanying silicification of the rock and a large formation of secondary mica.) In the partially greisenised granite, which originally consisted essentially of biotite, acid plagioclase, and a little quartz, the greater part of the tin ore is in a very fine state of division, usually enwrapped in scales of mica; the lesser part in grains visible by unaided eyes. When crushed and vanned a fine brown powder of tin ore is obtained, with zircon and topaz.

An important modification of the more common type of tin-granite is that due to the segregation of the felspars orthoclase-albite and oligoclase. In these white mica in fine scales is common, but original quartz is rare. Topaz, resulting from the action of fluorine vapours, is abundant, and with it is found the tin ore, usually in medium-sized grains. The tin ore is found in nests, bunches, in short irregular streaks, or fairly evenly disseminated through part of the rock. These felspathic rocks weather much more rapidly than the containing granites. The felspars are completely kaolinised, the topaz is pinitised in part, the mica is decomposed, and the contained tin ore is disintegrated into detached grains. Some of the more important of such bodies are opened in the Ransom, Anchor, Australia, Southern Cross, Mount Marie, Haley's (Macmichael Creek), and the northern group of sections. In many of these the upper parts of the soft rock have been sluiced for tin ore. The composition of the rock is shown in the table of analyses.

Pegmatite.

Common variations of the granites and alaskites of this district are pegmatites of similar minerals of composition. Sometimes the pegmatites occur as nests and veins; sometimes forming dykes in the granite, or forming the walls of felspathic dykes, with no sharp line of demarcation between them and the finer-grained rocks, and containing the same minerals; sometimes with many accessory metallic minerals filling horizontally disposed fissures between the tin-granite and the overlying alaskite. Thus is established the fact that the pegmatite magma was a residual portion of the main granitic magma. Furthermore, the large size of the component crystals, the tendency of the different minerals to segregate, and the elongation of occluded quartz, with cavities partly filled with water and contained in large crystals of pink felspar, clearly show that the pegmatite magma was far more fluid and mobile (probably because of the mineralisers) than the granite magma, so that migration during crystallisation was freer and segregation easier.

The more common essential components of the pegmatites are felspars, mica, and quartz, but in some places accessory minerals, such as topaz, fluorspar, tourmaline, fluor-apatite, and metallic minerals are present. Among the latter are cassiterite, molybdenite, chalcopyrite, and wolfram, which appear moulded on or sometimes replacing the mica or the felspars.

At the Anchor, Liberator, Crystal Hill, Don. and Australia Mines the pegmatitic materials fill contraction fissures between upper barren alaskite and tin-granite and lower tin-bearing altered medium-grained granite. In these albite-orthoclase, oligoclase, and quartz are the dominant minerals; mica in many variations is abundant, and accessory minerals of many kinds give to them an extraordinary interest. Felspar crystals 4 inches in length are not unusual, and in some places are intergrown with quartz, which also fills the intervening spaces between mica and felspar. Mica appears in large hexagonal plates, in local segregations of a dark-green colour, and in large masses of lamprophyric granite in an extension of the pegmatite; muscovite is both an original component and also secondary after biotite, through the removal of iron, which accounts for the presence of magnetite in association therewith. A section under the microscope shows:—White mica (with wavy extinction, due to crushing), partly replaced by chalcopyrite lined with analcite; oligoclase altering to mica; orthoclase slightly kaolinised; fluorspar, with a wavy fringe of secondary silica; quartz, with liquid and gas inclusions; corroded primary mica; and cassiterite in quartz. The indications are that the cassiterite was the first of the four metallic minerals to be introduced during the process of alteration.

Nearby are comparatively large bodies of dark-green mica, made up of innumerable plates, $\frac{1}{8}$ to $\frac{1}{4}$-inch wide, separated by finely divided analcite, the whole flecked with blebs and crystal aggregates of brown cassiterite. All such bodies of mica in the area contain a higher proportion of tin ore than the average stone.

A specimen, taken from the tin-granite near that spot, examined under the microscope, showed orthoclase converted into topaz, dark-green biotite, partly bleached and seamed and veined with cassiterite in cleavages and cracks, felspar altered to white mica, felspar with infillings of magnetite, radiating flakes of talc and pinite.

Near the road-crossing of Sun Creek is a larger and extensive pegmatite body of quartz-mica, almost barren of tin ore. The quartz is the dominant mineral, but the mica is of more interest. An analysis of the mica revealed the following composition:—

	Per Cent.
Silica (SiO_2)	36·76
Ferric oxide (Fe_2O_3)	19·16
Ferrous oxide (FeO)...	1·68
Alumina (Al_2O_3)	25·96
Titania (TiO_2)	0·20
Manganese oxide (MnO)... ...	1·13
Lime (CaO)	Nil
Magnesia (MgO)	0·19
Potassa (K_2O)...	8·59
Soda (Na_2O)	5·00
Ignition loss	1·99

This is a ferric iron mica with a composition like baddeckite, but containing a large proportion of soda.

On the Mount Marie property a dyke of fine-grained quartz-felspar rock is walled with pegmatite of pink felspar and quartz. The pegmatite extends from the footwall and hanging-wall about 2 feet; then, by gradations, merges into the fine rock. In extreme cases nests of pegmatite are completely surrounded by fine quartz-felspar. Pink felspar is the dominant mineral, and, although showing incipient crystallisation, is streaky, and that appearance is enhanced by the very numerous occlusions of long streaks of quartz, containing vesicles filled with liquid and gas. The streaks all trend in the one direction. This is illustrative of extreme fluidity. An analysis of the pink albite-orthoclase felspar showed the following constitution:—

	Per Cent.
Silica	66·00
Ferric oxide	1·43
Ferrous oxide	0·25
Alumina	20·29
Titania	Nil
Lime	0·60
Magnesia	0·29
Soda	3·60
Potassa	6·83
Ignition loss	0·50

Apparently in that felspar also an albite equivalent appears as an admixture with orthoclase, forming a soda orthoclase.

Another variety of pegmatite is to be seen extending from the Victory Mine over the road to Lottah. This consists of large phenocrysts of muscovite, set in a fine intergrowth of felspar and quartz.

A similar pegmatite extends from Lottah township, where the Weldborough and Poimena roads junction, to Ransom Mine. This varies from that of the Victory Mine, in having larger phenocrysts of felspar. Alongside it is a later pegmatite, similar in all respects to that of the Mount Marie ore-body, having large pink felspar, muscovite, and quartz on the walls and micro-pegmatite in the body of the rock.

The Victory type of pegmatite is represented in the Mount Marie property on the southern bank of the Wyniford River. Here cassiterite, in large crystals, is present, but is sparsely distributed.

The greater part of the tin-granite in the plateau area may be regarded as a micro-pegmatite, for it shows a general intergrowth of quartz and felspars, and sometimes of such accessory minerals as felspar and cassiterite. In many of the so-called aplite dykes the rock could better be described as a micro-pegmatite, with coarse pegmatite walls. Moreover, the laminar structure of the dyke-rock is a notable feature.

At the Cambria Mine, west of the Liberator, a pegmatite, showing intergrowth of very coarse crystals of pink felspar and brown cassiterite, and of quartz and cassiterite, forms the main ore-body. This pink felspar contains numerous elliptical blebs of quartz, arranged in parallel. Although pegmatites form some of the most extensive of the rich deposits, many are barren. Such ones consist of quartz-felspar-mica, of quartz-mica, or of quartz, many grading insensibly into quartz veins. The later pegmatites, although widely developed, are but rarely provided with cassiterite in notable amounts, and the same is true of the quartz veins associated with them. Many of the later, and barren, quartz-felspar veins of aplite cut through and displace greisen veins, rich in tin ore, and pegmatite veins.

Quartz-Greisen.

In various parts of the larger ore-bodies are examples of the complete silicification of the so-called tin-granite, and, in certain places, of the porphyritic granite also. The distinction between original quartz and the cementing material is almost obliterated in some cases, the cement being arranged in optical continuity with the crystalline structure of the original grains of quartz, thus producing a mosaic of solid quartz. Gradations of siliceous cementing to almost unaltered granite are noticeable; for instance, in the open-cut of the Anchor Mine, microscope examination of some specimens show secondary silica corroding and replacing the micas and felspars, in others their complete replacement. At the Liberator, Australia, and Moon Mines also the greisenisation of the tin-granite below the coarse pegmatite is extensive. In such bodies are found molybdenite in unusual proportion, cassiterite, and chalcopyrite, and fluorspar filling cleavages in the rock. The molybdenite is distributed irregularly in large flakes and veinlets, and the chalcopyrite in blebs, and the cassiterite also in blebs and veinlets, which, in places, form bodies of commercial importance.

Quartz-mica greisen veins are common in all the important ore-bodies, and extend into the normal granite. In these the felspars and dark mica have been either wholly or partially converted into secondary micas or replaced by secondary quartz. Pseudomorphs of topaz after orthoclase are not uncommon, and, in the partially greisenised rock, the partial replacement of orthoclase by topaz, secondary quartz, and pinite is in evidence. Where the veins enter and traverse normal granite the walls are greisenised, and the middle of the fissure is marked by comb structure of quartz. Molybdenite appears in the most silicified parts of the wall-rocks, where also are found blebs and grains of cassiterite, with definite crystal boundaries. The greater part of the cassiterite, however, is found in veinlets lining the original walls of the fissure.

In some places the greisen consists almost wholly of secondary mica, yellowish-grey to greenish-brown in colour, with fine interstitial secondary quartz and analcite, altering to kaolin. Such bodies are invariably carriers of tin ore, which is distributed in large crystal aggregates of cassiterite. Some of the important bodies are exposed in the Anchor, Mount Marie (Ling cut), Australia, Don, Crystal Hill, and Liberator Mines.

Analyses of the dark greenish-black mica showed the following composition:—

	No. 1. Per Cent.	No. 2. Per Cent.
Silica	37·00	35·20
Ferric oxide	5·86	7·58
Ferrous oxide	17·15	13·40
Alumina	24·92	27·75
Titania	Nil	Trace
Manganese oxide ...	0·56	1·16
Lime	Nil	Nil
Magnesia...	1·45	0·36
Fluorine	1·85	—
Lithia	Nil	—
Potassa	5·83	6·38
Soda	4·09	3·88
Ignition loss...	1·80	3·10

The high proportions of ferrous oxide and alumina and the low proportion of magnesia are extraordinary. A specimen of greisenised rock from the Anchor ore-body revealed the following associations:—Unaltered orthoclase close to topaz; cassiterite filling cleavages and cracks in secondary mica; chlorite after biotite, carrying cassiterite; white mica after felspar; magnetite filling cracks in felspar; green mica, with grains of cassiterite; pinite.

Another showed topaz enclosed in secondary mica and quartz, fluorspar enclosing grains of topaz, secondary quartz and mica, and secondary quartz fringing original quartz.

Alaskite-Aplite.

Alaskite aplite is represented in dykes in the granites. This rock, because of its fine and even grain-size and of its high proportion of quartz, is called sandstone by local miners. It is of homogeneous fine grain, and consists wholly of quartz and felspar, the former predominating. The dykes fill the whole spaces into which they were injected, and the walls are very sharply marked. They are less felspathic and more siliceous than the earlier and more mobile pegmatite intrusives, and are barren of ore minerals.

Quartz-Aplite.

Quartz aplites are likewise in the form of irregular dykes The rock is of fine grain, and is homogeneous both as regards composition and texture. To the eye it appears at first sight like a quartzite, and it fractures along sharp planes of jointing, the broken pieces having the shapes of fractured quartzite. One of the best examples is to be seen near the Wellington Mine, in a cutting of the track leading to Camp Creek workings. It contains a higher proportion of quartz than the alaskite aplite, and is the most acidic of all the rocks except its contemporaries, some barren pegmatitic quartz veins.

Accessory Components of the Rocks.

A large number of accessory minerals of considerable interest, and some of commercial importance, are contained in the various forms of the granitic rocks. Such minerals are those possessed of a small degree of solubility in a silicate magma, from which, in consequence, they separate at an early stage. Hence they often show very perfectly developed crystal forms, and are often completely enclosed in larger crystals of the later minerals.

The assemblage includes apatite, zircon, monazite, cassiterite, magnetite, and tourmaline. Others more characteristic of pegmatites are sapphire, pleonaste, the sulphides molybdenite, chalcopyrite, and pyrite, and wolfram. Topaz and fluorspar are also common, but such are of secondary origin.

BASIC ROCKS.

As shown on the geological map, a large number of narrow dykes of basic composition traverse the granites along generally parallel lines in a north-easterly direction. Those crossing the plateau and those in the neighbourhood of the Anchor and Lottah Mines were thought by Thureau and Montgomery to consist of basalt, which they strikingly resemble. Twelvetrees, on the other hand, after submitting the rock to microscopical examination, pronounced it a diabase. The component minerals are plagioclase and augite, the latter greatly chloritised. Probably one of the reasons for its identification as diabase is the absence of olivine, an almost universal accessory of Tasmanian basalts. Twelvetrees, in support of his identification, drew attention to the diabase structure of the rock; but in a dyke-body a similar structure might have been formed in a basalt magma. The rock has the megascopical appearance of a basalt, it weathers in scaly rounded forms, and in its weathered parts does not show the jointings common to diabase.

If the rock is a basalt, it is probably of the same age (Mid-Tertiary) as the adjacent sheets of basaltic lava, and, if so, these dykes mark the vents through which the lavas were extruded.

There are, however, undoubted dykes of diabase, usually much wider and more extensive than those already referred to. Such a one is that crossing the bed of Wyniford River, a few chains above the intake of Pioneer water-race. The rock is quite fresh, and has all the physical properties and the mineralogical constitution of the diabase of Mesozoic age, so widely distributed in Tasmania. No direct evidence is available in this area to allow of such designation as to age. Twelvetrees regards the diabase dykes as a part of the great Mesozoic irruption; Montgomery, on the contrary, suggests a causal connection between them and certain concentrations of tin ore in the granites of the Anchor Mine. Although cases are known of a final irruption of diabase from a granitic magma, in this case the differentiates passed through all gradations from sub-basic to final acidic types. The general trend of the dykes is north-easterly, in conformity with the general trend of many greisen veins, and in some cases the basic dykes appear to have followed directly in the path of greisen veins, thereby giving credence to the idea of association with ore-deposition. The dykes have no bearing whatever upon the deposition of the tin ore.

The dyke-rock decomposes into a yellowish-brown clay of the following composition:—

	Per Cent.
Silica	38·60
Ferric oxide	5·72
Ferrous oxide	1·55
Alumina	29·17
Titania	0·80
Lime	Nil
Magnesia	0·72
Potash and soda	0·25
Ignition loss	23·40

STRUCTURAL GEOLOGY.

The most striking feature of this and other tin areas in the North-Eastern quarter is the occurrence of large bodies of tin-granite near the summits of the highest ranges. These bodies of tin-granite intruded the earlier porphyritic granite, which had then completely solidified, as shown by the sharp line of demarcation between them. They trend in a general meridional direction, one approximately parallel to another. Their preservation is due to the bulwark of weather-resisting porphyritic granite and to the presence of numerous greisen veins in them. Examination of the surrounding country shows that these granite mountains represent a series of projections, or bosses, extending from a great underlying batholithic body, the projections being from 2000 to 2500 feet above present outcrops of the intruded sediments. The lines of weakness, therefore, that they mark are the lines of greatest vapour tension and, consequently, of ore-deposition.

The major structural planes of the tin-granites of Blue Tier are represented by a series of parallel, horizontally-disposed fractures, which separate the mass into layers of varying thickness. These planes mark isotherms in the earlier-cooled higher horizon of the tin-granite magma, and are well shown along the fringe of Blue Tier Range, above the Australia Mine, at Mount Michael, Little Mount Michael, McGough's Lookout, and other prominent peaks, and in the lower horizons they, with the associated greisen veins, form the most important and extensive of the ore-deposits, such as those of the Anchor, Liberator, Crystal Hill, and Don Mines.

The evidence to be given confirms the accepted view that, where a siliceous-alkaline magma-intrusion does not reach the surface, its slow cooling and crystallisation create a succession of isothermic curves above the focus of heat, and that these curves determine the successive zones of ore-deposition, one above the other, the uppermost being still far below the original surface. The conditions in this case were rather peculiar: first, it should be noted that the tin-granite portion of the magma was intruded into an earlier differentiate of porphyritic granite which had just consolidated under a deep cover of Cambro-Ordovician sediments; second, the sedimentary cover-rock rapidly conducted heat away from the upper portion of the tin-granite magma, which as rapidly solidified, but still, like the porphyritic granite wall-rock, retained heat in a considerable degree. The plane of division (geo-isotherm) between the upper solidified portion and the lower still viscous magma, where the minerals were being concentrated, was conditioned largely by the plane of the sedimentary cover. As a result it is found that the plane is an undulating dome. One set of fractures resulting from the contraction of the solidified and the unsolidified magma followed that plane and its parallels. That set of fractures did not provide continuous open spaces overhung by a cupola of granite. On the contrary, the pegmatite vein-dyke infillings show a pinching and swelling, and in some places the absence of pegmatite shows that the rocks in those parts remained in contact. Synchronously with the horizontal fracturing lateral shrinkage gave rise to vertical fracturing, and, immediately following the reduction in pressure, the released mineralising agents, acting upon the still viscous magma, and enhancing its fluidity, carried it into the fissures, where it formed as pegmatite. (The most important of the deposits of pegmatite are the so-called "floor" deposits, but pegmatite also forms the bodies of dykes and also some highly-inclined veins in normal granite.) Minor horizontal and vertical joints then formed in the still shrinking mass, dividing it into roughly cubical blocks, and providing in that manner other openings for invasion by the mineralising solutions and the resultant formation of greisen veins.

The tin-granite magma, just below the cupola of overhung granite, was, immediately after the later injection, subjected to the strong action of mineralising agents, such as fluorine and water-gas. Hence it is found that a number of secondary minerals have been formed in the granite at the expense of those most easily susceptible to attack.

A most striking feature, and one having a decided economic bearing, is the concentration of tin ore in the upper part of the undulating plane, where it is traversed by veins of greisen; that is, at the anticlines. For instance, the richest deposits are at the Liberator, Crystal Hill, and Anchor workings, along one section. These mark the anticlines of the undulating plane, the country between (the synclines) being poor in comparison. The ore-bodies rise with the hillslope at the angles of pitch of the anticlines.

The general trend of the dyke-like parts of the tin-granite is northward, varying from N. 10° W. to N. 10° E., and the dip is westward at 42°. North of Wyniford River the tin-granite, still keeping to the north course, is 1½ miles wide; immediately south of the river the western boundary is marked by a narrow belt of pinitised tin-granite, and the middle by the comparatively narrow Mount Marie dyke. The intervening rock is porphyritic granite, through which penetrate outliers of tin-granite of small extent, such as that of the Giant line; and on the east side of the Mount Marie line are the Full Moon outliers, which are close to the eastern boundary. (These outliers evidently represent tin-granite projections through incompletely absorbed porphyritic granite.) The Mount Marie dyke, lying between Wyniford and Poimena faults, apparently marks the middle of the intrusive body, and continues through the Southern Cross and Planet ground to Australia Hill, where the tin-granite is exposed again to its full width. Going south down Australia Hill, towards Don and Crystal Hill, it is found that a large body of porphyritic granite intervenes, the line of junction being N. 73° E., or almost exactly normal to the strike of the tin-granite. On the other, or south, side of the porphyritic granite divide the sharp line of junction between it and the Don tin-granite courses N. 73° E., and dips south at 65°. That is remarkable; yet a more remarkable feature is the almost parallel strike (N. 70° E.) of numerous diabase dykes of apparently Mesozoic age that traverse the granite country rock from end to end of the area. Probably the diabase followed along original structure planes.

Before leaving this stage of the discussion it is desirable to draw attention to the interesting occurrence of tin-bearing coarse pegmatite just south of Wyniford River, where the Mount Marie dyke adjoins the large Mount Michael body of tin-granite. That coarse pegmatite consists in part of the material of porphyritic granite, into which the tin-granite magma is intruded.

As regards the occurrence of tin ore in the tin-granite, it is found that the most important depositions are in association with groups of closely parallel greisen veins.

Near the junction of Sun and Moon Creeks, and south of Poimena, are strong bodies of barren quartz-mica pegmatite, coursing N. 73° E., and dipping south. At the Ransom and Victory Mines barren felspar-quartz-mica pegmatite courses N. 70° E. These barren pegmatites, belonging to one of the latest stages of differentiation, mark the lines of faulting consequent upon adjustment caused by contraction in the cooling granitic body.

It is noteworthy that all the greisen veins south of Poimena fault, and also those near Lottah, course east of north, and dip west of north, while those on the Tier, between Poimena and Wyniford faults, course west of north, from 29° to 53°, and dip south-westerly. Narrow dykes of alaskite aplite, coursing east of north on the eastern side of Blue Tier, intersect and fault the latter. In contradistinction, on the western side of the tin-granite body the alaskite-aplite and quartz-aplite dykes course west of north, and dip north-eastward.

The various types of intrusive rock and the order of their intrusion clearly indicate the successive lines of fracturing.

Major faulting appears to have resulted from movements in the granitic body during and immediately after consolidation.

The structure, as represented on the map, is probably in part the result of Mesozoic dislocation accompanying the intrusion of diabase into Permo-Carboniferous and Trias-Jura formations. A study of the stratigraphy shows that at that time the land was elevated at least 3000 feet, and that, following disruption, faulting on a grand scale took place. A remnant only of the Permo-Carboniferous remains, the conglomerate basal member of which rests almost horizontally upon Devonian granite, at an elevation of 2700 feet above sea-level. Data to serve as a basis of measurement are therefore lacking; but at Fossil Creek, in the neighbourhood of Weldborough, the corresponding members of that formation lie at a much lower elevation, clearly indicating a downthrow of considerable dimensions. Evidences of such dislocations and faultings are abundant in other parts of the island in connection with the great invasion of diabase. It appears, therefore, that some structural features are directly the results of that intrusion. The strike of the major faults is N. 73° E., and the dip is southward, at an angle of 55°.

Such relations point to a causal connection between the lines of diabase dykes and the parallel lines of faults. As the downthrow of the Permo-Carboniferous is to the south, it is assumed that the later faulting is the indirect result of the intrusion of diabase. Several lines of east-west faults are clearly evident along the south fall of Australia Hill; others are those near Groom River, below Anchor Mine. At the latter locality the tin-granite is faulted below the older granite, and no trace of it is seen again in the low-lying country farther south.

The idea has been held that the original upper limit of the Anchor ore-body was at the same level as the Moon, 1500 feet higher, and that it had been denuded of the barren cover-rock to its present level. That idea cannot be maintained on the basis of any positive evidence. In this connection it is interesting to note that the valley of Groom River, which leads past the Anchor Mine, contains shallow deposits only of alluvial, and the proportion of tin ore does not exceed 0·5 lb. per cubic yard. From this it seems that agents of erosion have only just uncovered the tin-bearing rock at the Anchor, the Australia, and the

Don; and that the variation in the elevations of outcrops is due in part to faulting and in part to original structure.

It is interesting to record that structure planes in the porphyritic granite trend N. 73° W., and dip north.

WEATHERING.

The ordinary agents of weathering are rain, frost, wind, and changes of temperature. Some are mainly physical in their action; others are mainly chemical; but it is only rarely that the effects of weathering are due to one cause. Chemical processes are largely due to the action of solutions in water, such as oxidation and reduction, and hydration, and the action of acidic and other compounds. The effects of weathering agents are greatest upon the minerals of igneous rocks, which were formed at temperatures and pressures much higher than those of the atmosphere. Such minerals are therefore unstable, and undergo change more readily than those composing sedimentary rocks.

In this area granites of various kinds, and their apophyses, occupy the greater part. Since the granites are granular rocks, composed of felspars, micas, and quartz, the decomposition of one component leads to the disintegration of them all. The felspars are the first to decompose and break up, and of these orthoclase is the least stable. Water alone suffices to bring about the transmutation of orthoclase into kaolin, or china clay, but possibly carbonic acid is a contributory agent. Oligoclase alters into clay and sericitic mica. Lime-rich plagioclase may yield chlorite and saussurite.

The biotite of granites undergoes alteration to chlorites by the removal of ferrous and ferric iron and potash, and by hydration. Ferro-magnesian minerals undergo a series of complicated changes in their decomposition, the main effects being due to the removal of magnesia.

The glassy part of basalt-lava is unstable, and this results in the rapid breakdown of the rock into fertile soils. Diabase, being a granular rock consisting essentially of augite and plagioclase, is able to resist the attack of weathering agents in a much higher degree.

The minerals of the igneous rocks, therefore, are the more unstable, and give rise to new minerals stable at atmospheric temperature and pressure.

As regards the weathering in sedimentary rocks, the processes are mechanical and physical, rather than chemical, in their nature.

The sediments of this area are now in remnants only. Some beds, the upper ones especially, were removed before they had completely solidified, shortly after the intrusion of diabase and uplift in Post-Triassic time. The only remnant on the Tier is that capping Mount Littlechild, and resting on granite at 2700-foot contour. That indicates that 300 to 400 feet of granite has been disintegrated and removed from Blue Tier plateau since Triassic time.

On the eastern fall of Blue Tier, a little west of the Australia Mine, the surface of the great flat slabs of fine to medium-grained granite is marked by many ramifying grooves, all of which are lined with a thin film of white quartz. These grooves in the rock vary in depth from ¼ to 4 inches, and are generally of semi-circular cross-section. They mark the positions of the roots and boles of trees, the round deep ones the ends of the boles. The quartz lining is the result of precipitation of silica from aqueous solutions by the action of the organic matter of the plant or, in part, by evaporation.

Silicification has extended also into the body of the surface rock, making it hard and weather-resisting. In consequence it is not uncommon to find the tin-granite and the granite porphyry much harder at surface than they are a few feet below. Road cuttings show hard boulders of granite resting upon decayed rock. In some places decomposition goes down to 30 and 40 feet. The porphyritic granite weathers in the ordinary rounded forms; the tin-granite in great flags or oblong rounded forms; the felspathic dykes, as a result of kaolinisation, are decomposed to great depths, and now have the density of clay.

The weathering of the rocks has set free the contained tin ore, and made possible the removal and concentration of alluvial deposits in the beds and banks of streams, and concentration in place by the removal of the lighter materials.

CHAPTER IV.—ECONOMIC GEOLOGY.

The mineral resources of Blue Tier are of tin and comparatively insignificant amounts of tungsten, molybdenite, and copper. All minerals, other than that of tin, may be regarded as of no present commercial importance. In fact, they are in such small proportion as not to be worthy of attention; but they cannot be ignored altogether, because of their admixture with the tin-ore concentrate.

However, the only objective of those interested in mining in this district is the production of tin ore.

MINERALOGY OF THE ORE-DEPOSITS.

The only metal of commercial importance that is found in this district is tin. In fact, the prosperity of the inhabitants depends directly upon the production of that metal.

In close association ores of other metals are found, such as tungsten, copper, molybdenum, lead, and bismuth, but in comparatively small proportion.

For convenience of description the minerals of commercial importance and of particular interest are divided into two classes, namely, metallic and non-metallic.

A list of the most important follows:—

Metallic Minerals.	Non-Metallic Minerals.
Cassiterite or Tin Ore	Andalusite
Wolfram	Topaz
Scheelite	Tourmaline
Molybdenite	Pinite
Chalcopyrite	Fluorspar
Galena	Apatite
Bismuthinite	Zircon
	Sapphire
	Pleonaste
	Analcite
	Chlorite
	Talc
	Sericite

Cassiterite (Tin Ore, Tinstone), tin oxide (SnO_2) (oxygen, 21·4 per cent.; tin, 78·6 per cent.), with a little ferric oxide, is the only ore of tin found in this district.

Wolfram—tungstate of iron and manganese (Fe Mn WO_4). This mineral is a component of the floor pegmatite and of veins on the bank of Groom River and on the eastern fall of Blue Tier.

Scheelite—tungstate of lime (Ca WO_4)—is a minor component of the floor deposits of pegmatite.

Molybdenite—disulphide of molybdenum (Mo S_2)—contains 59·95 per cent. of molybdenum and 40·05 per cent. of sulphur. It commonly occurs in the floor pegmatite and in the underlying quartz greisen in the forms of flakes and scales, and also massive.

Chalcopyrite.—Copper pyrites, sulphide of copper and iron (Cu Fe S_2), copper 34·5, iron 30·5, sulphur, 35·0. A component, though in small amount, of the floor pegmatite and quartz-greisen,

Galena—sulphide of lead (Pb S)—is found in very small proportion in the floor pegmatite.

Bismuthinite—bismuth trisulphide (Bi_2 S_3)—is a minor component of the floor pegmatite.

Fluorspar.—Calcium fluoride (Ca F_2). A common minor accessory component of the tin-granite. It is found in the body of the mineralised granite in association with tin ore, and also filling cracks in the granite. At the Liberator and Anchor Mines it is a prominent component of pegmatite.

Fluor-Apatite (Ca_5 $(PO_4)_3$ F) is found in hexagonal prisms as an accessory of the tin-granite at Crystal Hill. It is regarded as one of the oldest secretions of the granitic magma. Apatite is strongly attacked by waters containing carbonic acid, therefore it does not survive the after-effects of mineralisation.

Zircon—zirconium orthosilicate (Zr Si O_4)—is one of the commonest accessory constituents of the granite, and probably was the first among the silicates to crystallise from the cooling magma.

Sapphire (Al_2 O_3), a blue gemstone found in the wash derived from pegmatitic granite. It has not been seen in place, but there is little doubt of its origin. Stones up to 4 carats are common, and some are not flawed. In the gravels of Nisbet's prospect some large prismatic crystals are found with pleonaste.

Pleonaste—Iron—magnesium spinel (Mg Fe) $(OH)_2$ O_3)—has not been found in place, but is very common in all the tin-ore drifts and gravels.

Analcite ($Na\ Al\ Si_2\ O_6 + H_2\ O$) is a secondary mineral, probably derived from soda felspar. It is an interstitial part of some pegmatite minerals.

Talc—an acid metasilicate of magnesium ($H_2\ Mg_2\ (Si\ O_3)_4$)—is found here as an alteration product of biotite in the tin-granite.

Sericite—an orthosilicate of aluminium and potassium (HK) ($Al\ Si\ O_4$)—is of similar composition and origin to pinite, and is found in scaly or fibrous form in the altered granites.

Andalusite.—Andalusite ($Al_2\ Si\ O_5$) or ($Al_3\ (Si\ O_4)_3\ (Al\ O)_3$) is found as a 3-inch vein in granite at the Lottah Mine. The mineral is of a reddish hue and of radiating columnar structure. It is faced on both sides with muscovite and cassiterite.

Andalusite alters readily to muscovite under suitable conditions, and also to chlorite and kaolin.

Topaz (2).—The simplest empirical formula is $Al_2\ Si\ O_4\ F_2$, but with part of the fluorine commonly replaced by hydroxyl. It is a common accessory of the tin-bearing granite, and especially of the pegmatites and aplites. Topaz alters easily, by hydration and by the action of percolating alkaline solutions, and is transformed into compact muscovite. Its origin is due to the action of gaseous emanations containing fluorine, in some cases, upon felspar or mica.

Topaz is extraordinarily abundant in the tin-bearing granite of this district. In some places, such as that of the Mount Michael Mine, the richest material consists of quartz, topaz, and cassiterite, the topaz being an alteration product of original felspar. It is also an invariable component of greisen veins, pinitised bodies, and of some pegmatites.

Tourmaline.—A complex silicate of boron and aluminium, with also either magnesium, iron, or the alkali metals prominent. It is a rare mineral in this district, but is found in the pegmatites associated with metallic minerals, and as nodular segregations in granite away from the ore-bodies. Its comparative rarity is particularly remarkable, especially in view of the fact that the fluorine minerals are abundant.

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(2) *Vide* F. W. Clarke: Data of Geochemistry, p. 413.

Pinite.—Pinite is an alteration product of felspar and other minerals. In composition it is essentially a hydrous silicate of aluminium and potassium, corresponding closely to muscovite, of which it is generally regarded as a massive, compact variety. This mineral is extraordinarily abundant in the tin-granite of the district. It has been generally miscalled chlorite, which it resembles in appearance, but differs from in its content of alkalies. The composition of a sample of botryoidal pinite and incipiently crystallised muscovite, taken from a vein in the ore-body of the Australia Mine, was found to be:—

	Per Cent.
Silica ($Si O_2$)	53·40
Ferric oxide ($Fe_2 O_3$)	3·30
Alumina ($Al_2 O_3$)	31·10
Lime ($Ca O$)	0·36
Magnesia ($Mg O$)	0·14
Manganese oxide ($Mn O$)... ...	0·40
Soda ($Na_2 O$)	1·66
Potassa ($K_2 O$)...	5·69
Ignition loss	4·00

Another sample containing a high proportion of tin ore, taken from the Southern Cross Mine, was composed of:—

	Per Cent.
Silica ($Si O_2$)	44·80
Ferric oxide ($Fe_2 O_3$)	3·29
Alumina ($Al_2 O_3$)	34·71
Magnesia ($Mg O$)	0·72
Tin oxide ($Sn O_2$)	2·80
Soda ($Na_2 O$)	3·03
Potassa ($K_2 O$)...	6·37
Manganese oxide ($Mn O$)... ...	0·45
Ignition loss	5·08

The constant association of pinite with cassiterite (tin ore) is remarkable. This association is fully discussed in a later chapter.

Chlorites.—Under this general name a number of minerals are embraced which are closely related to the micas. These are, however, much more basic, highly hydrated, and *free from alkalies.* They are silicates of aluminium or ferric iron, with magnesium or ferrous iron, and resemble the micas crystallographically as well as in the scaly, or foliated, habit which they commonly assume.

It is obvious, from their hydrous character, that the chlorites cannot form as pyrogenic minerals. They are always of secondary origin, and when they appear in igneous rocks it is as the result of hydrothermal alteration. Almost any aluminous magnesian mineral, such as biotite, may yield chlorite in this way.

Genesis of the Ore-Deposits.

Tin is always genetically associated with siliceous rocks, especially granites, and never with those of the basic kind. It is among the final products of the granitic crystallisation, and the residual portion of the magma in which it was contained was rich in fluorine and sometimes boron; hence tin (almost always as the oxide cassiterite) is found in pegmatites and pegmatitic quartz veins, greisen veins, and other fissure fillings, and also in felspathic segregations, associated with minerals like topaz, fluorspar, and tourmaline, containing the gaseous elements above mentioned in combination with bases derived from the containing rocks. The ores occur usually near or at the granite contact, and, in this case, chiefly in the upper portion of the granite mass. As a rule the extent is not as great in the lower portions, showing that the tin-bearing residual magma solution ascended from and through the granite to near its upper contact, where the lower temperature was a cause of its condensation.

It may be affirmed that the metallic minerals in acid magmas, in contradistinction to those in basic magmas, tend to separate last and rise to the top. In the highly siliceous solutions rich in fluorine the tin and tungsten probably existed as fluoride at a high temperature. As the temperature falls these fluorides react with water according to the following equation:—

$$SnF_4 + 2H_2O = SnO_2 + 4HF.$$

Tungsten, which forms a still more volatile fluoride (WF_6), is precipitated in a similar manner. Molybdenite (MoS_2) and chalcopyrite ($CuFeS_2$), accompanying the tin ore, probably represent primary sulphide solutes. The released hydrofluoric acid then acts upon the lime-bearing felspars, forming fluorspar (CaF_2) and topaz, or crystalline micas. Volatile tin fluoride, in contact with the felspars and micas, precipitates tin oxide as cassiterite, and forms topaz, fluorspar, and secondary mica direct. Probably the topaz, by hydration and by the action of alkaline solutions, is then altered to pinite. It is a notable fact that abundance of pinite denotes abundance of tin ore, indicating a topaz origin of pinite.

Topaz appears to have been an original accessory component of the tin-granite, because its alteration product, pinite, is found in direct association with orthoclase and biotite, just outside the range of ore-deposition. Topaz from the quartz-felspar rock at Mount Michael Mine, by crushing and panning, can be separated with the tin ore. An anlysis revealed the composition of the rock:—

	Per Cent.
Silica	57·18
Ferric oxide	1·72
Alumina	24·24
Titania	Nil
Lime	Nil
Magnesia	0·50
Tin oxide	8·38
Potassa	0·28
Soda	4·09
Fluorine and ignition loss ...	3·30

Pinite from the Southern Cross Mine was composed of:—

	Per Cent.
Silica	44·80
Ferric oxide	3·29
Alumina	34·71
Titania	Nil
Lime	Nil
Magnesia	0·72
Tin oxide	2·80
Soda	3·03
Potassa	6·37
Manganese oxide	0·45
Ignition loss and fluorine	5·08

Thus topaz was formed at the expense of felspar, and fluorspar from oligoclase and apatite. (The fluorspar of the Liberator Mine is an alteration product of apatite and lime felspar.) The lateral expansion of mineralisation was brought about first by the confinement of the tin-granite below the alaskite cover, then aided by the development of channels of access along shrinkage cracks in the cooling rock. Alkaline solutions later permeated the whole rock, altering topaz to pinite and secondary mica, and forming many of the massive veins to tin-bearing mica. It is probable that such solutions contributed the sulphidic ores to the deposits, for they are of slightly later deposition than the tin ore. However, fluorine was still an active agent in the conveyance and deposition of cassiterite, as shown by the presence of the ore in flakes of secondary mica. Near the pegmatite roof cassiteritisation accompanied topazisation of the granite. Cassiterite there is pseudomorphous after felspar, as is the topaz.

Tourmaline is remarkable because of its rarity, showing that boron was not an important agent in mineralisation.

The Granite Magma.

A normal granite magma may be regarded as a system of the following components:—

Silica	SiO_2
Alumina	Al_2O_3
Potassa	K_2O
Soda	Na_2O
Lime	CaO
Magnesia	MgO
Ferrous oxide	FeO

The magnesia and ferrous iron are the least soluble in a silicate melt, and separate first as hornblende, or biotite, or phlogopite, or the soda analogues of those micas. Any lime present combines to form oligoclase or some other form of plagioclase. In this case the ratio $CaO : Na_2O$ is so low that the anorthite molecule is absorbed in alkali felspar. The final solution contains SiO_2, Al_2O_3, and Na_2O, with a certain amount of water. From such solution the following minerals may separate:—

Soda orthoclase,
Muscovite and quartz.

The mica usually crystallises before the felspar, leaving a final residue crystallising as a mixture of albite-orthoclase and quartz.

(3) The relative order of crystallisation of the different rock-forming minerals is by no means the order of their relative fusibility. Granites are easily melted, but do not recrystallise on cooling from the melt. It is universally recognised that the rock magma is to be conceived as a solution or a mixture of solutions, rather than as a melt, and the existence in the fluid magma of materials potent in assisting solution is indicated by the water which is found in microscopic cavities enclosed in the crystalline

(3) Rastall, R. H.: Physico-Chemical Geology, pp. 126-127

quartz of granite, and in the fluorine, boron, phosphorus, and other elements which enter, even though slightly, into the composition of such common rock-forming minerals as mica, topaz, tourmaline, and apatite. Indeed, experiments with the chief minerals of granite as to temperatures and other conditions of consolidation indicate that this rock crystallises at a relatively low temperature as compared with the less siliceous igneous rocks, such as basalts and diabases, and in marked contrast with the known differences in the fusibility of their melts. From this it follows that, although temperature is important as affecting solution, the magma is fluid more on account of solution than of heat.

(4) When in the final stages of crystallisation a silicate magma has attained eutectic composition after separation of the components in excess of the eutectic ratio, two (or more) solids are then in equilibrium with the liquid. This, in effect, means that two (or more) minerals are crystallising at the same time. Thus arise the many examples of graphic intergrowth of quartz and felspar in pegmatites, micro-pegmatites, and graphic granite which are formed by the crystallisation of magmatic residues. Investigation has shown that in graphic granite the ratio silica to felspar-molecule is nearly constant. However, it has been proved that graphic intergrowth is not a necessary result of eutectic composition, but that many varieties of rocks showing the ordinary hypidiomorphic or granular structure are eutectics, or nearly so.

(5) Although the study of eutectics throws much light on problems of petrogenesis, the principle cannot be applied to all cases, nor, perhaps, to the majority of cases; other conditions and relations may prevail excluding the formation of a eutectic. Nevertheless, it does hold in the solidification of magmatic residues, such as give rise to the many varieties of pegmatite dykes and veins and the tin-granites, in which are concentrated the less abundant constituents of the igneous rocks, including ores of tin, tungsten, and molybdenum.

Ore-Deposits.

The ore-deposits may be placed in two divisions, namely:—

Primary Deposits and
Secondary Deposits.

(4) Spurr, J. E.: The Ore Magmas, p. 66.
(5) Rastall, R. H.: Physico-Chemical Geology, pp. 128-130.

The primary ore-deposits may be classified as follows:—

(1) Magmatic segregations and concentrations.
(2) Pegmatitic segregations in veins and dykes.
(3) Greisen veins.
(4) Quartz-mica and quartz-veins.

(1) These are tinstone deposits in granites such as are found in the Anchor, Don, Liberator, Australia, Crystal Hill, Ransom, Moon, Mount Michael, and some other mines.

(2) In these, tinstone, molybdenite, wolfram, and chalcopyrite are found. The vein type is represented in all the mines named in (1) above. Dyke types are represented in the Mount Marie, Southern Cross, and Ethel Mines.

(3) Greisen veins are represented in all mines of the field.

Those classes of deposits are closely associated, and genetically related to the pegmatites, and they contain tin ore in commercial concentrations. In some places one ore-body is contained in or intersects another, yet each type is distinct.

(4) In addition to the tin-bearing bodies another class of deposit is represented in numerous quartz and quartz-mica veins. These, however, are of no commercial importance.

Secondary deposits may be classified into two groups, namely:—

(1) Alluvial deposits.
(2) Detrital deposits.

(1) Alluvial deposits are represented by the well-assorted stream gravels, derived from the tin ore-bodies and the containing rocks. Not many of great extent were found in this area of high relief, but the few were of extraordinary richness.

(2) Detrital deposits are concentrations of tin ore in place by the removal of the lighter containing rocks by the agency of water and wind. Such concentrations are found at the outcrops of the large ore-bodies.

The Distribution of the Tin-Bearing Granite.

The tin-granite, opened to a depth of 70 feet and a width of 1800 in the Anchor Mine, passes underneath barren alaskite to the east, north, and west, and is partly covered south of the cuts. At a depth of 100 feet the tin-bearing granite on the east side rests on an ill-defined floor of normal pink granite, but on the west side it extends to an undetermined depth, abutting sharply against the normal granite, and dipping easterly at an angle of 70 degrees. It passes completely out of sight before reaching Groom River, which follows a line of faulting marked by a number of pegmatitic veins containing cassiterite, wolfram, and chalcopyrite. A small patch of tin-granite crops through the alaskite cover at a spot above Weldborough-road, north of Anchor Mine; another body shows at Gough's house, and a larger body near the road crossing of Crystal Creek, which there bends and follows the line of a minor fault. Pinitised granite is exposed in main water-race west of Anchor Mine. This, and the outcrop at Gough's house, is parallel to the felspathic ore-body of West Anchor Mine.

The alaskite and medium-grained normal granite cover-rocks extend to Crystal Hill and to Liberator Mine, where the tin-granite again outcrops. Between the Anchor and Liberator Mines the southern boundary of the rock extends beyond Groom River; east of the Anchor a long tongue extends towards Gould's Country, where, on Press' property, this tin-granite again appears.

An almost parallel body passes a few chains north of Lottah to the Ransom Mine. This, on the south side, consists of barren mica-quartz-felspar pegmatite, against which is a kaolinised felspar segregation containing tin ore.

At Don Mine the tin-granite ends abruptly against a fault bearing N. 73° E., and dipping southerly. This fault extends westerly past, and on the north side of, the Duco and Liberator Mines, and easterly towards the Ransom.

From the southern part of the Australia sections tin-granite extends eastward almost to Poimena-road, and westward to Mount Littlechild, where it is covered with later formations. Going north through the Planet, Southern Cross, and Mount Marie properties the rock is confined to a narrow dyke and a few short, but parallel, bodies. Close to Wyniford River the body opens out, and a quarter of a mile north of the river it is almost a mile wide, and extends to the northern end of the area. An offshoot from the large projection extends westerly to the Kent Mine. Other, but much smaller, projections are those of Wellington, Giant, and Moon Mines.

Tin ore in place has not been found north of Ransom River, nor north of Lower George River. The explanation is that the tin-granites do not extend to those areas occupied by granodiorites.

The Vertical Range of the Tin Ore.

The vertical range of the ore varies somewhat in accordance with the type of deposit. Three types only may be considered:—

(1) Floor deposits;
(2) Pegmatite and eurite dykes; and
(3) Greisen veins.

(1) *Floor Deposits*, as they are called for convenience of reference, are of great lateral and lineal magnitude, but are of comparatively shallow depth. As mentioned before, they occupy the upper parts of folds, and rise in plane with the pitch of the folds, which varies from 5 to 9 degrees. The depth of the tin-bearing granite, as measured at right angles to the pitch, in few places exceeds 100 feet. Yet its great rise along the pitch gives to it the semblance of continuity in depth. For instance, the base of the Anchor body is at 700-foot contour, while that of the Australia is at 2200-foot contour, a difference of 1500 feet in 1⅝ mile. In this case, however, faulting accounts in a measure for the difference in altitude.

The finding of lower planes of tin-bearing granite similar in character and value is not a likely possibility.

(2) *Pegmatite and Eurite Dykes* are the offspring of the parent tin-granite, and extend to the depth of that rock. They are therefore of much greater measurement in depth than they are in length, but are much narrower. The tin ore in them is not evenly disseminated, being in narrow, short, and irregularly alternating shoots.

The pegmatite dykes at their extremities deploy fan-wise into normal tin-granites, losing their individuality, and clearly showing their origin.

(3) *Greisen Veins* are very narrow (1 to 3 feet), but are richer, longer, and deeper than either the floor deposits with which they are associated or the dykes. At Blue Tier there does not appear to be a considerable diminution in the content of the tin ore to a depth of 500 feet. They may extend to much greater depths and still retain their average proportion of tin ore. It may be safely assumed that half the length is a measure of the depth.

CHAPTER V.—MINING ECONOMICS.

In the consideration of the economics of mining several factors have to be taken into account, in addition to that of the actual mining of the ore. These may be enumerated under the following headings:—

(1) Power.
(2) Water-Supply.
(3) Milling and Concentration of the Ore.
(4) Transport and Communication.
(5) Timber-Supplies.
(6) Labour.

Information in detail will now be given on each of the abovementioned subjects.

POWER.

The provision of cheap power is essential to the successful development of the tin-mining industry in the North-Eastern Division. In the past that lack has been the chief cause of the failure of many mining companies in Blue Tier area.

The chief industrial enterprise of this State is the impounding of waters for the generation of electric power. Surveys performed by State engineers have shown that of all parts of Australia this, the smallest State, possesses the greatest supplies of water capable of being used for power purposes. The Government is fully alive to the great industrial value of this never-failing supply of power, which can be produced in large quantity at a price much lower here than in any other State, and is prepared to extend power-lines to any quarter, provided that sufficient guarantees are forthcoming from would-be users. The provision of cheap power of this convenient nature has already led to the establishment of large metallurgical works and other industries. Mining and metallurgical works now consume 64 per cent. of the available power.

In order to provide for future customers the Government is undertaking the construction of a series of great artificial reservoirs to augment the supplies from the natural lakes. The central situation of the highlands, the high and regular rainfall, the relief and geologic structure, and the character and course of the streams combine to form numerous basins easily convertible into lakes, because of their position and levels, and because of the impermeability of the ground.

An estimate of the power available on the basis of a continuous supply, but developed in part only, is given as 600,000 horsepower.

Power is supplied for general industrial purposes from ⅝d. per unit upwards. Special terms are arranged for users of large blocks of power. The water-power resources are vested in the Hydro-Electric Department, of which H. A. Curtis is Chief Engineer and General Manager.

As regards the North Eastern Division, of which Blue Tier area is a part, a survey is now being undertaken for the purpose of providing electric power when it is required.

WATER-SUPPLY.

An adequate supply of water is the first essential requirement of any company about to operate in this district. In this report consideration is given to the problem of supplies for mining and treatment purposes only—not for the generation of power. In the operations of milling and concentrating, a large quantity of water would be required; in fact, the whole of the available supply of 25 sluiceheads.

([6]) The following information is drawn largely from the report prepared by K. L. Rahbek, in 1901, under instruction from the Government. The object of the investigation and report was to ascertain the practicability of conserving water for power purposes and for use in the working of deep alluvial ground in neighbouring districts; the purpose of the investigation was the desire by the Government of the day to lend assistance to those companies operating upon the large low-grade deposits, and at the same time to use the available water for the general good and to the best advantage. The competition between users to obtain supplies led to duplication of work and wasted effort—in many cases a tax too great upon their resources. At that time the power requirements of the district were not great, but the supply of water for the alluvial workings was insufficient, particularly during summer. It was Rahbek's aim to use the water first for power, and then, by a careful system of distribution, pass it on to the hydraulicking companies.

Sun Creek Site.

On the plateau of Blue Tier Range, a little over a mile in a north-easterly direction from the small township of

([6]) Preliminary Report on the Feasibility of Conserving Water for Power Purposes in the Blue Tier District, by K. L. Rahbek, M. Dan. Assoc. C.E., 1901.

Poimena, is a plain (formerly known as the Wheal Tasman Flat) almost completely enclosed by the higher ridges of the range. This plain, situated as it is at the heart of the range, at an altitude of 2300 feet above sea-level, and 400 feet lower than the summit, at once impresses one as a suitable site for the impounding of a large volume of water. A closer investigation confirms the first impression, but leaves one in doubt as to the supply of water from the comparatively small catchment area. No difficulties are presented from the geological and engineering points of view, therefore the question of catchment is of the first consideration. However, the supply of water in the natural catchment area can be augmented by the diversion of streams in neighbouring areas to the proposed reservoir.

Sun Creek, a perennial stream, receives its waters from the drainage of the natural catchment area, and empties into Moon Creek, a few chains below the site of the weir, the two there forming Wyniford River. The natural supply coming from Sun Creek can be augmented by the diversion of Moon Creek waters into Sun Flat, at an elevation of 35 feet above ground-level. Another source of supply is Seven-Mile Creek, where are two suitable sites for feeder reservoirs of fairly large capacity. The waters from these sites may be conducted along a race (ditch) 3 miles in length to the central reservoir.

Thus the catchment area can be doubled—that is, from 1 to over 2 square miles. Although the rainfall (over 60 inches a year) is heavy, the slope of the watershed country steep, the rate of evaporation low, and notwithstanding the fact that the area of the reservoir is about one-sixth of the whole or combined catchment areas, a doubt appeared as to whether all the available water would be sufficient for the purpose in view. In order to have this determined, a permanent gauge was constructed a few chains downstream from the place of confluence of Sun and Moon Creeks, and records were taken daily from 13th June to 23rd September, 1901, and thereafter. The records of the rainfall at Poimena are few, and some are incomplete. The following will serve to convey an idea of the amount of distribution of rainfall:—

November, 1891, to June, 1892, it amounted to 62·91 inches.

September, 1900, to September, 1901, it amounted to 51·24 inches.

Comparing the daily quantities of water passed through the permanent gauge with the rainfall for the same period, and estimating that part of the total catchment area at 1·4 square mile, it is calculated that 0·67 is the proportion of the rainfall it is possible to store. On that basis, and assuming a total (direct and indirect) catchment area of 1·75 square mile (allowing for a further loss of 25 per cent.), a yearly rainfall of 66·43 inches, a yearly evaporation of 20 inches, and a minimum supply of 13 Tasmanian sluiceheads (equal to 452,425 cubic feet per 24 hours), the following table has been compiled :—

Month.	Monthly Available Proportion of Rainfall as Storage (in million cubic feet).			Monthly Evaporation (in million cubic feet).		Monthly Consumption (in million cubic feet).	Surplus (million cubic feet).	Deficiency (million cubic feet).
	Gain.			Loss				
	Rainfall in inches.	Coefficient.	Storage.	Inches.	Quantity.	Used.		
January ..	4·90	0·5	9·953	2½	1·815	14·025	—	5·887
February .	2·45	0·4	3·981	2½	1·815	12·668	—	10·502
March.. ..	6·35	0·5	12·929	2½	1·815	14·025	—	2·911
April	3·24	0·6	7·904	2	1·452	13·573	—	7·121
May	8·84	0·7	25·169	1½	1·089	14·025	10·055	—
June	7·46	0·8	24·247	½	0·363	13·573	10·311	—
July	4·10	0·8	13·348	½	0·363	14·025	—	1·040
August ..	10·29	0·8	33·466	1	0·726	14·025	18·715	—
September	3·56	0·8	11·592	1½	1·089	13·573	—	3·070
October ..	7·39	0·8	24·042	1½	1·089	14·025	8·928	—
November	4·97	0·7	14·108	2	1·452	13·573	—	0·917
December .	2·88	0·6	7·025	2	1·452	14·025	—	8·452
			187·764	—	14·520	165·135	48·009	39·900

In the computations a deduction of two sluiceheads per diem was made from the gauge records, because that quantity of water was forthcoming if no rain had fallen during weeks. That amount of water evidently represented general soakage. The yearly evaporation, estimated at 20 inches, is probably high. Loss by percolation—a negligible proportion—was not taken into account.

It is estimated that the approximate capacity of the central reservoir would be 134 million cubic feet, and that, with an inflow of 13 sluiceheads, it would take 10 months to fill it. Furthermore, the reservoir would be capable of forwarding 13 sluiceheads continuously for 296 days, assuming that no rain fell during that period, and neglecting the quantity of water evaporated during the same time.

The plain is covered with button-grass, and is fringed with scrub on the south and west sides, and with a beech (*Fagus cunninghami*) and eucalyptus forest on the east and north sides. This flat is a natural excavation in granitic rocks, and is occupied by 3 to 6 feet of sand, clay, and gravel, containing a little tin ore.

The advantages of this site are not only on account of its large size, and because the plain rises 1 in 250 only, but because of its commanding position at an elevation of 2300 feet above sea-level, and its impermeable foundation-rock.

With a 30-foot weir the impounded water would spread over 200 acres or thereabouts.

The length of the weir or dam would be about 17 chains, or 1120 feet. Two methods of dam-construction only will be considered, namely:—

(1) Earth embankments; and
(2) Concrete weirs.

Earth embankments are the most common of such structures, chiefly on account of inexpensiveness in construction. Sometimes a core of concrete or of clay is used to provide against leakage.

Concrete weirs, when well designed and constructed, are permanent structures. Such a dam also can be built without the aid of highly-skilled labour. Suitable materials are at hand for the construction of the dam or weir.

A plan showing the positions of the main reservoir and the three feeder reservoirs in relation to the mines is appended. Sections of the dam-site, and of an earth embankment and a concrete weir, are also attached as illustrations.

If the machinery site is selected in the valley of the Seven-Mile Creek, it would not be necessary to conduct the waters from the two reservoirs in that stream to the central or main reservoir. On the contrary, it would be of advantage to draw upon the Seven-Mile Creek supplies first, and leave main reservoir and its tributary, Moon reservoir, as the stand-by.

The Compensation Reservoir.

If the site of the milling and concentrating plant is selected at a lower elevation than the 2000-foot contour, an additional supply, if required, may be provided by the construction of another reservoir at the confluence of Wyniford River and Camp Creek. Although it is unlikely that the machinery site will be so far distant from the mines, and that a larger supply than that of main and feeder reservoirs will be necessary, this information as to another possible source of supply may not prove uninteresting.

The greatest quantity of the water which it is proposed to impound there is the storm-water of Wyniford River; but some of the lower tributaries contribute a considerable amount, almost as much as Seven-Mile, Sun, and Moon Creeks.

With a water-depth at the weir of 40 feet, the area of the water-spread would be about 70 acres, and the capacity about 58 million cubic feet.

Such a reservoir would be expensive, and probably not necessary until many years. Again, a smaller reservoir than the one here contemplated may suffice all requirements. The site of the weir is shown on the plan, and a cross-section is attached hereto.

Summary.

Sufficient water is available here for the treatment of 1500 tons per day if the whole of it is conducted into storage reservoirs. Water in the Blue Tier Plateau area is of such a comparatively high value that every gallon secured is of consequence. Not less than 25 sluiceheads running continuously is required if the deposits prove of commercial value.

Lower-Level Supplies.

About 25 years ago, when the Anchor, Liberator, Crystal Hill, Australia, and Don Mines were in active operation, attempts were made to provide for hydraulic power.

During winter the supplies were in some cases sufficient, but during summer the lack of water was a constant source of worry to all operators. For instance, owing to insufficient water-power, an average of 37 only of the 100 heads of stampers at the Anchor Mine were in operation during 1900. The company at later times provided additions to its Upper Groom and Laffer River supplies by constructing a water-race 26 miles to North George River, but that source of supply was never drawn upon. When operations are resumed on a large scale the North George will provide the larger proportion of the requirements for treatment purposes of the southern group of mines. On the basis of a through-put of 1000 tons a day, the quantity of wash-water required will amount to 20 sluiceheads—the present available summer supply. A further increase can be obtained by extending the North George race to South George River.

It is futile to seek a water-power scheme for large-scale operations, but ample water is now obtainable at little cost for milling and concentrating purposes.

An examination of the accompanying geological and feature plan will convey an idea of the steepness of the stream beds, particularly along their upper reaches. For instance, the fall of Groom River between the Liberator and Anchor Mines, a distance of less than 2 miles in a straight line, is 450 feet. Crystal Creek falls at a greater rate in places; Ransom River, in its upper 3 miles, falls at the rate of 400 feet a mile; and Laffer and Swan Rivers have likewise very steep beds.

It is quite evident, therefore, that the impounding of a large volume of water on the southern and western slopes of Blue Tier Range is not practicable.

Milling and Concentration.

The tinstone (tin-granite, felspathic granite, and greisen) in greater part is soft, and can be reduced very easily to sizes suitable for the separation and concentration of the contained tin ore. The lesser part, consisting of quartz greisen and quartz-mica greisen, is hard and more difficult of reduction. Tin-granite can be separated into its component particles with ease, but comminution is necessary to release the extremely fine tin ore enwrapped in the mica and felspar components. Felspathic granite is very soft, having the consistency of clay, and requires special types of machinery for its disintegration. In this rock the ore is generally of coarser grain-size.

Examination of the tin-granite under the microscope reveals the physical condition of the ore and its association with the minerals composing the rocks. At the Anchor Mine the tin ore in the pegmatite cover is coarsely crystalline; just below the pegmatite it is of equal grain-size to the essential components of the tin-granite; farther away it is found in part as coarse grains, and in greater part as minute granules filling cleavages in the crystals of mica and felspar. The problem to be solved is the separation and concentration of all grades of ore from the coarse to the very fine size, in a continuous series of operations.

Unless two units are to be set up—one to treat the coarse ore, the other to treat only the fine ore—a selection may be made from three possible processes:—

(1) The ore may be crushed and reduced in a Marcy mill or other suitable plant to 10-mesh size, the coarse material separated from the fine and treated in jigs of Newson type, and the fine on tables.

(2) The ore may be reduced to 20-mesh and classified and saved on concentrating tables.

(3) The ore may be completely pulverised before treatment on tables and vanners.

In the selection of the most suitable process advantage may be taken of the results obtained by J. B. Lewis, late manager of the Anchor Mine, who carried out many large-scale experiments to determine the most efficient and economical methods of milling and concentration. In a very informative article appearing in "The Chemical Engineering and Mining Review" of September, 1924, he gives an account of the results of those experiments. Of course, the plants to-day are much more efficient, but the general principles remain the same, therefore the results are of interest and value.

In the original arrangement Hartz jigs, with brass wire grates and ragging of lead shot, were used. The jigs were inefficient, requiring careful attention and the use of a large volume of water, and they absorbed a disproportionate amount of power. The substitution of tables simplified the treatment, reduced the consumption of power and the amount of dressing water, and gave a slightly better result.

Tailing tests of the various grades of material showed that the loss in the coarsest was very small:—On a 30-mesh sieve from 6 to 20 per cent. of the tailing remained, containing tin oxide from 0·02 to 0·121 lb. per ton of stone; on a 120-mesh sieve about 50 per cent. remained, and almost the whole of the tin ore of this grade was saved, the loss never exceeding 0·10 lb. per ton. The greatest loss was in the material that passed through the 120-mesh sieve; in fact, a very small amount only of that grade was saved. That proportion represented 20 per cent. of the whole, an amount too great to be discarded as unprofitable. It is learnt from the record that a greater throughput can be obtained by a reduction to 20-mesh; a greater efficiency can be gained by the elimination of the process of jig-concentration; the loss of tin ore in grades down to 120-mesh is not serious; and that tin ore passing through 120-mesh, being in small bulk as compared with the gangue materials, is lost. The saving of the fine tin ore, therefore, is the problem, and it is of this that the following remarks deal in particular.

The subject of slime settlement is one that has received much attention, and many experimenters have published the results of their works. In the "Proceedings of the Australian Institute of Mining Engineers, 1912," W. Shellshear has carefully reviewed the literature, and has given the results of his own testings. These directly deal with the separation of slimed tin ore from clay, and therefore are of particular interest in the present investigation.

Slime has been defined as material that will pass through a screen of 150-mesh, and also as a mixture of small particles of crushed ore of varying sizes which, when mixed with water, tend to maintain a high degree of homogeneity in it. The first definition is that generally accepted. Slime may be divided into two parts—the granular portion and the amorphous portion (which is usually called colloidal). In clays and soils the crystal grains are coated with gelatinous colloid matter, the same being true of certain slimes. The colloidal coating material is obtained from the silica and felspar. Colloidal slime occurs in two physical states. In one case it is called a gel—that is, when it is in a solid condition; and when in solution or suspension it is called a sol. If the gel form be acted upon by suitable reagents, such as caustic soda, it assumes the sol form. Richards states that the colloidal part of slime contains, as a general rule, minerals which have chemically combined water, such as kaolin, talc, steatite, and clay;

and that the dehydration of colloids in clay causes them to settle rapidly. The chemical analysis of slime colloid is given as—

	Per Cent.
Silica	64·2
Alumina	25·4
Ferric oxide, &c.	4·1
Combined water	6·3

The general opinion is that the slow settlement of siliceous slime is due to silicic acid, possibly due to the action of CO_2 on kaolin.

The following factors influencing slime settlement have been arrived at by the several investigators:—

(1) Viscosity of Pulp Solution:

The rate of settlement of a slime to a clear solution varies inversely as the viscosity of the water within certain limits, provided that the pulp is not too dense, and, as the viscosity of the water decreases with the temperature, the rate of settlement increases as the temperature of the water increases.

(2) Thickness of Pulp:

The greater the dilution of the slime pulp, the greater will be the rate of settlement to a clear solution.

(3) Electrostatic Effects:

Matter suspended in water acts as if it were statically charged with electricity. In some cases the charge seems to be negative, in others positive, as compared with the water. As a rule the charges seem to be negative. The suspended particles, holding like static charges, repel each other, and the repulsion increases as the particles come nearer each other—*i.e.*, with the thickness of the pulp. In a thinner pulp the particles are farther apart, and hence settling is not much interfered with. The effect of temperature on a thin pulp is more potent, therefore, than that of electrolytes. For this reason settlement is aided by dilution.

(4) Influence of Electrolytes:

These are said to nullify the effects of electrostatic charges on the surface of the particles, and to have greater effect in dense solutions, the effects varying with the valency. Good settling agents are sulphuric acid, lime, calcium chloride, magnesium sulphate, alum, and iron salts, tannic acid, and permanganate of potash.

(5) Nature of Slime:

The sizes and shapes of particles, specific gravity, and crystalline or amorphous nature have a great effect on settlement. The rate of settlement, as a rule, is determined by the rate of settlement of the topmost layer.

(6) Velocity of Flow:

In settling slime attention must be paid to avoidance of currents or agitation, but there is a certain action in the slow movement of water in a body. This causes a changing of the relative positions of the water particles and solids, allowing the latter to more readily sink, owing to the influence of specific gravity. An easy rotary movement, if the material is contained in a round tank, will, as a rule, help settling, as it tends to cause the particles to aggregate.

The main result of those investigations is that the rate of the settlement increases with the dilution of slime. Shellshear set out to discover, in addition to that information, the action of the various materials on one another, and how that action would modify the settling of different slimes. His examination of the minerals tin oxide, felspar, kaolin, and steatite, such as are found in this district, and which constitute the ores and gangues, showed that they all belong to slow-settling suspensions, and that the minerals have no effect on the settling of one another. Moreover, he showed that the heaviest minerals, tin oxide and wolfram, settled at slower rates than felspar and steatite, thereby illustrating the fact that when material is crushed beyond a certain fineness specific gravity plays a very minor part as compared with physical phenomena. In slimes of this mixture it was found that the greater the dilution the greater the settlement, and that, of the electrolytes, potassium permanganate settles slime with greatest rapidity.

Assembling the data:

(1) The proportion of tin ore to gangue materials is very small.

(2) Although the bulk of the tin ore is coarse, a little in its natural condition is finer than 100-mesh, and to that amount would be added the proportion slimed in the crushing operation.
(3) The bulk of the gangue consists of felspar and kaolin, with quartz as the other important component.
(4) The tin ore is in crystal aggregates, and is free.
(5) The proportion of sulphidic associates is immaterial.

Deductions from the data :-

(1) The tin-bearing rock ought not to be crushed finer than the tin ore particles.
(2) Pulverising is not desirable.
(3) No difficulty need be apprehended in the separation and concentration of the unslimed tin ore.
(4) Classification through all stages is desirable.
(5) A large volume of clean water is a first requisite in the settling and concentrating of the slimed ore.
(6) The slimed material should be diluted as much as possible.
(7) A continuous draw-off from the settlers is essential.
(8) The felspar and kaolin, being in such large bulk, will seriously interfere with the settlement of the tin ore under any conditions.
(9) A considerable loss of slimed tin ore is inevitable—
    (*a*) Because of incomplete settlement; and
    (*b*) Because of loss in concentration.

Having arrived at that stage, consideration will now be given to the subject of milling. First, it is necessary to assume, as a result of the work already performed at the Anchor Mine, and recorded by J. B. Lewis, that fine crushing is uneconomical and undesirable from any point of consideration. The most satisfactory process apparently is to reduce the material to 20-mesh, classify it. and concentrate the tin-ore in such a manner as to strike an economic mean between costs and tailing loss.

In the operations of milling a serious difficulty is presented, *i.e.*, the choking of the crushers and pulverisers by the wet and rather sticky material. Choking can be prevented by eliminating the comminuted material from the crushing and pulverising machines in turn, using shaking screens for the coarser grades and screens of the Ahern and Callow types for the finer.

The feature of the year has been the introduction into practice of the Symons cone crusher. The large reduction ratio of the horizontal disc crusher and the great success attending the use of the vertical disc crusher, with its finer output, led naturally to the display of unusual interest in the Symons type, the cone crusher. A striking quality of this crusher is its large reduction ratio in one operation of 5-inch to $\frac{3}{8}$-inch, with a through-put of 60 tons of quartz per hour, and a power consumption of 65 horsepower. Exhaustive tests have demonstrated the extraordinary efficiency of this crusher when it is not required to handle wet, sticky ore, the clearance between bowl and cone for $\frac{1}{2}$-inch product being too small for wet material.

An illustration is given of a gain of 8000 tons per month, at a cost of 45 horsepower only, by the use of a Symons vertical disc crusher. The disc crusher was placed between secondary gyratory crushers, which reduced the stone to a 3-inch size. Material of minus 1 inch having been screened out, the 3-inch stone was passed in to the vertical disc crusher, and there was reduced to a $1\frac{1}{4}$-inch size at the rate of 75 tons per hour, and a power consumption of 40 to 45 horsepower. A set of discs outlasts the crushing of 125,000 tons of quartz.

On this subject some extracts from the pages of the "Engineering and Mining Journal" of December, 1927, will prove of interest:

"The old stamp has done its work well, but at a heavy power cost—a duty of 0·57 to 0·14 ton per horsepower-hour is much too low to be acceptable to-day for impact crushing. Mining engineers of repute apparently have one idea in common—the endeavour to avoid the use of stamps. Aside altogether from the inefficiency of the stamp, there are many reasons for the desire to have it displaced by automatic and less cumbersome machines. An endeavour is being made to displace gyratory crushers, and even Marcy Mills, by the use of a cone crusher, which, it is claimed, is capable of a reduction from 12 inches to $\frac{1}{8}$-inch in one operation. This appears to be impracticable, certainly in the case of wet material. The aim of the designer is too ambitious, because there is an efficiency limit beyond which it is futile to go. In general practice the efficiency limit is 8 to 1. Yet it is claimed for the latest type of cone crusher, a reduction of 330 tons per hour of 10 to 12 inch stone to ¾-inch size, at a consumption of 150 to 200 horsepower per hour, depending on the hardness of the rock."

The following milling plant is suggested as suitable for this class of stone:—

One No. 6 gyratory crusher... ...	35 h.p.
One Symons disc crusher... ... ... *or* One Symons cone crusher	45 h.p.
One 8 by 6 feet Marcy mill ... ... *or* Two sets of rolls of same capacity	225 h.p.

A milling plant of that class and standard is capable of handling over 1000 tons of stone per diem.

The Symons disc crusher can handle 60 to 100 tons per hour of this material with a reduction to ¾-inch size. It is claimed that the Symons cone crusher is of higher efficiency and capacity.

One 8 by 6 feet Marcy mill for breaking down ¾-inch stone to 10-mesh is capable of a through-put of 1000 tons per day. Whether or not rolls would be preferable for this class of stone is open to question.

If it is found desirable, in order to effect the complete separation of the very fine tin ore, to further reduce the 10-mesh material, rod mills or tube mills might be employed with advantage.

The concentration of the coarser tin ore does not present any serious difficulty. With modern appliances, an adequate water-supply, and careful regulation of feed, a high ratio of extraction may be obtained. In the case of the fine material many difficulties appear. The felspar and mica components of the containing granitic rocks, particularly when in their decomposed conditions, are carried away in suspension by the wash-water. In this heavily-laden water a large proportion of the slimed tin ore is carried also; the problem is to arrest the fine ore. This is ordinarily accomplished by the use of classifiers and settlers. Special provision is necessary in this case to allow for the disproportionate amounts of clay pulp. Having arrested the fine ore, it is separated from the waste material and concentrated on vanners of the Buss-Lubrig type.

The problem of slime settlement and concentration of slimed tin ore is exciting interest in every large tin-mining field at present. Oil-flotation methods seem the most suitable means of effecting separation and concentration of slimed tin ore, especially in such cases where the proportion of tin ore to the bulk of the material is very low. Developments of an important character may be expected as a result of experiments now in train.

Transport and Communication.

In general the rail and road lines of transport are of a high standard, according to Australian conditions, the roads in particular being in better order than those of any other State. It is not the policy of the present Government to continue the construction of railways, but to provide roads instead. That decision is due in part to the revolution in the mode and rate of transport, brought about by the coming of the internal combustion engine, and by the broken nature of the country. The frequency of gullies and ravines makes communication difficult and costly, and restricts the service of any line of transport. The mountain roads serving this district carry a heavy motor traffic, but are kept in good repair. Basalt and diabase are used as covering materials, the former being preferred because of its property of resilience. The grades are rather steep in parts; in few places, however, exceeding 1 in 12.

At present the cost of transport by hire motor-lorry from Herrick (the terminus of North-Eastern Railway) to Poimena is at the rate of £3 per ton for one-way freight, or at £2 per ton with freight both ways. Railway freight is from one penny per ton per mile.

Timber-Supply.

The whole of the Blue Tier area was once covered with a thick forest of hardwoods, mostly beech, pine, and eucalypts. In opening the mines a large part was denuded of forest, yet a considerable portion of the plateau was conserved by the miners for future use. These supplies are now available, and are sufficient to provide all the wants for many years.

Labour.

Labour of a high standard is available from local and nearby sources. Most of the inhabitants of the North-Eastern Division are skilled miners and good workmen. As compared with other States, Tasmania is subject little to strikes in industry, the troubles as a rule coming from outside. Skilled miners are paid 14s. to 15s. per day of eight hours.

Methods of Mining.

The district is divided geologically and geographically into two groups of mines, viz., those on the southern fall of Blue Tier and those on the plateau.

The first group includes the Summit, Australia, Don, Anchor, Crystal Hill, and Liberator Mines; and the second the Ethel, Planet, Southern Cross, Mount Marie, Wellington, Moon, Mount Michael, Perennial, and others at the northern end of the plateau.

The geological dividing-line is not very strongly marked, there being little difference between the two types of deposit; but the geographical line is clearly drawn, and effects a complete separation (from an economic point of view) of the two groups.

The ore-bodies on the plateau can be worked in open-cuts to a shallow depth only, the shaft method being immediately necessary in some cases; those on the southern fall can be worked in open-cuts and quarries. The plateau deposits are mostly of dyke formation, while the southern ones are "floor" deposits and of comparatively shallow depth.

Large-scale operations only are economically sound in dealing with such low-grade deposits. In so far as present knowledge of the size of these deposits permits, the opinion may be expressed that an output of 5000 tons per day of 24 hours ought to be the aim of future operators. The possibility of attaining such a large output is not established yet, but the indications point to a very great potential reserve. If, as a result of exploration by drilling and later development by open-cutting, it is found that a sufficiently large aggregate reserve is available, a system of mining may be designed with that end in view.

The basis of such a system would be:—

(1) The opening of a number of mines at the same time as units of a whole scheme, and the working of each in turn;

(2) The use of electric power exclusively;

(3) The use of drilling-machines;

(4) The use of a number of electric shovels of not less than 1000 tons per day capacity;

(5) The adoption of the most economical means of transport from the mines to the treatment plant;

(6) The use of the latest machinery for the milling and concentration of the ores.

The thought to bear in mind is the elimination of unskilled labour from the general scheme. Any method based on the use of manual labour is foredoomed to failure.

EXPLORATION AND DEVELOPMENT.

An outline of the early works of exploration and development is given in another chapter. During later years the Mount Lyell Mining and Railway Company, with Luke Williams as field superintendent, completed a carefully designed plan for the thorough testing of some of the ore-bodies. In the light of later knowledge that plan cannot be regarded as an altogether well-designed one, yet the information obtained in respect to the parts closely investigated is of great value. The work was performed with care and exactitude, and was of extensive scope; but some parts of the more important bodies received scanty attention, while a great amount of attention was given to parts of the tin-granite body that obviously were very poor at surface. More effective work could have been performed had a thorough geological survey been made in the first place.

Of late years local miners, mining syndicates, and companies have completed a large number of exploratory works. To-day the Mines Department is drilling the Mount Marie line of lode in an endeavour to gain reliable data regarding the nature and value of the tin-bearing stone at depth. This work, in addition to that already performed, will be sufficient only to form an idea as to whether a more intensive sampling is warranted or not. In this connection it should be kept in mind that operation on a very large scale only is likely to lead to success, and that selection of ore is not only desirable, but is a necessary act to ensure an average grade of 0·25 per cent.

The large ore-bodies are of low-grade; that fact should be realised at the beginning. Local enrichments occur which are likely to convey an exaggerated idea of the value. Many such appear at surface, and are naturally the parts that have received the greatest attention.

The cost of development is small because the rock is soft, and the configuration is such as to allow of opening by way of adits in many parts.

As regards the plateau area, the greater part is in the hands of one company, now engaged in the preliminary testing of the deposits. If the results prove satisfactory doubtless other lessees in that area will endeavour to amalgamate their interests with the larger company.

In the southern area the mines are held under a number of leases, and, as this area is apparently of greater present economic importance, an arrangement is about to be made by which the Government will institute an active programme of drilling and sampling. As a preliminary to that work a basis of agreement has been arrived at between all but two of the lessees for an amalgamation of interests.

A committee, styled the Blue Tier Tin Committee, has been set up by the Government for the drawing up of plans of operation. It is proposed to provide £10,000 for the purpose of performing these exploratory works.

It is the aim of the committee to ascertain whether these deposits contain 30,000,000 tons of tin-granite of not less than 0·20 per cent. tin grade. Under existing conditions it is thought that stone of that quality, if worked on a very large scale, with modern appliances, would be productive of such profitable results as to warrant the necessary outlay.

It is hoped that the drilling work will be started within three months.

CHAPTER VI.—THE MINING PROPERTIES.

It is fitting that the following reports on the various mines should begin with the Anchor, for that is not only one of the oldest and most important, but the only mine to have received a thorough testing on a large scale over a long period. For that reason also articles by the late manager, J. B. Lewis, have been drawn upon for reliable information as to costs of mining and treatment. The methods followed in those days would be subject to modification to-day, yet accurate comparisons may be made where the conditions are similar.

It will be noticed that few attempts have been made at calculations of ore reserve. The reason is obvious: lack of the necessary data. Many of the mines have large potential reserves.

The records of most of the late companies are so meagre that it is impossible to trace their vicissitudes of fortune from stage to stage. All were foredoomed, and it may be averred that the history of lode-mining on this field is written in an unbroken record of failures. The contributory causes of such failures are too numerous to mention, but the chief ones may be enumerated:—

(1) The low average grade of tin-bearing stone.
(2) The irregular distribution of tin ore in the stone.
(3) The floor form of deposit, limiting depth extension.
(4) The cost of removal of overburden.
(5) The high cost of power.
(6) The early-day high cost of transport.
(7) The erection of treatment plants before a sufficient reserve had been developed.
(8) Insufficient initial capital.
(9) The low market rates of tin.
(10) The cost of establishing the nature of the ore and the structure of the ore-bodies.
(11) Shortage of water during mid-summer.

However, against those disadvantages, the following advantages may be cited:—

(1) The tin ore is as a rule of coarse grain size.

(2) The proportion of other metallic minerals in association is very small.

(3) The containing rock is soft and granular and is easily disintegrated and pulverised.

(4) The conditions generally for mining are decidedly favourable.

(5) The ore-bodies are large.

(6) The costs of mining, milling, and treating are very low if estimated on data obtained from large-scale operations.

To-day many of the difficulties insurmountable in the past are not presented, therefore the conditions are not closely comparable. For instance:—

(1) Ample electric power will be provided by the Government at comparatively low rates if sufficient guarantees are forthcoming.

(2) Ample water is available, and in some cases is actually provided, for purposes of concentration and milling.

(3) The application of modern methods and the use of modern machinery would effect a great reduction in cost of production.

(4) Transport facilities are provided.

(5) The average market rate of tin is very much higher.

(6) The greater part of the country is now denuded of forest and laid down in grass.

So much exploratory and developmental work has been performed that the engineer to-day is able to closely assess the values of the several bodies at a comparatively low cost. The difficulty in all cases is that development has not been kept ahead of mining.

The Blue Tier Tin Mines No Liability.

This company was formed a few years ago to acquire the mining rights of the lessees of the Anchor Mines. The capital of the company was sufficient only to equip the mine with a small milling and concentrating plant and to put the workings in order, yet it was able to pay its way from ore sales until the end of last year. A party of local miners is now working the ore-bodies on the tribute system.

The holdings of the company consist of consolidated lease 8838-M, of 141 acres, charted in the name of J. A. Hodgman; dam site 1819-W, of 20 acres; and water-rights 1814-W, 1818-W, 1815-W, and 2292-W.

The Ore-Bodies.

In an earlier chapter a detailed description is given of the nature of the tin-bearing rock, and particular reference is made to the sections exposed in this mine. It is unnecesary, therefore, to dilate upon every phase here. Notes pertinent to peculiar occurrences only will be given, and should be regarded as supplementary only. On the east side of Pentridge face, just below the pegmatite band, is some very rich stone, consisting of pinite enclosing topaz and cassiterite. In places the pinite is in very fine scales; as a rule, however, it is massive. Cassiterite and topaz in well-formed crystals are splashed through the rock in individuals and crystal aggregates. Similar stone, but poorer in cassiterite, forms the bulk of the body exposed in Nos. 1 and 2 faces. There it is likewise of a pale-green colour, owing to abundance of pinite, and it contains in addition secondary mica, topaz, zircon, and a little quartz. Original oligoclase became decomposed under the action of fluorine, and was altered into topaz and mica. Here it is rare to see a crystal of cassiterite where it is usually fine in grain and enwrapped in scales of mica or pinite. Fluorspar, evidently derived from lime-bearing felspars, fills cleavage planes.

At the north end of Pentridge face, west of but close to the rich pinite rock just referred to, is a distinct continuous body of quartz-greisen containing molybdenite and a little cassiterite in minute veins. Under the microscope it is seen that the rock consisted originally of oligoclase and orthoclase, quartz, and dark mica. Some of these minerals still remain, but the greater part of the rock has suffered complete silicification. The evidence available points to this formation as the result of an after-action following the fracturing of the cooling rock. Yet another type of deposit may be seen on the east side of that face; that is composed almost wholly of dark-green mica, and is rich in tin ore.

A type of considerable importance and of particular interest is represented by the soft decomposed bodies consisting almost wholly of felspars (oligoclase and orthoclase) and their alteration products. The best examples are to be seen at the Haulage and West Anchor faces. Topaz and fluorspar are prominent; chalcopyrite and molybdenite are not discernible; and the tin ore is associated with magnetite, in grains of medium size, in some places filling cracks and crevices. This rock decomposes readily, and the disintegrated components are carried away by waters and the heavier are concentrated in the beds of streams. It is probable that these are infillings of the earliest lines of fractures extending into the cover-rock, such as those dyke-like penetrations of the Southern Cross and Mount Marie properties.

In addition to the aforementioned are numerous veins of greisen trending obliquely across the body in a north-east direction. Some consist almost wholly of mica, and are rich; some are of quartz-mica, and of medium grade; a few are of quartz, and poor.

Dykes of diabase cut through this ore-body in a north-easterly direction, and are of considerable size, one being over 50 feet wide. Lewis remarks that in the neighbourhood of these dykes tin ore is more plentiful. Why that should be is difficult of explanation. unless the diabase is a basic last differentiate of the granitic magma, which seems unlikely.

THE EXTENT AND VALUE OF THE ORE-BODY AND DISTRIBUTION OF THE ORE.

The quality of the tin ore from this mine is high. A little wolfram, scheelite, chalcopyrite, galena, and molybdenite appear in the roof band of pegmatite, but the proportions to the whole are so low as to be of little detriment to the quality of the tin ore. In the early days of mining here the ore of this mine was thought to be the poorest, but that opinion was formed on the basis of the grade of stone mined from the several deposits. Stone from this mine was passed unsorted to the milling plant, although it should be mentioned that the poorer parts of the ore-body were left in place.

An examination of the ore-body reveals that it is variable as an ore-carrier, and that certain north-easterly trending belts of tinstone are separated by wider belts of almost barren material. A closer investigation shows that the variability of quality and the distribution along certain belts are due in part to north-east lines of greisen, which traverse the tin-granite along structure-planes. It will be seen that the lines of greisen are sharply marked by veins of mica, or of quartz-pinite, or the rock is almost completely silicified. In the poorer or inter-tinstone belts secondary talc (not unlike pinite) after biotite is the only remarkable alteration. It may be conceived from this observation that by a careful inspection an idea of the grade of the ore may be obtained from its appearance.

In the past the cuts have been opened along lines parallel to the strike, and have been advanced at right angles thereto. In consequence the cuts have passed through successive belts of the north-east trending tinstone and the intervening bodies of poor rock. It appears advisable, therefore, to so arrange the work that the poor material may be left untouched in its original position.

Observations taken with the clinometer show that the pegmatite band separating the barren alaskite cover-rock and the tin-granite dips at angles of 8 to 10 degrees southward, and near Groom River passes underground again.

The following analyses of bulk samples taken from the west cut are generally representative of the grade of the material as a whole, and are confirmatory of the results obtained in actual treatment:—

Table of Analyses.

Western Open-Cut.

Registered No.	Mine No.	Sample Taken From—	Tin Content (per cent.).	Remarks.
1186	1	Extreme western side	0·28	Tin ore-body
1187	2	10 feet east of 1	0·40	
1188	3	10 " " " 2	0·70	
1189	4	10 " " " 3	0·15	
1190	5	10 " " " 4	0·15	
1191	6	10 " " " 5	0·20	
1192	7	10 " " " 6	0·15	
1193	8	10 " " " 7	0·18	
1194	9	10 " " " 8	0·07	
1195	10	10 " " " 9	0·30	Silicified
1196	11	10 " " " 10	Trace	
1197	12	10 " " " 11	0·15	
1198	13	10 " " " 12	0·15	
1199	14	At present battery site	0·05	
1200	15	10 feet east of 13	0·07	Unaltered granitic rock, pinitised felspar and secondary quartz
1201	16	10 " " " 15	0·10	
1202	17	10 " " " 16	0·12	
1203	18	10 " " " 17	0·28	Pinitised felspar and secondary quartz
1204	19	10 " " " 18	0·12	Pinite and secondary mica
1205	20	10 " " " 19	0·28	
1206	21	10 " " " 20	0·15	Pinite prominent in ore-body, mica after felspar.
1207	22	10 " " " 21	0·10	
1208	23	10 " " " 22	0·20	
1209	24	10 " " " 23	0·30	

1210	25	10 „ „ „ 24	Trace	Talcose
1211	26	10 „ „ „ 25	0·15	
1213	27	10 „ „ „ 26	0·05	
1214	28	10 „ „ „ 27	0·05	
1215	29	10 „ „ „ 28	Trace	
1216	30	10 „ „ „ 29	0·05	
1217	31	10 „ „ „ 30	0·20	
1218	32	10 „ „ „ 31	0·10	Molybdenite visible
1219	33	10 „ „ „ 32	0·10	
1219	34	10 „ „ „ 33	Trace	Kaolinised felspar in granite
1220	35	10 „ „ „ 34	0·18	
1221	36	10 „ „ „ 35	0·25	Pinitised
1222	37	10 „ „ „ 36	Trace	
1223	38	10 „ „ „ 37	0·15	North-east end of western cut
1224	39	South-east end of western cut	Trace	
1225	40	„ „ „ „	0·07	
1226	41	„ „ „ „	0·85	A mica body 18 inches wide
1227	42	On bench above A, western side	0·07	
1228	43	15 feet east of 42	Trace	
1229	44	15 „ „ „ 43	0·15	
1230	45	15 „ „ „ 44	0·30	
1231	46	15 „ „ „ 45	0·05	
1232	47	15 „ „ „ 46	0·10	
1233	48	10 „ „ „ 47	2·15	Result too high to be representative
1234	49	15 „ „ „ 48	0·05	
1235	50	A hole 20 feet north of 44	1·32	A rich make here
1236	51	Bench slope north of 50	0·15	

The lateral limits of the ore-body have not been determined, but it is open-cut over a width of a quarter of a mile. In depth the tin does not extend beyond 200 feet, except at such places as the Pentridge face, which marks one of the channels of egress of mineralising solutions. It appears that the lateral extent of mineralisation from the north-east trending greisen veins is variable from point to point, but is greater near the upper limit. Confirmation of this is in evidence throughout the workings. It is found that enrichments do not, as a rule, extend deeper than 30 feet from the pegmatite band. Some of the rich seams, containing up to 80 per cent. of cassiterite, are very short. The upper limit of the tin-granite is usually marked by the pegmatite band (although mineralisation extends beyond it into the alaskite cover in places), but the lower limit is indefinite in the few places where it has been exposed for observation. Exploration at a depth of 100 feet below the cut has been performed by means of the diamond-drill. Most of the holes passed into greisen stone of low grade. This raises the question as to whether other "floor" deposits are likely to be found below the upper one. That is unlikely, because the mineralising solutions would have been at too great a temperature and pressure, and because the solutions in this case would have been exhausted at the uppermost level.

PRODUCTION.

The early records of production are incomplete, but the original company crushed at least 12,307 tons for a yield of 134 tons of tin oxide, or an average of over 24 lb. per ton. From 1898 to 1903, when Lewis took charge, 267,266 tons were crushed, for 829 tons of tin oxide, a proportion of nearly 7 lb. per ton. During the period 1903 to 1914, when operations were suspended, 1,093,983 tons of stone was crushed, for a yield of 1718 tons of tin ore, the proportion being 3·5 lb. per ton. Subsequently a party of tributors worked the mine. The records are incomplete, but it is known that during a portion of the time 22,194 tons was crushed and treated for 42 tons 6 cwt., a saving at the rate of 4¼ lb. per ton. When that party ceased work it was reported that the stone was worth 10 lb. per ton. Thus, the records up to that time show that 1,395,750 tons of stone was crushed and treated, for 2723 tons of stone, in the proportion of 4·37 lb. per ton. As the higher early results were obtained in the crushing of the richest stone only, the grade of the ore, viz., 3·5 lb. per ton, or 0·2 per cent., as recorded by Lewis, may be accepted as a fair average.

From an old record it is gleaned that prior to 1892 over 288 tons of tin ore was saved in the treatment of 30,734 tons of lode stone, or at the rate of 0·937 per cent. It is evident from this record that the richest stone was selected for treatment.

The scale of operations varied greatly under the control of the several companies. At present operations are on a very small scale, and the richest ore only is sorted for treatment. During last quarter 1126 tons of stone yielded 4½ tons of tin ore, or at the rate of 0·4 per cent.

The mine is now in the hands of tributors, who are producing on a small scale.

THE COST OF PRODUCTION.

The cost of production depended largely upon the supply of water, for that was the means of motive-power as well as the essential medium in milling and concentrating.

The whole of the water-power was supplied from two races, the shorter and smaller delivering at a head of 500 feet, and the larger (30 miles) delivering at a head of 380 feet.

A portion of the power-water was used for dressing purposes. About 720 cubic feet per minute was required for the power and treatment plants.

During the most favourable year (1906-7), as regards water-supply, in the history of the Anchor Company 153,738 tons of ore was crushed. The results of an analysis of costs are given in the subjoined tables:—

Table I.—Tonnages and Costs.

Quantity of ore treated	153,738 tons
Tin oxide concentrated	225 ,,
Alluvial tin ore saved	8 ,,
Average content of tin in ore ..	71 per cent.
Tin oxide per ton of stone	3·28 lb.
Tin metal per ton of stone ..	2·328 ,,
Cost per ton of stone	27·68 pence
Received per ton of stone	45·11 ,,
Average number of stamps in use	87·24 ,,
Stone crushed per stamp in 24 hours	5·85 tons
Costs, stores per ton of stone ..	1·71 pence
,, renewals per ton of stone	3·63 ,,
,, explosives per ton of stone	2·46 ,,
,, labour per ton of stone ..	19·88 ,,
,, shoes per ton of stone ..	0·365 ,,
,, dies per ton of stone	0·317 ,,

Table II.—Analysis of Costs in Pence.

Subject.	Labour.	Stores and Renewals.	Explosives.	Total.
Quarrying..	9·47	—	—	—
Maintenance plant ..	0·46	0·23	2·46	12·62
Trucking..	1·51	0·17	—	1·68
Crushing	0·92	0·66	—	1·58
Pulverising & dressing	3·68	—	—	—
Repairs..	1·85	3·08	—	8·61
Power	0·88	0·01	—	0·89
Clearing, &c.	0·10	—	—	0·10
Office	0·29	—	—	0·29
Sampling	0·27	—	—	0·27
Sundries	0·28	0·11	—	0·39
Freight	0·17	0·52	—	0·69
Horse feed	—	0·42	—	0·42
Timber	—	0·14	—	0·14
	19·88	5·34	2·46	27·68

Table III.—Realisation of Tin.

Estimated weight of concentrate at mine	233 tons
Net weight at smelters	228 tons
Metallic tin in concentrate	156·86 tons
Average price of tin per ton ..	£190 17s. 4d.
Average price per ton, less smelting costs, &c.	£179 11s. 7d.
Amount realised	£29,800

Lewis stated that, with wages and materials at pre-war rates, tin at £120 per ton, and continuous running the value of the product would be sufficient to pay expenses.

THE WORKINGS.

The ore was excavated on the open-cut principle, with four benches at 20 to 40 feet intervals. By reason of the irregular outline of the workings, as shown on the accompanying plan, it is apparent that the ore is not evenly distributed through the body of the rock. If the tin ore had been evenly distributed the costs of mining and handling could have been greatly reduced.

One of the difficulties to overcome is the removal of the barren alaskite overburden. On the east and west sides of the cut the overburden is 70 feet thick, and on the north it is up to 30 feet thick. It is in a decomposed condition, however, and is easily broken.

The tin-bearing stone varies through all degrees of hardness. As a rule the richest ore is the softest, and the hardest ore the poorest, but there are exceptions to that rule.

The length of the open-cut from east to west is 1200 feet, and from south to north is 700 feet. In consequence of the practice of excavating the richer shoots of ore first, large indentations appear on every level and at every turn, and occasional islands dot the floors of open-cuts, thereby adding to the irregularity. It is problematical whether the richer material so obtained could be regarded as a counterbalance to the increase in cost of breaking the stone.

To-day, with a very small plant, selection of richest ore is essential to success, and therefore is a justifiable scheme.

The bench system as adopted here was not satisfactory, and the lay-out of the works in general was not conducive to efficiency. Haulage of ore in trucks from one bench to the next higher, and then by horse to the milling plant, cannot be regarded as an economical means of transport. All breaking was by hand-boring and blasting, and spawling, and the raising of the broken material into trucks was by hand also. In later years machine drills, driven by compressed air, were used for boring the rock and large boulders, and proved of great advantage. The cost of labour for boring holes ranged from 4½d. to 6d. per foot, for jumping 7½d. to 11d. per foot.

The present workings may be extended in a north-easterly direction without hindrance, and the tin-granite may be attacked at a lower level; but on the east and west sides the overburden of barren alaskite presents a serious impediment, and it is a matter for the engineer to determine whether the removal is economically possible. Perhaps that operation might be accomplished by means of water under great pressure.

In addition to the Anchor faces the company drew large supplies from the Australia Mine. The ore was conveyed to the Anchor milling and concentrating plants by way of a two-rope aerial, the send-off site being so arranged as to serve a number of mine openings. At that spot was erected a gyratory crusher direct-coupled to a Pelton wheel. Another aerial connected this with the main opening of the Australia Mine, and a self-acting tramway led from Bryce and Hodgman's Mine, higher up the hill. Another short self-acting tramway connected the Puzzle face with the crushing-station. Tramways on low grades connected other parts of the deposit. From 120 to 150 tons of tin-granite was conveyed to the crushing-station and delivered at the Anchor battery each day of eight hours. The aerial skips ran by gravity, the excess of power having been absorbed by brakes.

Another survey was made of an aerial line to the Moon leases to connect with the Australia line.

CONCLUDING REMARKS.

This report may be concluded with the remarks of J. B. Lewis, (7) late general manager: "The larger formations have given payable returns from time to time, even when worked on a small scale, and at the Anchor when worked on a fairly large scale; and, with regard to the latter body ore above the average was being opened when work ceased. The writer's scheme, which consisted of a central treatment plant (the Anchor battery) and aerial lines, seems to be the most satisfactory. A series of bad seasons, a fall in tin, and other serious difficulties, however, caused a cessation of work, and the outbreak of war prevented a resumption. Had work continued a little longer advantage would have been gained from the high price of tin during the war, and the company would not only have recouped itself and earned handsome profits, but many other deposits would have been profitably worked. Any new venture would not start under better conditions, as the Anchor battery was out of date, and could not be worked to the best advantage, and a hydro-electric scheme practically independent of droughts and bad seasons had been designed, which the Anchor Company had not the means to carry out."

THE CRYSTAL HILL MINE.

This mine lies south of the Australia and between the Anchor and Liberator Mines. It is now held under Lease 10133-M by a Scottsdale syndicate, and is charted in the names of G. McArdell and A. G. Galloway. The syndicate holds Water-right 2550-W also.

(7) Lewis, J. B.: The Blue Tier Tin Fields. (Chemical and Engineering and Mining Review, December 5, 1923.)

Crystal Hill is comprised of the tin-granite of the district, the disintegration product of which contains a little tin ore in many parts and rich concentrations in a few. The alaskite cover-rock has been removed by agents of erosion on the south side of the road, and the seam of intervening pegmatite shows in the road-cutting at the highest point, between Crystal and the Liberator turn-off. The pegmatite seam here consists of quartz, felspar, and mica, with a very little of metallic minerals, notwithstanding that a large body of tin-bearing rock has been opened in a long cut nearby.

The peak of Crystal Hill is composed wholly of pinitised tin-granite containing a little tin ore; in fact, the whole area appears to be occupied by rock of that nature. How much of it is profitable is not known. The Mount Lyell Mining and Railway Company and other companies have drilled and trenched the rock at various points, yet the data obtained are insufficient to base estimates of quantity and value. Much more exploratory work is necessary, and such work is certainly warranted.

THE MINING WORKS.

A trench (No. 2 of the eastern workings) 8 feet deep and 12 feet long has been cut into a peculiar variety of the normal rock. The stone is of a reddish colour, and is composed of orthoclase, oligoclase, and fluorapatite, the last in the form of pale-green hexagonal prisms. Cassiterite is present; a borehole dipping westward was drilled 100 feet to test this body at depth.

Trench No. 1, further east, is cut 60 feet up the face of the hill, exposing a dyke 8 feet wide of soft granular granite encased in clay. It courses eastward, and stands upright. The stone is barren up to the dyke, but in fair proportion beyond it. A bore directed north was sunk 100 feet here.

Trench No. 5 is a small cut on the north side of the hill, in soft yellowish granite containing a little tin ore.

Trench No. 4 lies 20 chains west of the old battery-site, and opens a large body of soft tin granite to a depth of 23 feet. The tin ore is irregularly distributed through this rock, but, it is reported, a ton of ore was obtained from the stone excavated in this cut. A borehole drilled 100 feet in a westerly direction failed to reveal richer stone.

Trench No. 3 and Gaunt's shaft are on a low saddle north-east of the old battery. The trench, 6 feet deep and about 20 feet long, is cut in tin-granite containing a high proportion of pinite, and is veined with quartz. The stone is reported higher than the average, about 1 per cent.; but that has not been verified. A borehole directed north-west was drilled here to 100 feet in poor stone.

The shaft (4 feet by 3 feet) is 20 feet deep, in similar pinitised rock, veined with quartz. Here and in other parts of this property quartz veins, which ramify in all directions, are regarded as indicators of tin ore.

No. 7, or west, trench, north-west of the mill site, opens a large body, consisting of fresh, fine-grained quartz, two micas, two felspars, and pinite. The average content of tin is reported at 0·25 per cent.

Main workings consist of a deep trench (150 feet long), bearing S. 30° E., leading to a deep open-cut, 60 feet in diameter. At the end of the open-cut is a shallow shaft on a rich body of stone, and a drive extends from the same point 16 feet into white and soft aplitic rock containing tin ore. At the mouth of the drive pinite is particularly prominent, and the tin ore content is proportionately high.

Near the north end of the shaft is a body of decomposed pink felspar, dark-green mica, and fluorapatite with tin ore. In the west side of the cut is a large body of quartz-pinite-mica, branded with quartz greisen, and alongside is a 4-foot body of quartz-mica greisen coursing N. 55° E., and containing tin ore at the rate of 1 per cent. At the north-west end of the cut alaskite is the characteristic rock.

Between the open-cut and the outer end of the trench is a 20-foot body of yellow kaolin, coursing 80° W. of N., and dipping south. The tin ore content of that material has not been ascertained. From a point below Main-road a long adit (30° W. of S.) is connected with the end of the long trench by way of a rise. A borehole 100 feet deep, and directed west, was drilled to test the body at depth. These constitute the whole workings of this area.

THE VALUE OF THE STONE.

The aggregate widths (2479 feet) of tin-bearing stone in the 6058 feet of trenching showed an average tin content of only 0·012 per cent. The width of richest stone in the trenches is 30 feet, containing an average of 0·37 per cent.

In the more important bodies exposed in open-cuts, 342 feet of sampling showed an average content of 0·1227 per cent. tin, and 56 feet contained 0·4359 per cent.

It is quite evident from the statement of results that the rock as a whole, although tin-bearing, is poor, and that selection of ore is essential to success.

TREATMENT OF ORE.

In 1901 a 10-head battery and steam-power plant was erected on the south side of the peak to treat the ore from all quarters. All the openings were connected by tram-road to the mill. A start had not long been made when a bush fire swept the country and destroyed the plant. No work has been performed since.

GENERAL REMARKS.

Many investigators have visited this property and have attempted a sampling, but the Mount Lyell Company only has carried out effective work. The results obtained clearly show that the ore-bodies are not rich, and the more important are not very extensive, so far as is known. It is not anticipated that the average grade of workable stone here will prove of greater tin content than that of the Anchor, which it resembles in every particular, nor that the richer and poorer stone can be broken indiscriminately and in large quantity without recourse to selection. However, it is thought that large bodies can be opened here to augment the supplies from the other sources.

THE LIBERATOR MINE.

Lessees: C. R. Fleming and others
Lease: 9547-M, of 5 acres.

The ore-bodies here were discovered by the late Thomas Bakhap in 1891, who at once commenced active development, and in the process unearthed bodies of rich ore. Such, however, proved of small extent, bonanzas only in a very large body of comparatively low-grade stone. He sold his mining rights to the Liberator Tin Mining Company N.L., which erected an up-to-date milling and concentrating plant, and, owing mainly to seasonal shortages of water, carried on in a desultory manner for only two years. In 1896 the property came into the possession of the Anchor Company, which, it is reported, expended £30,000 in developing the ore-bodies. The result of such a large expenditure is not apparent: all that can be seen are two small open-cuts and a connecting drive to the larger one.

THE ORE-BODY.

About the middle of the section is the summit of a well-moulded hill, sloping very gently northward and very steeply southward to the bed of the Groom River. On the north slope the sluicing of detritus has been productive of profitable results. The tin ore got there was the fine black crystallised variety so characteristic of this class of stone. The whole of the rock laid bare contains tin ore, but at the summit of the small hill it is much richer.

The ore-body here is of the "floor" and greisen type, well represented at the Anchor. At the south side of the small hill the pegmatite seam covering the tin-granite dips south-easterly at 6 to 8 degrees, while on the north side the dip is north-easterly at 5 to 7 degrees. Apparently this marks an upper curve of the undulating body, and incidentally, the plane of the geoisotherm.

The tin-granite is continuous from Crystal Hill, but is not seen west of the Liberator beyond Working Miners' Creek. The ground between the summit of the hill and Groom River has not received much attention. Whether the floor deposit extends to that depth is open to question; whether lower parallel planes contain seams of tin-bearing pegmatite is open to doubt, actual exploration being necessary to determine the downward extent.

At the main workings in the summit body the upper 15 feet of the rock is a granite, composed of equi-dimensional quartz, felspar, biotite, and muscovite, almost barren of tin ore. Then successive beds (20 feet aggregate thickness) of pinitised rock with much purple fluorspar. The distinct dividing seam of pegmatite is not apparent here, yet the change from barren cover-granite to the tin-granite is quite abrupt.

THE WORKINGS.

Main quarry is at the crown of the hill, about 300 feet above the milling plant. This quarry is 31 feet in depth, 100 feet long, and 60 feet at its widest part, the bottom being an enclosed floor, from which a tunnel exit leads to an inclined tramway.

The stone exposed here is generally similar to that of the Anchor and Crystal Hill, but varies in one important particular—its high proportion of fluorspar as compared with the rock in the other mines named. Fluorspar is not only associated with it as infillings of joints, and as nests and veinlets in the granite, but pervades the rock generally. Some specimens consist almost wholly of fluorspar—the micas and felspars having been completely replaced—but, as a rule, partial alteration of the lime felspar is noticeable only.

Between planes are nests and veinlets of coarse pegmatite, consisting of quartz, molybdenite in large thick flakes, large well-formed crystals of cassiterite, chalcopyrite, fluorspar, felspar, and a large flaky white mica. Tin ore in the harder stone is often found in nests (one crystal of 9 lb. weight is reported), and large tin crystals are found in cavities with large crystals of quartz.

On the north side of the cut the rock is much harder and more siliceous. In this tin ore and molybdenite are prominent, but are not in such spectacular concentrations.

No. 2 open-cut or quarry lies close to main quarry, and is opened in exactly similar tinstone. This cut is smaller than the main one, being about 35 feet long, 20 feet wide, and 30 feet deep.

A third face, a little west of the others, is opened in similar rock, which here is deeply stained with iron oxide. Fluorspar covers large faces of the jointed rock, and molybdenite is freely disseminated through the stone in minute scales.

Outside the western boundary of this lease, about 100 feet down the hill, short cuts in tin-granite show encouraging prospects. The stone here is softer than in the other faces, much resembling the soft bodies in the main cut at Crystal Hill. A shallow pit, 9 feet deep, is sunk in stone of average grade.

THE TREATMENT OF THE STONE.

In 1901 the milling plant of the Liberator Mine consisted of a stone-crusher (Gate No. 2) and 20 heads of stamps of 1000 lb. each. The battery ran at 48 revolutions a minute, and the stamps dropped 7½ inches.

The concentrating plant consisted of 8 jigs, 9 Frue vanners, and 2 buddles.

Power was obtained from a large Pelton wheel operating under a water pressure of 430 feet, a small Pelton for the dynamo, and a breast water-wheel.

Although only 5 sluice-heads of water was required for power, and 3 sluice-heads for dressing, the supplies were short six months of the year.

The present plant is a very small one, much too small to be of effective use.

PRODUCTION.

Remnants only of the records of production are available. In 1899 a little over 3000 tons of selected stone was crushed for a yield at the rate of 0·75 per cent. tin oxide; in 1900 the quantity was 3100 tons, averaging 0·63 per cent. tin oxide. The concentrated tin ore is dressed to an average of 73 per cent. tin, the range being from 72·3 to 73·8 per cent. Some of the rock crushes easily, but some is hard. The softer is usually the richer.

North-east of this section a creek bed, it is reported, yielded 150 tons of tin ore.

From the small plant at present in operation the yield is at the rate of 0·4 per cent. It must be understood that selected ore only is treated, and that the average is not more than 0·2 per cent. grade.

GENERAL REMARKS.

The operation here is cramped and the system generally is wrong. Probably the reason for the opening of the ore-body in this manner is due to the fact that the richest known part of the deposit is at this spot. It is significant that the cost of mining here is at least twice that at the Anchor, yet the conditions for working are better.

There is here a large body of stone of average grade already developed. It appears that the Liberator body is at the apex of an anticline of the isothermic plane, therefore immediately west and east in the synclines almost barren stone intervenes the next deposits. That is the explanation for the barren section between Liberator, Crystal Hill, and Anchor Mines, all three being at anticlines of the ore plane.

These ore-bodies should be worked in conjunction with those of the Crystal, Anchor, Don, and Australia. No ultimate good can result from operations on the present small scale.

North Liberator Mine.

North of the Liberator, just above the road, an ore-body of tin-granite has been denuded of its covering of detrital material as the result of sluicing performed many years ago. Shallow openings show here material of similar grade to that of the Liberator (0·2 to 0·25 per cent.). This, apparently, is on the line of the Liberator fold and the Australia strike, as is also another exposure 40 chains up the hill, west of the Australia Mine opening. These exposures are worthy of closer investigation, and may prove to be portions of large bodies of average grade. In that event the aggregate reserve of the southern group of mines would become very great.

Don Mine.

This ground is now held under extended prospecting claim by F. Windred, of Beaconsfield.

The first work performed here was by the Don Tin Mining Company No Liability, of Melbourne, under the supervision, first, of A. Robinson, and, later, of Dempster. Subsequently work was performed by the Australian Tin Mining Company.

A party, consisting of Gough, Bryce, and Russell, erected a 5-head battery, and carried on operations with fair success. They mined the ore on the panelling system, taking out the richest only for treatment. The workings now present the appearance of a long (300 feet) cliff face into which have been cut deep and roomy caves. That panelled and blocked out is the upper and richer part, just below the pegmatite band which separates the alaskite cover-rock and the underlying tin-granite.

The Nature of the Ore-Body.

In all essentials the stone here is similar to that of the Anchor and the Australia. It is medium-grained tin-granite, more or less affected by mineralisers, that present such a conspicuous geologic feature of the district. Here, as elsewhere, the presence of topaz and pinite is indicative of tin ore.

Selected tinstone (containing about one per cent. tin) was conveyed by tramway to the late Australian Company's mill and there subjected to treatment. The milling plant was at a higher elevation than the mine, therefore power was required for haulage. It is stated that the stone rejected and dumped contains a higher proportion of tin ore than the average grade of material excavated and treated by the late Anchor Company. That statement has not been verified, but it is not unlikely, because stone of lower grade could not be mined and treated at a profit under the conditions of that time. Certainly a large quantity of tinstone of unknown grade has been dumped outside of the workings. In some of this tin ore is visible.

The ore-body dips southward at very low angles, varying in different parts from 5 to 8 degrees. Its junction with the normal porphyritic granite is sharply lined along a north-east course, the junction here apparently marking the position of a fault. Any other suggestion as to the relation appears incomprehensible. In any case the ore of this body does not extend north-westward beyond that line. North-east of the cut in Tin-dish Creek the tin-bearing greisenised rock is exposed again. Here it is lower than the average grade of the stone. A little higher upstream is a dyke of hard and barren alaskite-aplite, coursing N. 73° E., and passing into the tin-granite.

THE AVERAGE VALUE OF THE STONE.

Samples were taken by the Mount Lyell Company over an aggregate length of 1319 feet. The average value of these samples was reported as 0·0831 per cent. tin. The richest part of the body, 32 feet in width, contained tin in the proportion of 0·81 per cent. Between the extremes of rich and poor are extensive bodies of ore of profitable quality. The details of sampling, and the results obtained, are given in the subjoined table. The records read from west to east of the workings.

Length of Sampling (in feet.).	Place Taken From.	Tin (per cent.).	Remarks.
38	Upper Bench	0·04	
35	,, ,,	0·03	
33	,, ,,	0·03	
43	,, ,,	0·18	
10	,, ,,	0·57	
47	,, ,,	0·19	
35	,, ,,	0·01	
44	,, ,,	0·02	
27	,, ,,	Trace	Cover-rock
28	,, ,,	Trace	,,
44	,, ,,	Trace	,,
40	,, ,,	0·12	Below cover-rock
43	,, ,,	Trace	
29	,, ,,	0·05	
35	,, ,,	0·01	
47	,, ,,	0·01	Cover-rock
38	,, ,,	0·02	,,
35	,, ,,	0·18	Ore-body
33	,, ,,	0·06	,,
38	,, ,,	0·17	,,
10	,, ,,	0·11	,,
52	,, ,,	0·09	,,
32	,, ,,	0·81	,,
41	,, ,,	0·38	,,
28	,, ,,	0·23	,,
31	,, ,,	0·11	,,
40	,, ,,	0·02	Cover-rock
36	,, ,,	0·04	,,
29	,, ,,	0·02	,,

Bore No. 45 was drilled 100 feet at an angle of 45° in a north-easterly direction from the north-west corner of the face, where the trench sampling showed 0·03 per cent. grade. The bore results were likewise of 0·03 per cent. Bore No. 46 was drilled 100 feet at an angle of 60° in a south-westerly direction through stone of 0·02 per cent. average grade. This, it should be remembered, passed through the almost barren cover-rock. Bore No. 43 was drilled 100 feet at an angle of 70° in a south-easterly direction through cover-rock and tin-granite of 0·11 per cent. average grade. Bore No. 44, also in a south-east direction, and at an angle of 80°, cut through stone of only 0·02 per cent. quality. Another bore, No. 47, was drilled 100 feet at an angle of 45° in a north-easterly direction underneath a rich section of stone from a point in the lowest level of the cut. Here the underlying stone was of 0·003 per cent. grade only. It is quite evident that this bore penetrated the poor country rock below the "floor" deposit, and that the thickness of these peculiar flat ore-bodies at this mine is generally not more than 100 feet.

No. 48 bore, away to the north-east of the cut, was drilled 72·5 feet in cover-rock at an angle of 60° in a south-easterly direction. The stone passed through contained tin in the proportion of 0·003 per cent. only. Another bore, No. 49, a vertical hole, was drilled 79·5 feet from a point 300 feet north of the cut. This contained tin of 0·01 per cent. grade. The last is more encouraging, especially when it is known that the whole of the cover-rock is included in the sample.

GENERAL REMARKS.

The stone here, although not in very large quantity, will provide another source of supply to a centrally situated milling and concentrating plant. This part of the ore-body cannot be worked with success as an individual mine. It is therefore of value only as a unit in a large general scheme.

AUSTRALIA MINE.

Lessees: A. and J. Dishington.
Lease: 9660-M, of 20 acres.

Tin ore was discovered here many years ago by Peter Hodge, who called it "The Puzzle," because of the difficulty he found in arriving at an understanding of the nature of the ore-body. The property was soon after acquired by the Australian Tin Mining Company N.L., and then received its present name. That company carried on operations for some years in the two open-cuts at the top of the hill. These were abandoned in 1898 in favour of the Don ore-body at the bottom.

In later years the mines were worked by the Anchor Company with fair success. Prior to the Anchor Company taking over the property, this and the Don Mines were explored and sampled by the Mount Lyell Mining and Railway Company. It is apparent from the positions of sites of bores and of trenches that the engineer for that company had not a true generic idea of the nature of the formation, consequently the work performed by that company was not always to the best advantage.

THE ORE-BODY.

The main body of tinstone is the tin-granite of the district, similar in all respects to the Anchor, Crystal Hill, Liberator, Ethel, Southern Cross, Mount Marie, and Mount Michael Mines. Between this body and the Anchor are dykes of alaskite-aplite and a line of faulting. At the summit of Australia Hill and along the ridge to Mount Littlechild similar tin-granite extends, but it is more siliceous westward. At the summit the rock weathers in enormous lens-shaped bodies, one lens resting horizontally upon another, the lines of division marking geoisotherms.

In the open-cut of this mine the most prominent rock is a pinite-mica variety of the tin-granite, merging on one hand into a more felspathic kind, and on the other into a more siliceous rock. The whole greisenisation effect has been induced by the action of mineralisers following four parallel channels, coursing N. 70° E. Between these four rich east-trending veins the tin-granite has been completely transformed, providing an ore-body at least 40 feet in width. Looking eastward the successive rocks are composed of: pink felspar, pinite, and a little dark mica, quartz felspar, with a little cassiterite; dark-green mica, pinite, quartz, and cassiterite; felspar, quartz, and pinite; and quartz felspar, two micas, and pinite. A soft kaolin-topaz body, 2 feet wide, trends N. 70° E., and dips with the other veins north-west. Other veins, one of kaolin, another of dark-green mica and pinite, and yet another, but very siliceous, body presenting a hard, glassy appearance, are exposed in the cut. From these the lessee is now getting 100 lb. of tin ore per cubic yard of stone.

East of the open-cut some old trenches expose chalcopyrite, wolfram, and cassiterite in association with quartz. Other quartz veins, higher up the hill, coursing eastward, carry chalcopyrite and tin ore.

THE VALUE OF THE TINSTONE.

In the days of the Australian Tin Mining Company the manager, wishing to encourage the shareholders, sent selected stone to the mill containing tin ore in the proportion of $1\frac{1}{2}$ to 2 per cent.—material of satisfactory richness and yield. His failure to maintain that average brought disappointment and discouragement, and attention was then directed to Don Mine. When work ceased the published accounts showed a yield of 0·66 per cent. tin from the Australian stone. After a trial of 25 tons of Don stone, with the usual abnormally high first return, viz., almost 2 per cent., the Don property was acquired by the company. The next crushing yielded 1 per cent., and during the first half-year of 1889 stone weighing 2206 tons was crushed for 20 tons of tin ore, equal to 0·90 per cent. In 1900 the average had fallen to 0·5 per cent., but in 1901 two lots (one of 773 tons yielded 0·75 per cent., the other of 1075 tons yielded 0·93 per cent.) gave much higher returns.

The results of the latest mining of the richest ore show an average grade of 0·4 per cent. of recoverable tin. At the Puzzle face samples taken from the richest sections over an aggregate width of 200 feet showed tin in the proportion of 0·495 per cent. Away from that rich belt, which is 30 feet wide, the stone is invariably tin-bearing, but poor.

The results of sampling the upper bench of the face from the west to the east sides are given in the subjoined table:—

Width of Sample, in Feet.	Tin, Per Cent.
35	0·73
35	0·81
75	0·17
33	0·18
40	0·05
60	0·13
25	0·09
25	0·43
25	0·08
25	0·27
42	0·24
35	0·15
10	0·18

That average is fair, and is strikingly richer than that of the lower bench, below the easterly-trending veins, which is given hereunder:—

Width of Sample, in Feet.	Tin, Per Cent.
43	0·04
75	0·08
43	0·02
69	0·54
60	0·01
35	0·06
10	0·18

THE TREATMENT PLANTS.

The Australian Tin Mine was equipped in 1901 with a battery of 30 stamps, each weighing 616 lb. It ran at 45 revolutions a minute, with a drop of 8 inches. Even in those days the machinery was described as obsolete. The motive power was steam, costing not less than £30 per horsepower per annum.

Two rotary tables, 12 jigs, and 3 buddles completed the equipment of the treatment plant.

Relics of the old plant remain at the site on the bank of Crystal Creek.

THE WORKINGS.

The ore-body is well exposed in an open-cut 300 feet long, 60 to 100 feet wide, and 40 feet deep. Its east and west extensions have not been proved, nor has any real exploratory work been performed north of the cut. One hole was drilled to a depth of 100 feet at an angle of 50° south from a point 150 feet north of the cut, but this was drilled on an angle parallel to the dip of the body. Many trenches have been cut north and south of the ore-body, but all such represent so much wasted effort, and clearly show that the investigators had little idea of the nature and structure of the ore-body.

GENERAL REMARKS.

The Australian belongs geographically to the southern group of mines, of which the Anchor is apparently the most important. Opened on the south side of a very steep and high hill, and near the summit thereof, its situation is such as to present every facility for open-cut and adit methods of attack. Although much development work has been performed in the middle of the ore-body, little attempt has been made to explore the east and west lateral extensions.

The particular feature of note is that greisenisation, with its concomitant mineralisation, spread laterally from a number of east-trending and north-dipping veins, the metamorphic effects involving the whole intermediary rock. Floor deposits are not in evidence here, but appear higher up, near the Summit Mine. The east-trending greisen veins here, as in the Anchor body, mark the channels of ingress of the mineralisers, and on their number, extent, and proximity depend the extent and value of each ore-body. The ore-bodies of the Australian Mine extend to much greater depths than the floor deposits. There is here a very large potential reserve of tin-bearing granite.

Summit Mine.

Lessees: J. A. Hodgman and G. Bryce, Junior.
Lease: 9121-M, of 5 acres.

This is a lease of ground at the summit of Blue Tier Range, directly north of the Australian Mine, and on an extension of that body of tin-granite. The records show that the greater part of the work here was performed by the Anchor Company. That work consists of a narrow open-cut, 140 feet long, into a quarry 72 feet long, 48 feet wide, and 30 feet deep.

The type rock here consists of quartz, dark-green mica, pink and white felspar, and pinite tending to yellowish-green mica. The rock is soft, rough to the feel, and is stained with manganese and iron oxides. The relative proportion of components is not extraordinary, except in a few places where quartz predominates and biotite is absent. Greisenisation is not in evidence and tin ore is not visible. Apparently this is the extension of the uppermost layer of tin-bearing granite at the apex of an anticline in the pegmatite seam. West of the open-cut similar capping rock of quartz, muscovite, felspars, and pinite extends 400 yards, allowing of the opening of a large body if the tin ore content is high enough for successful operation; on the east side the pinitised rock extends 200 yards.

There the uppermost layers have weathered in horizontally disposed lenticular blocks, their thicknesses being measures of the spaces between planes of geoisotherms.

The average tin-ore content of the stone is not on record. Apparently it is no richer than the average grade of stone mined in the Australian cuts.

Victory Tin Mining Company Proprietary Limited.

This mine was originally known as the East Coast Bischoff. It was so named by the late W. Rattray, the first manager, who was instrumental in floating a company in Launceston to open the ore-bodies. The unwarranted reports that were issued from time to time regarding the thickness of the deposit created a feeling of uneasiness among those who had invested capital in this and other mines in the neighbourhood. When it was proved that the reports were without foundation on fact the company decided to cease operations.

The mine lay idle for many years, until W. Lascelles. of Melbourne, formed a small company to continue the work of development. Under the management of Chas. Robinson a few patches of rich ore were opened, and a battery of five stamps, a table, and sluices, together with a 4-foot Pelton wheel, were erected to treat the ore.. These people failed, as did all others who attempted to work on a small scale a large low-grade ore-body.

A branch of the Anchor tin-granite body extends south-east into this property, and there, in that rock, are a number of parallel veins of tin-bearing quartz. All the way from the Anchor the rock consists of fine-grained muscovite-biotite granite, occasionally porphyritic and coarser in grain than the normal type. None of the component materials is persistently idiomorphic, except perhaps the micas, but idiomorphic individuals of felspars are noticeable in a few places. From the saddle near the road the rock contains strings and nests of quartz-mica pegmatite, which extend to and beyond the mine. These veins course N. 40° E. to N. 45° E., and dip S.E. at 80°.

An open-cut, 60 feet long, exposes the veins and the containing rock, and cross-cuts therefrom south-eastward open soft, kaolinised, medium-grained granite. Drives southward expose ore similar to that in the cut, and no richer. The veins lie parallel and close to one another, and are from 6 inches to 12 inches wide, the larger ones occasionally widening to 2 feet. The quartz is much ironstained, and contains large flakes of white mica. Tin ore is not visible in the specimens collected of quartz, but on the footwall of the veins the ironstained kaolin contains a fair proportion of tin ore over a width of 12 to 15 inches.

A thorough sampling of this group of veins is recommended to ascertain the truth of one of the conflicting reports as to the actual value of the stone on this property.

GOUGH VEINS.

This ground was held under lease many years ago by the Crystal Tin Mining Company.

North-east of Don open-cut a number of deep and long trenches, bearing N. 20° E. to N. 45° E., open bodies of quartz-mica greisen, 6 to 18 inches wide. These veins are comparatively rich in tin ore, and contain also chalcopyrite, molybdenite, and wolfram. The forkings on the sides of the trenches exhibit many rich specimens, some quartz pieces being studded with coarse crystals of tin ore.

Caving of the sides has covered the veins in the bottoms of the trenches, but in the north ends they are exposed to view. There the smaller ones appear as they are down the hill; the larger are split into many veinlets, and are in harder rock of different character.

These deposits are not of any considerable importance from the commercial viewpoint.

WOLFRAM VEINS.

North of Gough Veins, and east of the Australian Mine, is a group of wolfram-bearing veins, discovered in the eighties. The most important vein is exposed in trenches, at intervals of 6 chains, over a distance of 21 chains, and in an adit, cross-cut, and drive about 130 feet in length. It strikes in a north-east direction, and dips south-easterly, and consists of 3 to 6 inches of quartz containing scattered patches and crystals of wolfram and iron and copper pyrites. Cassiterite is reported, but could not be perceived in the many specimens examined. The crystals of wolfram are faced with azurite and malachite, and extensive azurite staining is seen on the footwall of the vein exposed in the drive. The quartz is the vitreous variety usual in this field. Porphyritic granite is the containing rock.

Including 4 inches of hardened wall-rock, the vein outcrop is 15 inches wide over-all.

The occurrence is of geologic interest only.

COMPEER MINE.

Lessee: J. B. Symons.

Leases: 10037-M and 10053-M, each of 10 acres.

The ground leased by Symons is part of a large area near the headwaters of Seven-Mile Creek, once held by the Compeer Tin Mining Company No Liability. Some years ago the company erected machinery and built a large dam in connection with the working of the shallow alluvial ground there. Two engines were in use: one for nozzle water, the other for a gravel pump. The operations were unsuccessful. It is possible that tin-sluicing on a small scale would have been productive of good results had the ground not been so flat. In any case the shallowness of the gravels and the small extent did not warrant expenditure on power plant.

The gravel, 3 to 6 feet deep, consists of vein quartz, quartz greisen, and occasional pebbles of quartz-felspar-tourmaline pegmatite. Few stones are greater than 6 inches diameter. The gravel rests upon a soft tin-granite bottom, which abuts porphyritic granite near the breast of the dam.

A number of quartz-mica greisen veins, 3 to 9 inches wide, traverse the porphyritic granite and the tin-granite, and all contain tin ore in varying proportions. Just over the southern boundary is a large body of barren quartz pegmatite, coursing N. 70° E.

Planet Mine.

This ground, south of and adjoining Southern Cross, is not held under lease to-day. In 1889 it was the property of the late W. L. Crowther, of Hobart, who carried on sluicing operations there to concentrate the tin ore contained in the shallow (2 feet deep) detritus. The material represented the waste of the dyke of tin-granite which was found underneath. The tin ore obtained was sharp and angular, having been derived largely from tin-bearing veinlets of quartz contained in the granite rocks. No attempt has been made to define the dyke nor to ascertain the value of the stone.

A tributer (Willing) years ago got 7 tons of tin ore in three months at a cost of £15 a ton. That is an indication of the value of the detritus, and lends encouragement to the belief that the dyke-rock is worthy of closer investigation.

Ethel Mine.

A small company was formed in 1888 to explore the tin-bearing rock in this ground. Operations ceased in 1889, and no work has been performed since.

The Southern Cross tin-granite dyke passes south from the Planet through this ground to join the main body at Australia Hill. A shaft has been sunk in the tin-granite dyke to a depth of 60 feet, exposing stone of low grade;

and trenches have been cut across it at intervals of 5 chains. In a few places the stone is of high grade, and everywhere in this section it carries a little tin ore.

About 10 chains south of the 60-foot shaft is a large body of pegmatite quartz, coursing N. 70° E., the extension evidently of that outcropping at the south boundary of the Compeer.

Wellington Mine.

The development of this mine was the work of a Launceston company in the late eighties.

Here, as elsewhere in the district, the first work was that of sluicing the detritus, which extended over a wide area. The removal of the detritus revealed many quartz-mica greisen veins, some 1 to 6 inches in thickness and a few 12 to 18 inches. Two shafts, one 37 feet, the other 80 feet deep, have been sunk, and an adit crosscut, 494 feet in length, has been driven to explore the more important ones. The first 370 feet of the adit was driven through hard porphyritic granite, the remainder through soft country. Two veins were intersected in the performance of the work: No. 1 at 370 feet from the entrance, and No. 2 at 407 feet. At 455 feet a soft body, composed largely of kaolinised felspar, was intersected, and the adit was driven along its course to the end of the working. It was reported that the kaolin material contained tin ore in the proportion of ½ per cent. That report is not correct, but tin ore is distributed through the material and, in some places, in fair amount.

No. 1 vein courses almost due east and is almost vertical. Its north wall is hard and sharply planed. The walls enclose a body of decomposed granite 8 feet wide, with a casing of quartz 3 inches thick, containing tin ore. No. 2 vein consists of 12 inches of soft granite, with a thin quartz vein in the middle. It is parallel to No. 1, but dips northward. These veins show at surface, the larger ones as a stockwork of quartz-cassiterite veinlets.

Another tin-granite dyke passes through this ground in a north-westerly direction towards Kent Hill, where is a larger outcrop. No attention has been given to this by the operators.

In the adit crosscut, at 350 feet from entrance, a basic dyke, 2 feet wide, is intersected. The dyke cuts through both veins. A few chains north-east are two parallel dykes (2 feet) of alaskite-aplite, coursing 340°, and dipping north of east.

A careful sampling of the Wellington ore-bodies is desirable.

Griffin Dyke.

What is known as the Griffin dyke of tin-granite is exposed in the road-cutting on the way to Camp Creek and Wyniford River junction. The body is 150 feet wide, medium to fine in mineral texture, and consists essentially of felspars and quartz, with pinite and occasional flakes of white mica. It conforms closely to alaskite, and is similar to that of the cover-rock of the Anchor and other bodies in that quarter. That being so a high tin content is not likely, yet pinite is a prominent mineral component. It is trenched north of the road, and its southern continuation is exposed in old workings at Seven-Mile Creek and in a deep trench on the hillside.

The porphyritic granite on either side is hard and fresh.

The Southern Cross Mines.

Lessee: Bart. Griffin.

These were parts of the original holdings of the Marie Louise Company, and the ore-bodies were exposed by them in the processes of sluicing the detrital material and concentrating the tin ore. In later years the ground was leased by the Haley brothers, who sold their mining rights to an engineer named Lewis, acting on behalf of a Melbourne firm, and who in turn organised a company with a capital of £10,000 for the purposes of opening the mines and erecting machinery for the treatment of the stone. The work performed by the manager (Cock) consisted of trench-cutting, shaft-sinking, other exploratory operations of a like character, and the erection of buildings. On these works the capital was exhausted, and no attempt at mining was made. After a long interval another company (the McGough) was formed, with the late W. Cundy as consulting engineer and Tregaskis manager. A battery of stamps, a concentrating plant, and a steam-power plant were erected and put into operation. After a long-sustained struggle this company fell the way of all others, owing to the low price of tin and the high cost of power.

No actual mining has been performed since that time.

LOCATION, AREA, ETC.

This property is situate south and adjoining the southern section of the Mount Marie group, and encloses a portion of the long pegmatite dyke.

The property consists of leases 9278-M, of 20 acres, and 3920-M, of 20 acres, and water-right 1732-W.

THE ORE-BODIES.

The ore-bodies are of two kinds: the tin-granite dyke rock and quartz-mica greisen veins. At the northern end of the property the dyke rock is not as soft as the interstitial cassiterite. It is there wider and coarser in grain, and the component topaz is much more abundant, and secondary mica and pinite are prominent. Tin ore (cassiterite) increases as the proportion of topaz increases. The rock is deeply stained in many parts with manganese and iron oxides, and is traversed by veins of chalcedony 2 to 4 inches wide, and by two basic dykes, now decomposed, bearing N. 65° E., and dipping south-easterly.

Variants from the normal type of tin-granite consist of: quartz, yellowish-white and yellow felspars, bronzy-grey and dark micas, muscovite, topaz, and fine interstitial and enwrapped cassiterite, and large bodies of massive pinite rich in brown cassiterite and associated with fine quartz-felspar deeply stained with iron and manganese oxides.

The dyke rock varies in width from 30 to 120 feet, and in its wider parts encloses unassimilated porphyritic granite, which is barren of tin ore. Towards the boundary the dyke splits into two narrow bodies, which, diverging widely, are lost below the soil cover. The line of division between the porphyritic granite and the intrusive tin-granite dyke is quite distinct.

The strike of the dyke is a little west (5° to 7°) of north, and the dip is west at 42°.

The slope of the surface along the course of the dyke is so gentle that the adit method of attack is limited to a very shallow level, and open-cutting is shallower because of the narrowness of the dyke. Eventually a shaft opening will be necessary to work the whole body, preferably one situated in such a position as to command the Mount Marie part of the dyke as well.

Veins coarser in grain (Young and White veins, for example) are associated with the dyke ore-bodies. These consist of mica, quartz, felspars, tourmaline, and cassiterite, exhibiting remarkable intergrowth, and are walled with coarse pink felspar enclosing quartz. In these may be seen quartz surrounded by felspar, and quartz completely enclosing felspar and mica. These are more typical pegmatites than the dyke rocks.

The outstanding feature of the tin-bearing rocks is the closer association of cassiterite with topaz and pinite.

THE WORKINGS.

The workings are all open-cuts and quarries, except two prospect shafts.

At the northern end is Morling's shaft, now inaccessible, sunk, it is reported, on ore of 1 per cent. grade. That report can be discounted, because just alongside the bulk content of a 25-foot section is 0·20 per cent. Next are Tregaskis' cuts, Nos. 1, 2, and 3. Of these Nos. 1 and 3 expose ore of average grade, but No. 2 is poor, yet it is cut along a rich shoot. Along the tunnel leading to north open-cut the stone is poor; but along the section of tunnel to south open-cut it is generally rich. Almost the whole of the stone exposed in north open-cut is of average grade, as it is in south open-cut and No. 8 east cut. Near McGough shaft is a rich body of stone, above the average grade; and in McGough cut are some rich bodies of stone with poor stone between them. Beyond that cut the main dyke rock is poor, but the offshoots exposed in Nos. 1 and 3 trenches are of average grade. At the south end, where the dyke splits and becomes small, a large number of narrow quartz-mica veins appear, all tin-bearing and many rich.

In addition to the cutting of many long and deep trenches across the ore-bodies, the Mount Lyell Mining and Railway Company drilled ten holes to depths of 100 feet. Sufficient work has been performed to provide data for an estimate of reserve and value to a depth of 50 feet.

THE PROCESS OF TREATMENT OF THE STONE.

In 1888 milling and concentrating plants were erected about ¼-mile away on the bank of a west-flowing stream that passes by the northern boundary of the property. This milling plant consisted of a battery of 15 stamps, the 5-foot Huntingdon mill, belonging to the New Moon Company, and two rock-breakers, one for the battery and the other for the Huntingdon mill. Eleven Frue vanners comprised the concentrating section. A 40-h.p. steam-engine provided power for the milling plant, and a smaller steam-engine was used to drive the machinery of the vanners. The pulverised material passed direct to the vanners without classification.

THE VALUE OF THE STONE.

In order to convey an idea of the work performed by this plant, and of the value of the stone mined, the following information is given:

During the period May to November, 1888, the quantity treated was 5037 tons, from which was obtained 32 tons 13½ cwt. of concentrated tin ore. The highest assay of the concentrate was 73 per cent.; the lowest 65·8 per cent.; and the average of 13 assays was 69 per cent. The yield works out at 0·6486 per cent. tin oxide from the stone.

Almost the whole of the stone mined was sent to the mill. The stone varies so much in value, rich and poor alternating every few feet, that selection is not economically possible.

During 1906 the Mount Lyell Mining and Railway Company thoroughly tested the ore-body from end to end of the workings. The aggregate widths of the better grade material covered by those tests outside the workings amounted to 262·5 feet, of an average tin content of 0·3113 per cent.; and the aggregate widths of the better grade stone in the workings amounted to 667 feet, containing 0·201 per cent. tin. Altogether the width footage of the tests of workings, irrespective of quality, amounted to 2006 feet, of value 0·1585 per cent. tin. A thorough sampling of Young and White veins showed the tin content of each to be 0·19 per cent.

A reference to the accompanying assay and feature plan will show that, by judicious selection, the average grade of ore can be kept at 0·25 per cent. tin; it shows also the extraordinary variation from point to point.

ORE RESERVE.

On the basis of the very close sampling of this ore-body it is estimated that the reserve of ore to a depth of 50 feet is made up of—

124,000 tons of 0·20 per cent. grade, or
322,000 tons of 0·158 per cent. grade—

and outside the dyke 28,000 tons of 0·31 per cent. grade.

DIREEN'S PROSPECT.

In the corner between the north and south sections of the Southern Cross, and on the east side a few chains from the boundary, is Direen's Prospect. This is a tin-granite outlier, through which runs a rich vein of coarse pegmatite similar to Young and White veins.

At this place the tin-granite body is very poor. It has been trenched, drilled, and carefully sampled, and contains only 0·01 per cent. tin. The pegmatite vein contained in it is, on the contrary, rich in tin. Samples taken across the vein, which is 18 inches wide at two points, showed a tin content of 6·43 per cent.

The outcrop is not prominent, but may be the uppermost projection of a much larger body below. In fact, the evidence indicates a widening.

The Tasmanian Tinstone Association No Liability.

This company holds, under lease from the Crown, a large area of tin-bearing country. Many of the deposits which were worked in the early days of alluvial mining as individual properties, such as the Full Moon Extended, the Wheal Tasman, the Rising Sun, the Lottah, the Giant, the Full Moon, and the Perennial, are now included in the holdings of this company. Some of the old names have been dropped and new names substituted therefor. To-day the mines are placed in two groups:—

(1) The Mount Marie group, including the Perennial, Giant, Full Moon Extended, the Wheal Tasman, the Rising Sun, and the Full Moon; and

(2) The Lottah-Moon group.

This arrangement has both a geographical and a geological significance. The geographical is obvious; the geological is due to type of deposit, one being of the dyke type, the other of greisen vein type.

The Mount Marie Mine.

AREA, SITUATION, ETC.

The leases enclosing the ore-bodies of this mine are held by the Tasmanian Tinstone Association No Liability, of Hobart, a company duly registered under the Mining Companies Act, 1884. The ore-bodies within the boundaries of these leases were explored many years ago by a New Zealand syndicate, and later by the Mount Lyell Mining and Railway Company. Those exploratory works consisted of a large number of deep trenches, spaced 5 chains apart, and cut across the ore-body at right angles to the strike, and of a few boreholes. Records are available of the Mount Lyell Company's work, and are cited in this report. Some of the results recorded of assays of samples do not seem to tally with those obtained by the writer and other investigators; but more of this anon.

The holdings of this company on the Mount Marie line consist of—

Mineral Leases—

10213-M, of 18 acres;
10194-M, of 40 acres;
10195-M, of 40 acres;
10240-M, of 20 acres;
10239-M, of 20 acres;
10238-M, of 20 acres;
10237-M, of 20 acres;
10257-M, of 20 acres;
10258-M, of 40 acres.

Dam Site—

2568-W, of 101 acres.

These holdings extend northward from the Southern Cross Mine, through the middle of the plateau, on the west side of Mount Michael, enclosing the Perennial Mine, to McGough's Lookout.

EARLY MINING.

The rich detrital materials resting upon the ore-bodies, and the alluvial in the beds and along the banks of streams, were removed by sluicing. This method was gradually superseded by open-cutting and mining as the ore material became more compacted and harder. Not one of the mine openings, however, is of any considerable extent. A few half-hearted attempts were made to mine and mill the tinstone, each time and at each place on a small scale. During the past 30 years the area has received very little attention. Fossickers have cut into the richer sections, and, by means of the crudest appliances, have eked out a livelihood: that is the only result of the work performed since that time.

The reasons for the long neglect are twofold:—

(1) The flatness of the country; and
(2) The difficulty in conducting water to that high elevation.

PRODUCTION.

No record has been kept of the production of tin ore from these properties. The greater part of the total output was the result of the work of early miners. However, it is known that the annual output was large during the early period.

THE ORE-BODIES.

The ore-bodies consist of dyke-like intrusive bodies of tin-granite, composed in some places of medium-grained biotite granite, in others of muscovite-pinite granite and of felspathic granite. In addition to the main body outliers appear on either side. The whole apparently represents the highest projection of offshoots from the main body of tin-granite underneath. The main or narrow dyke-like body exhibits the structure of pegmatite, with its graphic intergrowth and its large pegmatitic borders of pink felspar enclosing elongated lenses of vesicular quartz, and the structure indicates a condition of extreme fluidity at the time of intrusion. Along the walls, which are sharply defined, the pegmatite is very coarse; in the body of the dyke the component minerals are free and in a decomposed condition. Topaz, felspar, and secondary mica are the prominent components. Tin ore is not evenly distributed: a little appears as disseminations, but the bulk of it is concentrated near the middle of the dyke in fine crystal aggregates. In the topaz-rich rock the tin ore is in coarse crystals of equal size to the essential components, or is found as infillings of cracks in the form of veinlets.

The ore-body follows a sinuous course from north 10° west to north 10° east, and dips westward at angles of 45 to 50 degrees. It varies in width from 40 to 120 feet, and extends unbroken from Southern Cross Mine to Wyniford River, a distance of a mile.

THE VALUE AND EXTENT OF THE DYKE-ROCK.

In order to collect sufficient data to form an idea of the actual tin-ore content of the dyke, a careful sampling of the rock exposed in trenches, cuts, and shafts has been undertaken by officers of the Department. The sampling of the trenches is being performed under the supervision of the writer and his assistant, Q. J. Henderson, and the greatest care is being taken to get samples truly representative of the rock at those places.

In addition to that work a number of holes have been drilled to test the ore-body at depth. The drilling is in charge of W. Laughlin; the collection and preparation of samples are duties of F. Blake, Assistant Government Geologist; and the analyses are performed under the supervision of W. D. Reid, Chief Chemist, Mines Department Laboratories, Launceston. Each officer concerned is taking the greatest care in ensuring accuracy.

The accompanying plan shows the positions of samplings, and the subjoined tables the results of analyses:—

Sample Taken From—	Nature of Material.	Width of Ground sampled (in ft.).	Depth of Sample (in feet).	Tin (per cent.).
No. 2 trench	Tin-granite	10	6	0·20
Ling open-cut	Greisen	2	6	1·30
	Aplite	10	8	0·21
	,,	20	8	0·01
No. 3 trench	Medium-grained granite	10	5	0·08
		10	5	0·24
		10	5	0·06
		10	5	0·10
		10	5	0·05
No. 4 trench	,,	10	6	Trace
	,,	10	6	0·33
	,,	10	6	0·19
	,,	30	6	0·005
	,,	30	6	0·08
	,,	12	6	0·07
No. 13 bore	Tin-granite		1 to 11	0·03
,,	,,		11 to 20	0·05
,,	,,		20 to 37·5	0·01
,,	,,		37·5 to 64	0·17
No. 5 trench	,,	10	5	Trace
	,,	10	5	Trace
	,,	10	5	0·60
	,,	10	5	0·10
No. 6 trench	,,	30	4·5	Trace
	,,	10	5	0·13
	,,	30	5	0·01
No. 14 bore	,,		15·5 to 19	0·015
,,	,,		19 to 21·5	0·006
,,	,,		21·5 to 33	0·005
No. 7 trench	,,	23	6	0·01
	,,	5	6	0·15
	,,	22	6	0·07
No. 8 trench and cut	Soft felspathic material	22	8	0·01
	,,	22	8	Trace
	,,	14	8	Trace
No. 8 trench and shaft	,,	8	4	0·06
	,,	10	10	0·34
	,,		16	0·18
	,,	10	10	0·10

Sample Taken From—	Nature of Material.	Width of Ground sampled (in ft.).	Depth of Sample (in feet).	Tin (per cent.).
No. 9 trench	Soft felspathic material	10	15	0·01
	,,	10	17	0·15
	,,	10	23	0·05
No. 16 bore	,,		0 to 7·7	0·014
,,	,,		7·7 to 9·3	0·006
,,	,,		9·3 to 43	0·072
No. 10 trench	Felspathic material	10	15	0·05
	,,	10	17	0·12
	,,	10	20	Trace
No. 17 bore	Tin-granite		3·2 to 7·5	0·08
	,,		7·5 to 11·3	0·05
	,,		11·3 to 36	0·11
No. 11 trench	Felspathic material	10	22	Trace
	,,	10	26	0·28
	,,	10	18	Trace
No. 18 bore	,,		2·5 to 27·8	0·407
	,,		27·8 to 31·8	0·03
	,,		31·8 to 63	0·06
No. 12 trench	,,	10	15	0·12
	,,	10	18	0·18
	,,	10	22	Trace
No. 19 bore	Felspathic tin-granite		2 to 27·25	0·13
,,	,,		27·25 to 36·7	0·14
,,	,,		36·7 to 49·25	0·18
,,	,,		49·25 to 51·25	0·04
No. 20 bore	Tin-granite		2·0 to 29·0	0·32
,,	,,		29·0 to 30·3	2·85
,,	Tin, hard		30·3 to 38·0	0·038
,,	,,		38 to 43·2	0·063
,,	,,		43·2 to 60·3	0·038
,,	,,		60·3 to 68	Trace
,,	,,		68 to 78	0·04
,,	,,		78 to 82	0·038
,,	,,		82 to 90	Trace
No. 21 bore				

The results of the samplings of the dyke-rock exposed in the numerous trenches and shafts, and of those sections of the rock cut in depth in boreholes, clearly show that the rock as a whole is of low grade; that the tin ore occurs in shoots, and that it is confined to a narrow strip near the middle of the dyke; and that the concentrate obtained in dishing consists, in large part, of iron, manganese, and titanium ores. It is possible that the deeper boring now under way may reveal higher results in general, but it is not anticipated that the rock as a whole will contain tin ore in profitable proportion.

The results are confirmatory of those obtained by the Mount Lyell Mining and Railway Company in its investigations some years ago. The very careful sampling of the Southern Cross (late Haley) portion of the dyke by the Mount Lyell Mining and Railway Company, disclosing an extensive body of 0·2 per cent. tin grade, led to the belief that the Mount Marie portion of the dyke would prove at least of equal value. In some sections that is so, certainly not in all, and in two places much richer shoots are exposed. It may be pointed out at this stage of the investigation that the tests already carried out are at widely separated sections, and that a closer drilling and sampling may reveal intermediate shoots of greater value. As the only object of the "scout" boring and sampling is to ascertain whether a more exhaustive investigation is warranted, it is obvious that no computative value can be placed upon such results.

It is quite evident that the associated iron and manganese oxides have been mistaken by the company for tin ore. In one concentrate, for instance, iron oxide constituted 60 per cent. of the material. Dish tests of the surficial material gave misleading results because of the wrong identification of the heavy associated minerals. In consequence of this the company expected a very much higher result from the test boring than that actually obtained. The final results of the boring operations now in progress, it is thought, will show that shoots of tin ore and almost barren sections alternate, the poor sections proving the larger. In this event it becomes essential to arrange for an amalgamation of the interests of all leaseholders in this, the northern area of Blue Tier, in order to provide for a sufficient reserve of ore of average grade.

The information in hand may be summarised as follows:—

(1) The dyke-rock, as a whole, is of low grade, and in parts is barren.

(2) The tin ore is found in shoots separated by longer stretches of almost barren material.

(3) The tin ore is associated with other heavy minerals.

(4) The tin ore is confined to a narrow strip near the middle of the dyke, the pegmatite walls being invariably barren.
(5) Four shoots of undetermined lengths contain tin ore in excess of 0·4 per cent.
(6) The width of the shoots of tin-bearing rock varies from 2 to 30 feet.
(7) The richest shoots are associated with the results of greisenisation processes.
(8) The containing rock is soft, but is compact in places at surface and in every part at a depth of 100 feet.
(9) The first results of the "scout" testing now in process certainly warrant a more intensive investigation and a more thorough exploration by drilling.

On the leased ground traversed by this dyke a number of outcrops of other bodies of tin-granite have been opened in trenches and pits. In some places the rock is veined with quartz-cassiterite, and in the pinitised parts the rock itself carries tin ore. A great amount of exploratory work is necessary to get sufficient data for a basis of calculation.

Lease 10195-m—40 Acres.

In 1888 the Full Moon Extended Company performed many works of an exploratory character on the dyke and veins at this place. A large number of trenches were cut across the dyke, defining its outlines and exhibiting its nature, and a shaft was sunk to a depth of 34 feet. The early reports read that the proportion of tin ore increased as the depth. The pump was too small to cope with the inflow of water, therefore an adit crosscut 65 feet lower was driven from the bank of Wyniford River towards the shaft. After driving through 105 feet of hard grey granite the soft dyke-rock was entered a few feet, when the funds of the company ran out.

After 40 years exploratory work has been resumed, this time by the Tasmanian Tinstone Association; the old trenches have been opened, new ones cut, and a prospect shaft has been sunk 20 feet on a body of pegmatite, which appears to terminate the dyke at the north end. This body of pegmatite, known as Mundy's Lode, is 2 feet wide, and courses N. 50° W. It consists of quartz, pinite, and mica, and where exposed in cuts is contained in pinitised quartz-felspar. The mica is the dark-green variety, and is in large flakes; the pinite is massive to fine scaly; the quartz is milky-white, sometimes well crystallised and partly filling large cavities; and the cassiterite is coarse and irregularly distributed through the pinite or filling interstices. The body is not well defined, being contained in a pegmatite of felspars, mica, and quartz. It may be in some way connected with the strong quartz-mica pegmatite that crosses Wyniford River near the Mount Michael Company's dam, and that outcropping so boldly above the confluence of Sun and Moon Creeks. This body is not likely to prove of any commercial importance, except possibly where it crosses the line of the dyke.

A basic dyke, 3 feet wide, crosses the third trench north of the shaft, bearing N. 27° E.

The New Moon Mine.

The New Moon Mine is enclosed within the boundaries of 5-acre lease 9120-M.

In the historical notes reference has been made to the richness and extent of the detrital deposits that at one time covered this ore-body. This consists of tin-granite an eastern outlier of the main body passing through the Southern Cross and Mount Marie properties.

The mine was worked many years ago by open-cut and shaft, but not with any degree of success. In later years the deposit was explored by the Mount Lyell Mining and Railway Company, which thoroughly trenched and drilled the body. Altogether nine holes were drilled into and across the ore-body to an average depth of 100 feet. The position and dips are shown on the accompanying plan. The results obtained here were higher than in any other deposit explored by that company during the period (April, 1906, to June, 1907) of its investigations.

THE NATURE AND VALUE OF THE TINSTONE.

The ore-body has been proved to extend at surface over 373 feet long and 350 feet wide. It is in all essential particulars similar to that of the Australian, Don, Anchor, and other mines. The stone varies greatly in character in this small compass. Through the middle of the body the rock has been silicified in the process of greisenisation. In that class of stone molybdenite is more conspicuous than tin ore, but the latter is actually in higher proportion. Partly greisenised stone composed of quartz, white mica, and pinite contains also cassiterite in crystals equal in size to the other components. At the south-eastern end the rock is felspathic, and has suffered kaolinisation only. This rock contains as an accessory a little topaz and also cassiterite in fair proportion.

The tin ore is, as a rule, coarse in grain and of high quality.

The Mount Lyell Mining and Railway Company tested the ore-body over a width of 373 feet and to a depth of 100 feet. The richest part of the body is 44 feet wide, and contains tin at the rate of 0·44 per cent.; over the full width, 373 feet, the average content is 0·1485 per cent.

PRODUCTION.

Over 1000 tons of tin ore has been produced from this mine in the sluicing of the detrital and alluvial deposits. That information is of no particular interest at present, because this report deals only with the rock deposits.

The records of production from the rock mine are very meagre, but an idea may be formed of the quality of the material from a statement issued by the manager in 1890. During the period February to July, 1890, the company crushed 2088 tons of stone for a yield of 26 tons of tin ore, the average tin content of which was 62 per cent. The yield was at the rate of 0·79 per cent. tin. The average through-put of 165 tons of stone a fortnight yielded an average of 35 bags (cwt.) of tin ore. A small proportion of the stone was discarded, not because it was valueless, but because it was too poor under the existing conditions of treatment and prices. Work stopped here, it should be observed, because the appliances used by the operators were unsuitable, and the price of tin too low.

THE MILLING AND CONCENTRATING PROCESSES.

The plant used in milling and concentrating the ore consisted of a Dodge rockbreaker of 50 tons per day capacity; a Huntingdon mill, with Challenge ore-feeder; and three Frue vanners—and was driven by a steam-engine.

A later company, on acquiring the property, began to erect a battery of 30 stamps and some concentrating machines, but this work was not completed owing to the financial depression following the failure of the Bank of Van Diemen's Land at that time. The only vestiges that remain of that mill are the foundation trenches on the side of the hill above the mine. The mill site is not a good one, because all the stone had to be hauled uphill; but the country around the mine is either higher than it or slopes so gently away that a suitable site could not be obtained within reasonable distance.

THE WORKINGS.

The ore-body is situated in the valley of Moon Creek where it is joined by Hope Creek. Moon Creek is a slow-flowing stream, therefore it is obvious that the only methods of attack are shaft and quarry.

The old shaft is only 45 feet deep. It was sunk near a very rich body of ore, reported to have been of 5 per cent. grade. The irregular outline of the quarry suggests the idea that the operators sought the richest material only. This is confirmed by the results of milling as compared with those of sampling. The stone was quarried to a depth of 20 feet only. No reliable information is available in connection with the results of the shaft work.

GENERAL REMARKS.

This seems to be one of the most important of the outcrops of the tin-granite. It is not very extensive at surface, but indications point to a widening underground. That remark is based on the fact that the contact between the tin-granite and the porphyritic granite on the west side is vertical, while on the north-east side the dip is east at 12°. Moreover, it is noteworthy that tin-granite encloses bodies of porphyritic granite; and north-west of this body are other projections, some of them very narrow, indicating a much larger body below.

As regards the working of the stone, no other methods than those adopted appear suitable. This property should be included with the others in one big scheme. It is futile to attempt to operate on a small scale, and this body in itself is too small to allow of operation on a commercial scale.

Full Moon Mine.

Leases: 10192-M, of 20 acres, and 10193-M, of 62 acres.

The earliest work was performed by J. C. Macmichael, prior to 1889, for at that time underground development had been suspended, and the workings have not been unwatered since. Hope Creek vein is the most important of a large number on this property similar in character to those of the Lottah Mine. This, coursing N. 53° E. and dipping south-westerly at an angle of 65°, is exposed in a deep trench and underhand stope over 1000 feet in length.

In the early days two shafts, the northern one 120 feet deep and the southern one 80 feet deep, were sunk to test the veins at depth, and if the average tin-ore content were found in profitable proportion these were to have been used as mine openings. It is reported that from those shafts 700 feet of driving has been performed in one direction and another, but no record is available as to the value of the veinstuff. This and other veins proved rich at surface. Dish prospects of the material in the dumps from the shafts show very high results.

Some years ago the men engaged in surficial mining endeavoured to unwater the shafts in order to attack the vein matter below, but the plant used was too small for the purpose.

At surface the Hope Creek vein, consisting of dark-green mica, quartz, and kaolin, is 18 inches to 2 feet wide, and is contained in porphyritic granite. The vein material in some places shows tin ore, molybdenite, fluorspar, and chalcopyrite set in a gangue of quartz and greisenised granite. Greisenisation extends only a few inches into the wall-rock. In the underground workings a basic dyke cuts the vein.

About 4 chains south-west of the 120-feet shaft is a 6-inch vein of hard white quartz, contained in hard medium-grained granite. This quartz is tin-bearing and is flecked with native bismuth. The vein courses a little west of north, and dips at a high angle westerly. Many other veinlets, similar in all respects, lie closely parallel in this area.

The records of the results of the milling operations are not available, therefore it is quite impossible to attempt an estimate of value. It is evident, however, from the manner in which the vein has been stripped at surface that the material there was of fairly high grade, at any rate in profitable proportion.

This area is worthy of the closest attention. Unfortunately attention has been confined in the past to the largest vein only.

Lottah Mine.

The first work performed here dates back to 1876, when a beginning was made upon the mantle of detritus. That work laid bare the ore-veins and enabled the operators to form an idea of their value. By the year 1889 a great amount of development work had been performed, but not with very good results. No development work of any importance has been done since that time.

LOCATION AND AREA.

These leaseholds are situated on the southern slope of Blue Tier Range, near the headwaters of Ransom River. The ground held under lease, and charted in the name of A. W. Fisher, is comprised of—

Leases—
- 10191-M, of 20 acres;
- 10188-M, of 40 acres;
- 10190-M, of 10 acres;
- 9131-M, of 5 acres;
- 10189-M, of 25 acres;
- 10187-M, of 40 acres;
- 9124-M, of 10 acres.

Dam site 2563-W, of 2 acres.

Machinery site 10248-M, of 5 acres.

THE ORE-VEINS.

The ore-bodies consist of a number of fissure fillings of the vein-dyke type. They lie in roughly parallel lines, course 15 to 17 degrees west of north, and dip in a south-westerly direction at angles of 65° to 75°. No. 1 vein dips at a higher angle (80°) than No. 2, and, in effect, is intersected by it at the lowest level of the workings.

The veins consist of quartz, 4 to 8 inches wide, with a little arsenopyrite and occasional bunches of cassiterite and molybdenite, some bonanzas showing wonderfully formed crystals. The quartz of the vein divides and coalesces many times along its course. In addition to the middle band are many disconnected lenticular shoots of quartz, 1 to 4 inches wide, separated from the middle band by heavily mineralised and altered granite of a dark-grey colour. Both the quartz and altered granite contain tin ore, molybdenite, chalcopyrite, and arsenopyrite, and in places the concentrations are rich. Over-all the ore channels are from 1 to 4 feet wide.

Milling tests of 5-ton lots, broken over a width of 3 feet, showed the recoverable content to be 0·45 per cent.

Quite a different type of ore-body is exposed higher up the hillside, about 10 chains northward of main workings. This is a pegmatite vein, consisting of an intergrowth of coarse quartz, felspar, and mica, with a little cassiterite (tin ore). This body is similar to that of Sun Creek, and lies parallel to the ridge of the Tier, N. 70° E. It belongs to the later pegmatites, and therefore is not likely to contain tin ore in profitable proportion.

Veins of this character are persistent along their course and dip.

THE WORKINGS.

The hill-slope is so steep that the adit form of opening is best. The main veins, Nos. 1 and 2, are opened in long adits at different levels. Lowest adit, 904 feet in length, follows the course of No. 1 vein. Intermediate adit, also along No. 1 vein, is 158 feet above the lowest one. Two easterly crosscuts from intermediate adit cut No. 2 vein, which is exposed in a drive along its course, a distance of 160 feet. Intermediate and lowest adits are connected by a rise which extends to surface. This rise follows a fault which heaves the veins at the lowest level. A drive, 70 feet in length, between lowest and intermediate levels, leads northward from the rise.

In addition a short, shallow-level adit, 89 feet above intermediate level, opens No. 1 vein for inspection. About 4 chains eastward is Simson adit, 70 feet in length, on a narrow vein of no importance.

A dyke of diabase or basalt, 2 feet wide, cuts through the veins in the northern part of the workings at all three levels. The dip of the dyke is northward, at a high angle, and the strike is a little north of east. Another basic dyke, 15 feet wide, is exposed along its course 30 feet in an adit driven in an easterly direction.

The suggestion has been made that the Moon ore-bodies could be attacked at greatest advantage from this part. The idea is economically unsound.

GENERAL REMARKS.

Although so much exploratory work has been performed, and though tests of small lots of the veinstuff have been made in a milling and concentrating plant, the average value of the crude material is not known. It is claimed that the result of the milling tests (0·45 per cent.) is representative of the material over a stoping width of 3 feet. That claim, however, cannot be upheld, because the two parcels were broken from two places over a few feet only. Assuming that the material treated was truly representative, it is doubtful whether at present market rates it could be mined, treated, and transported at a profit to operators. If, on the other hand, those works can be performed at such low rates as to allow of profitable operation, then it may be stated that sufficient stoping length is open to provide material at the rate of 100 tons per day for a long period. It is certain that to achieve the desired result the mine would have to be equipped with the latest labour-saving appliances.

Before a decision is arrived at a thorough testing of the veinstuff should be undertaken in order to determine the average content. Chip-sampling and channelling are unreliable methods, invariably giving a result much higher than the actual value. Since the foregoing remarks were written a cut into the footwall side of the vein, near the end of the lowest level, has revealed ore of excellent quality. The extent of the body has not been determined, but it is the intention of the company to continue the work of exploration from that point.

Another discovery of note is a large east-trending body of quartz, with coarse cassiterite, a little to the north of the present workings. Such quartz bodies, representing the latest phase of mineralisation, are unlikely to prove of any great economic importance, except where they intercept greisen veins and other quartz bodies.

RANSOM MINE.

Lessee: R. Young.
Leases: 9912-M and 9913-M, each of 40 acres, and Water-right 2541-W.

This is another of the many ore-bodies discovered during the early days of exploration and left undeveloped until recent time. Since the leasing of the ground by R. Young, of Hobart, active development has been carried on without intermission.

The leased ground is situate in the valley of Ransom River (an inconsiderable stream), about half a mile eastward of Lottah township.

From Lottah, in a north of east direction, a body of mica felspar pegmatite, similar in character to that of Victory Mine, leads to the Ransom, and forms the southern wall of the ore-body. The rock itself is hard and fresh and quite barren of ore. It is contained in the belt of alaskite that extends along Poimena-road for half a mile north of Lottah, and apparently is connected directly with the Anchor body.

An adit crosscut, bearing N. 50° W., has been driven 150 feet from the bank of the stream to intersect the tin-bearing stone, opened many years ago, in a prospect shaft 25 feet deep. This adit exposes 130 feet of soft white micro-pegmatite, with occasional nests and streaks of coarse mica-felspar-quartz pegmatite, then 20 feet of hard, barren, coarse pegmatite, planes in which course N. 45° W., and dip N.E. at 80°. The muscovite and oligoclase components of the coarse material are in large crystals, but the quartz is finer and inferior. An extension of 20 feet should expose the footwall of the ore-body.

In a crosscut trench above lower adit is exposed a dyke-like body similar in all essentials to that of Blue Tier plateau. There it courses N. 80° W., dips N. at 70°, and is about 20 feet in width. The remarkable change in direction (normal to that of Blue Tier) and dip is unaccountable at present, but further investigation may lead to a satisfactory explanation.

The dyke-rock consists of kaolin, with walls of pegmatite composed of very coarse pink felspar, including elliptical streaks of quartz, which in turn are crowded with vesicles. The long axes of the quartz inclusions lie parallel and in the direction of the flow. The kaolin of the body of the dyke is in places peppered with tin ore, and is stained with iron and manganese oxides. A sample of the white material was subjected to chemical analysis, with the following result:—

	Per Cent.
Silica	49·00
Ferrous oxide	0·30
Ferric oxide	0·64
Alumina	32·68
Tin oxide	Trace
Magnesia	0·14
Soda	2·79
Potassa	3·59
Ignition loss	11·94

The composition is almost identical with that of similar bodies at the Australia Mine, where they are rich in tin ore. It has not been traced westward past the trench, but it bears direct to the Anchor Mine, and east to the old Cable workings, where tin-bearing rock of similar nature is open on the bank of Laffer River.

About 20 feet east of the trench is the approach to upper adit. The approach bears N. 12° E., a distance of 30 feet to the shaft. In this cut is exposed coarse, barren pegmatite to 20 feet; then commences the dyke-rock, which here shows an incipient growth of secondary mica, after felspar, soft and unctuous to the feel. Through the dyke ramify veinlets of quartz-cassiterite, and cassiterite is disseminated also through the body of the rock. The drive from the end of the approach bears due north 23 feet to the hanging-wall of biotite granite, then N. 75° E., a distance of 28 feet, into that rock. The biotite granite is composed of large phenocrysts of quartz and smaller crystals of pink and white felspars, and biotite with a few small flakes of muscovite.

In the upper adit the typical tin-bearing rock consists of vitreous quartz, aggregates of secondary mica, pinite. and kaolinised pink and white felspars. Quartz is not present in some parts, is subordinate in others, and nowhere prominent. The rock, therefore, in bulk is composed of kaolinised felspars and aggregates of scaly mica, with a foot-wall exhibiting large crystals of felspar intergrown with, and encased in, large crystals of quartz.

Three bulk samples, taken by F. Blake, Assistant Government Geologist, of the tin-granite at the Ransom Upper workings consisted of:—

	No. 1.	No. 2.	No. 3.
Silica	59·80	59·00	58·40
Ferric oxide...	2·72	1·27	1·86
Ferrous oxide	1·40	0·64	1·40
Alumina...	25·11	27·74	26·81
Magnesia	0·88	0·59	1·00
Lime	Nil	Nil	Nil
Titania	0·40	Trace	0·40
Manganese oxide ...	Trace	—	Trace
Soda	0·98	0·10	2·30
Potassa	3·48	2·75	3·92
Tin oxide	—	—	Trace
Ignition loss	6·10	8·20	4·50

No. 1 sample is representative of the material exposed in the face of the open-cut; No. 2 is that white felspathic material exposed in the trench west of the shaft; No. 3 is a sample of the ore-body along the side of the shaft and into the adit.

The value of the ore-body as a whole has not been determined. Fine tin ore, in small proportion, is disseminated through the body, but the bulk of it appears to have been introduced after the consolidation of the rock, in the form of veinlets with quartz.

Cable workings are close to the south-east corner of Lease 9913-M. Here the sluicing of similar dyke-rock and overlying wash was productive of 20 tons of tin ore. The wash is composed largely of hard, fresh boulders of diabase, a dyke of which cuts through the ore-body.

If later developments warrant it the cable end is the most suitable place of attack. That is the lowest point.

and will allow of adit openings; and there is an adequate supply of water right at hand. Exploring work should be so designed as to serve that end.

The Perrenial Workings.

The discovery of a bonanza of tin ore here over 30 years ago led to the formation of a Hobart company for the purpose of opening a mine and working the ore-body. The engineer in charge of the work, as the following remarks will show, had little idea of mining. In consequence of ill-advised operations the company expended its capital without accomplishing any of its aims. The methods employed in mining, transporting, milling, and concentrating the crude tinstone were of the most primitive, and the several operations were performed upon such a small scale as to preclude any possibility of success.

The soft tinstone (consisting of quartz-mica-greisen, quartz-felspar-pinite, felspar-mica, and quartz-pinite) was conveyed along a roughly-formed tramway to a small Moody mill, about half a mile away. It was there crushed in the mill, and the coarser tin ore in the reduced material was then concentrated in sluice-boxes, and the finer tin ore on a vanner.

The operations of open-cutting and mining were performed by hand, the loaded trucks were pushed by boys to the mill, the material was raised and fed to the mill by hand, and the " streaming " of the tin ore also. In this connection it should be remembered that the tinstone at the first place opened was of such an extraordinarily high grade that the company thought the cost of the several operations was not disproportionate to its richness. However, as development proceeded it was found that the rich ore was of small extent and the bulk of the ore was of low grade and of irregular distribution. As a natural consequence the company ceased operating and disbanded.

At the place of opening the country rises very gently in a northerly and easterly direction, so gently that open-cutting above natural drainage level can be performed only to a shallow depth. In order to arrive at the rich body exposed in the original prospect shaft, at the deepest level, a long trench was cut in an easterly direction to the shaft. From that point the workings now extend 35 feet in length, 30 feet in width, and 15 feet in depth, exposing a large section of the ore-body for examination.

Cooper's shaft, at the south-west corner of the cut, is only 20 feet deep. Specimens of the tinstone from the shaft are of loosely compacted, sheared quartz-felspar-pinite, with a very little dark mica and some tin ore (cassiterite). The sheared stone is contained between two slickensides, 2 feet apart, the western or footwall one being the more pronounced. These slickensides are exposed along their course (N. 55° W.) and on their dip (north-easterly at 70°), and the encased stone at every point contains tin ore, but not in high proportion. The selvage of the slickensides is almost wholly of kaolin; and the wall-rock is the medium-grained granitic rock so common in this area, composed of quartz, felspars, dark mica, and a little pinite. Other parallel veins, containing more or less pinite and cassiterite, from 12 to 18 inches wide, are exposed towards the middle of the cut; near the eastern side is an ironstained quartz-mica greisen body, 24 inches wide, fairly rich in tin ore; and at the eastern side is a body like that on the western side, but not as rich. In the pinite stone the cassiterite (tin ore) is distributed in crystal individuals and in crystal aggregates, and is a primary accessory component of the containing rock. The normal rock is the fine to medium-grained biotite granite.

It is reported that 2 tons of concentrated tin ore was taken from Cooper's shaft. At the bottom (20 feet) of the shaft fairly high-grade ore remains, but not comparable in richness with that taken out. The actual value of the ore-body as determined by the work already performed is not on record.

At the time when the original company was in operation a party of miners endeavoured to intersect the southern extension of the rich shoot in the adjoining property, close to the entrance to the main workings. They cut, in their operations, a long trench (N. 25° W.) across the wall-rock, and containing rock of pinitised granite, and a short adit across veins of tin-bearing quartz-mica greisen; but no stone of extraordinary richness was exposed in either working.

North and south of main workings a number of trenches expose tin-bearing stone of average low grade. Tin ore in fair proportion is found in the detritus and in the subsoil along the course of the ore-body. From the north branch of Perennial Creek rich concentrations of tin ore were sluiced and removed by T. Mundy many years ago. That occurrence shows that the tin-bearing stone extends to that part of the area.

Lease 10257-m, of 20 Acres.

Within the boundaries of this lease prospector T. Mundy has unearthed a body of mica greisen and quartz about 30 feet wide. It courses N. 55° W., and is exposed in trenches a distance of 10 chains, trending along the east flank of McGough's Lookout. In the mica greisen tin ore is abundant, but the quartz is almost barren. It is of the vein-dyke type, and represents the latest phase of the tin-granite in which it is contained, and therefore is not likely to be an important tin-ore carrier. The mica greisen is narrow, 12 to 14 inches, irregular, and carried tin ore in coarse crystal aggregates.

Although the quartz of the ore-body is barren the mica greisen part is richer than the average grade of stone. From the east fall of McGough's Lookout a number of very small streams lead to the broad valley floor of Cotton Creek. That valley is floored with tin-bearing gravels derived by way of aforesaid streams from the extension of this ore-body.

If the ore-body prove of value it can be attacked from the valley of Cotton Creek to great advantage. The prospect is such as to justify further investigation.

The Mount Michael Tin Mining Company No Liability.

Tin ore was discovered here by R. Beale 30 years ago, and a shallow prospect shaft was sunk by him to test the value of the stone at that point. In later years the detritus of the ore-body was sluiced for its content of tin ore by George Briggs, of St. Helens. The denudation of the ore-body led to an investigation by T. Mundy and H. Lawry, who continued the work of development. The results were satisfactory to H. Lawry, and he decided to form a company in Melbourne for the provision of the requisite capital for opening and equipping a mine. In 1924 the Michael Tin Mining Company was organised for the purpose, and operations have been carried on without intermission since that time. Although it cannot be claimed that the work has been productive of good business results, developments have certainly enhanced the value of the properties, and the company is now in a position to arrive at a fair assessment of its prospective value. The mining, milling, and concentrating operations may be regarded as a large-scale sampling of the deposit at the mine opening, but not, of course, of the body as a whole.

The company, having accomplished so much, is now desirous of finding whether the application of other means and methods will prove more successful.

The holdings of the company consist of:—Mineral Lease 9152-M, of 20 acres, the south-east corner of which is on the summit of Mount Michael; Tramway Right 2331-W, Machinery Site 9269-M, of 5 acres, on the north bank of Wyniford River; and Water-right 2325-W.

The mine lies between Mount Michael and Little Mount Michael, about 2 miles north of Poimena. A road connects the mine with Poimena and the main thoroughfares.

PRODUCTION.

The records of production in detail are not available. About 60 tons of stone is broken, milled, and treated daily, the average grade being 0·4 per cent. To date the value of the output is £17,000.

THE ORE-BODY.

Bearing in mind that this is an extension of the Mount Marie-Southern Cross line it is incomprehensible to find that no sustained attempt has been made to unearth it at other points. No essential difference is noticeable in the composition of the tin-granite of these properties, therefore the probability is that other commercially important leases exist in the intervening country. The tin-granite north of Wyniford River opens out widely into a large outcropping belt enclosing the two peaks and extending at its full width beyond McGough's Lookout.

The tin-granite exhibits all phases and stages of alteration. Pinite is highly developed, topaz is abundant in some parts and is everywhere present, secondary micas are conspicuous, fluorspar and malachite coat cleavage joints, and secondary silica is noticeable. All these secondary minerals clearly indicate the nature of the processes of change and the causes of the deposition of tin ore. In the open-cut the green hue of the tin-granite is due to pinite and talc. Where these minerals are abundant tin ore is plentiful. Contained in that rock are shoots of white, very fine quartz and topaz, and felspar peppered with tin ore of equal grain-size. This rock, so rich in tin ore, is very friable, and disintegrates under pressure of the fingers. Probably the fractures it fills mark the channels of solutions responsible for the mineralisation. Here, as pegmatite band does not appear above the ore-body—in fact, the original cover-rock was tin-granite, but poor—the ordinary processes of greisenisation are not in evidence. Mineralisers did not spread equally in all directions, but ramified along joints in the hot, but consolidated, rock, attacking here and there as the opportunity offered.

At Mount Michael, from foot to summit, weathering along horizontal lines (geoisotherms) is a striking feature. As the summit is approached, where the effects of weathering are more pronounced, large lenticular blocks of the tin-granite lie one upon another, leaving large open spaces below and above the lines of abutment. At the mine the horizontal planes are only 6 to 10 feet apart; close vertical jointing in conjunction with the horizontal jointing has produced a tesselated effect at surface.

MINING AND HAULAGE.

The open-cut method of mining is in operation, but in one bench only. The country is almost flat, and a bench lower than 20 feet would be below drainage level. In the processes of breaking and removing the stone an opening has been made 300 feet in diameter and 20 feet deep. The outline is irregular because the richest portions only have been broken. The rock, being of medium grain and partly decomposed, is easily bored; and because of block-jointing across geoisothermic lines it breaks readily. All the works of excavation and filling into trucks are performed by hand.

The broken material is conveyed to the mill along a 2-foot gauge steel-rail tramway. Six trucks to a rake are drawn by one horse, and at least 10 journeys are made per day of eight hours.

Six men are employed at mining and one at hauling.

MILLING AND CONCENTRATION.

The mine is equipped with a battery of 15 heads of stampers, of which 10 only are in operation. Three concentrating tables are in position, but two only are in use. This plant is milling and treating between 60 and 70 tons of stone per day.

The process is as follows:—

From the storage-bin the stone is passed through a jaw-crusher to the battery floor, from which it is shovelled into the mortar-boxes of the battery. The crushed material is passed, unclassified, direct to the concentrating tables, from which two grades of concentrate are separated.

The loss in any modern plant is not less than 10 per cent.; in this the amount of loss must be very high.

First it should be noted that the amounts of feed and feed-water are beyond the capacity of the concentrator; then that sizing of the pulverised material is not attempted. The tin ore in the concentrate is separated from included waste by hand sluicing.

The plant may be described as of the most crude. It is driven by a suction gas-engine, in which wood is used as fuel.

SUMMARY RESULTS.

The company has revealed a large section of tin-bearing stone of low grade. The body is a part of that exposed at many points from one end of the Tier to the other. The ore in bulk is of low grade, but the material can be mined and milled at very low cost with the use of modern machinery and the application of modern methods. Very little profit can be expected under existing conditions, but the work is valuable in arriving at an idea of the nature of the tinstone, its width and extent. If it is desired to do more than explore the ore-body in the near future, the present plant should be scrapped and a modern one erected. (In passing, it may be stated that stamper batteries are most inefficient milling machines, and are now going out of use, and later concentrating machinery is displacing that in use by the company.)

A body of such dimensions and low grade should be worked on a 1000-tons-a-day scale to get the greatest commercial success. An amalgamation of interests with neighbouring companies would be the first step on the way to that resumption. However, the work being performed is of considerable importance considered as a demonstration of the value of the ore.

The company cannot look forward to an improvement in the quality of the ore. No bonanzas of any great extent need be looked for. Everywhere along this belt the grade of the ore is low as compared with that of veins.

The develpoment work should be continued.

HALEY'S TEN-ACRE LEASE, 10097-M.

The surficial deposits on this property were sluiced of their tin ore about 30 years ago by local miners, some of whom are still resident in the district. In later years the Mount Lyell Company trenched and sampled the tin-bearing rock at regular intervals, and a few pits were sunk to test the extent of the richer veins.

The containing rock is a fine to medium-grained aplite, consisting essentially of orthoclase, muscovite, and quartz of equal proportions and equal dimensions. Owing to the complete kaolinisation of the orthoclase component the rock is now very soft and of a milk-white colour. It is quite different from the adjacent biotite-pinite granite of medium texture which constitutes the bulk of the belt of tin-bearing rock, and it is of slightly later formation, but is not affected by the agents of greisenisation.

A number of dish prospects of the aplite, taken from the banks along the course of the creek, revealed an even distribution of tin ore of fine grain-size, with occasional richer veinlets and pockets of coarser grain. Care was taken in these rough tests to exclude all surficial material, therefore the results may be accepted as indications of the tin-ore contents at those places. The stone appears to be of average grade—0·25 per cent. tin ore.

The width of the body has not been determined, but it is at least 50 feet; its continuous length likewise is unknown. Similar rock has been unearthed at intervals along the course of the body, a distance of 20 chains in a northerly direction, and southward towards the Perennial.

Aside from the surficial deposits, which consist of kaolin and large to small stones of angular barren quartz, the only openings are a few shallow pits and trenches. One such pit sunk near the side of the creek exposes a rich vein of tinstone to 12 feet; another, about a chain to the west, is 20 feet deep on similar stone, but of lower quality. The valley floor of the stream has been sluiced to the watershed. Prospecting, however, has not been carried into the hills.

A great amount of development work is necessary to determine the actual extent and value of the aplite body as a whole. It is not rich, but it is extensive, and is worthy of a thorough investigation.

P. Haley's Five-Acre Lease.

The ground held under this lease lies a little to the north of the 10-acre block. It is occupied by rock of quite different texture, the more common type being a fine-grained porphyry, consisting of phenocrysts of quartz set in a groundmass of quartz, felspar, and muscovite. Apparently it is a variant of the more common aplitic type of tin-granite.

Just inside the north boundary are a pit, 15 feet deep, and a borehole sunk by the Mount Lyell Mining and Railway Company in 1907. All the material taken out of the pit was sledged to a nearby dam and sluiced. No record is available of the results of these works.

A few paddocks of ground have been sluiced of the detritus cover.

The ironstained detrital material is fairly rich in tin ore, but is of shallow depth.

No idea can be formed of the average tin content of this rock; as in other parts, it likely is confined to a definite line on belt, and along that belt is alternately rich and poor.

WYNIFORD RIVER TIN MINING COMPANY.

This is a Melbourne company formed a few years ago to equip and work alluvial ground in a section of Wyniford River and tributaries. A considerable sum of money has been spent in providing for equipment sufficient for deposits of much greater extent than those occurring here. It is doubtful, on the information at hand, whether such a large outlay was justifiable. The deposits are very shallow, very narrow, not of great length, and apparently not of extraordinary richness. Their value has been determined in small parts only, and there the material is not above the average grade.

The mine is equipped with blower and nozzle and long pipe lines, which convey the water-supply from races leading from reservoirs. Lately two of the reservoirs broke down, and their renewal delayed the work of sluicing many weeks.

SITUATION AND AREA.

The properties of the company lie in the valley of Wyniford River, about 2 miles west of Poimena, Blue Tier. They are connected by a road, constructed by the company, to the Blue Tier road, and are thus easily accessible.

The company holds the following lots under lease from the Crown:—

679-DC, of 19 acres;
669-DC, of 10 acres;
752-DC, of 20 acres;
9700M, of 8 acres; } H. C. Lawry.
9701-M, of 5 acres; }
10113-M, of 2 acres;
753-DC—H. C. Lawry.

And Water-rights—

2496-w }
2927-w } H. C. Lawry.
1495-w }

Velocipede Creek, a small tributary of Wyniford River flowing from Kent Hill, exposes 3 feet of peat-covered wash resting upon soft biotite granite. The banks, 20 feet on both sides, have been sluiced from the confluence of the creek and Wyniford River to a point half a mile upstream. The tin ore in the wash is coarsely crystallised, and is associated with zircon and pleonaste. Specimens of cassiterite-quartz vein-matter and greisen are abundant, and occasional specimens of tin-bearing quartz-tourmaline are found with very large crystals of smoky quartz. The sluiced wash contained tin ore in profitable proportion, and as much remains to be worked, probably of equal value. Apparently the whole of the tin ore in these shallow deposits has been shed from quartz and greisen veins in Kent Hill.

Blue River (upper Wyniford River) flats, which were very rich, have been worked over three times. The deposits were 3 to 10 feet deep, about 3 chains wide, and half a mile long. A deep bed of tailing discharged from the Mount Michael Company's milling plant now covers the whole area.

Macmichael Creek has been worked from its confluence with Wyniford River to a point a mile upstream. Except near its debouchure into the Wyniford River valley, the stream, although rich, was very narrow, and the deposit on its bed and banks was soon sluiced of its tin ore. At the point of confluence the company is now working 3 to 4 feet of shallow ground by means of a nozzle and a blower. The bottom wash is rich in tin ore, which here is invariably accompanied by zircon and pleonaste.

Higher up the Wyniford River the alluvial beds are reported to be deeper, but they are covered with 10 feet of tailing. The average width is not more than 2 chains.

Lot 9700-M, of 8 acres, appears to offer better prospects, because there Camp Creek joints the Wyniford, and apparently this section is still occupied by unsluiced ground. Accurate information regarding this deposit is so meagre that estimates cannot be made of its value.

The ground held by the company contains deposits suitable for small parties of miners, but they do not warrant heavy outlay in plant.

Lottie Chintoch Prospect.

Lease 9489-M, *of* 5 *Acres*.

This prospect lies in the western part of the area, close to the Kent Mine. The ore-body was unearthed by W.

Chintoch five years ago when engaged in sluicing the porphyritic granite waste for tin ore. Shortly after the discovery an option of purchase was let to J. Northey, who, on behalf of a Melbourne syndicate, sank a shaft 40 feet deep into the only place of outcrop, and from the bottom of the shaft cut across the body east and west 16 feet. It is claimed by the lessee that the ore-body trends a little west of north, but no trace of it appears at surface in that direction, nor, for that matter, does it outcrop anywhere else.

About 12 chains west of north of Chintoch's is the Kent Mine. Whether the two are in any way connected is not known, but it is thought by some that they are related. No opening, except the shaft, is made, and that is inaccessible.

THE ORE-BODY.

The tinstone, contained in porphyritic granite, consists of quartz and mica greisen; original felspars are converted into pinite and secondary white mica and replaced with quartz and cassiterite. Openings are marked by lines of crystallised quartz and cassiterite in the forms of geodes, and elsewhere exhibiting comb structure. Much of the stone is cellular, and is deeply stained with oxide of iron, suggesting an original repository for chalcopyrite. Secondary mica and quartz in fine crystal aggregates after felspars are features of the tin-bearing stone. Cassiterite extends into the granite wall-rock.

A dyke of diabase, well exposed in the bed of Wyniford River, at the left arm of a sharp bend a few chains east of the Pioneer dam site, passes in a south-westerly direction a little to the north of the workings. This dyke-rock has no bearing at all upon the formation of the lodes.

DEVELOPMENTS, PRESENT AND FUTURE.

The only productive development work is the 40-foot shaft sunk at the only place of outcrop. That work is insufficient to allow of a determination of the structure of the ore-body, whether it is of vein-dyke or of pipe form. Although it is contended that the ore-body trends north-westward no attempt has been made to intersect its supposed extension. Two shallow trenches have been cut north of the shaft, but without good result. One exposes the diabase dyke. This unexplained occurrence probably deterred the prospectors from further effort at that point, and discouraged them from extending the field of exploration in a northerly direction.

The ore in the dump at the shaft is of 1 to 2 per cent. tin grade, and if that can be accepted as a fair sample of the whole the prospect is worthy of further attention.

THE KENT ORE-BODY.

At the extreme western side of this area is a large body of tin-granite exactly similar in character to that of the Anchor and others in that neighbourhood. The surficial material was stripped from the solid rock and sluiced in 1889. Tin ore was found in the bedrock, and a few shallow holes were cut into it where the ore appeared in greatest proportion. In places the stone is heavily impregnated, but as a whole the rock is poor. The richer material apparently follows definite lines of jointing.

No effective work has been done since the early days of the field, although the presence of a 10-head battery there suggests that another futile attempt was at one time about to be undertaken.

This is another of the many large but poor bodies of tinstone which have shed the rich alluvial accumulations in every valley of this district. Its actual value is not known.

About 20 chains along the track towards Blue Tier is another body of pinitised granite veined with mica greisen. This has not been opened.

These bodies, and the Pedestal rocks south of them, exhibit horizontal jointing marking successive geoisotherms. The structure therefore is exactly similar to that of Blue Tier.

CHAPTER VII.—SOURCES OF PRODUCTION, MARKETS, AND UTILISATION OF TIN.

Almost all of the world's tin is fabricated and consumed in the United States of America and Europe. It has been estimated that during the next few years the annual tin consumption of the United States will amount to 70,000 tons of new metal out of an estimated world production of 125,000 tons. The balance of 55,000 tons will practically be consumed in Europe. The United States, therefore, will consume 60 per cent. of the world's tin, and Europe will use the rest.

Assuming a world production of 125,000 tons, it is likely to be derived as follows:—

	Tons.
Malaya	37,000
Bolivia	33,000
Dutch East Indies	24,000
China	9,000
Siam	7,000
Nigeria	6,000
Australia	4,000
Cornwall	2,000
India	1,500
South and South-West Africa	1,500

From the foregoing it is seen that the bulk of the tin is used by the highly industrialised countries of Europe and America, and conversely the bulk of the tin ore is produced in countries in which manufacture is comparatively low in the industrial scale.

The output estimated for Australia may be regarded in some quarters as high, but a considerable increase is anticipated, especially from Tasmanian sources. The production of Australia in 1925 was 2072 tons, of which the State of Tasmania contributed 1130 tons, or 54·5 per cent. Calculated in terms of world production Tasmania now contributes about 1 per cent., a not insignificant proportion.

The estimated tonnage (125,000) of tin to be used may be apportioned among the various industries approximately as follows:—

	Tons.
Tin and terne plate	48,600
Solder, babbitt, and bearing metals	41,600
Brass and bronze	8,300
Foil	6,800
Collapsible tubes	4,200
White metal	2,700
Miscellaneous	12,800

CHAPTER VIII.—THE PRICE OF TIN.

The economic history of tin is replete with records of sensational, and apparently irrational, price fluctuations, such as the recent market fall of £50 per ton. It is true that during 1927 the world consumption of tin was a little under normal owing to a reduction in the requirements of America, but an increase in production was not recorded despite a sensible expansion of dredging output, and at the end of the year the visible supply was not much greater than at the end of 1926.

The statistical position to-day is probably sounder than it has ever been, for notwithstanding the smaller American requirements the world consumption of tin during 1927 exceeded production, and supplies are to-day insufficient to meet the demand. The fall in price is accountable to speculative manipulators.

As regards the true outlook for tin-mining the following notes (8) may prove of interest:—

Dredge production in the East is increasing, and during the next three or four years is likely to show a greater progressive increase, but the production of tin from other alluvial mines is declining at a greater rate. About 25 years ago the whole of the output of the East was obtained from the easily accessible alluvial and eluvial deposits by sluicing, gravel-pumping, and similar processes; to-day dredges account for 30 per cent. of the output. The expansion of dredging compensates at the present time for the decline in sluicing and other processes, but every year brings to an end a dredging area at one time an important source of tin ore. There are in every part unmistakable indications that, unless the price of tin rises to and is sustained at a high level, Malaya during the next decade must fall from her high estate as the most important source of supply.

Of the other producing countries Bolivia and Dutch East Indies are pre-eminent, but no expansion can be looked for there.

In fact, a progressive decline is inevitable. The output of Africa, now gradually increasing, compensates a little for the lower production of other countries, and a more considerable increase may be expected from the west and south-west States in the early future.

---

(8) "The Industrial Australian and Mining Standard," 16th February, 1928.

Returning to the consideration of tin-mining in the East, it is common knowledge that few of the remaining sluicing companies can operate at a profit with the price of tin at less than £245 per ton. On the contrary most dredging claims can be operated profitably at that figure, and the suspension of work on the sluicing claims and the resultant reduction in total output is in consequence an advantage to the dredger.

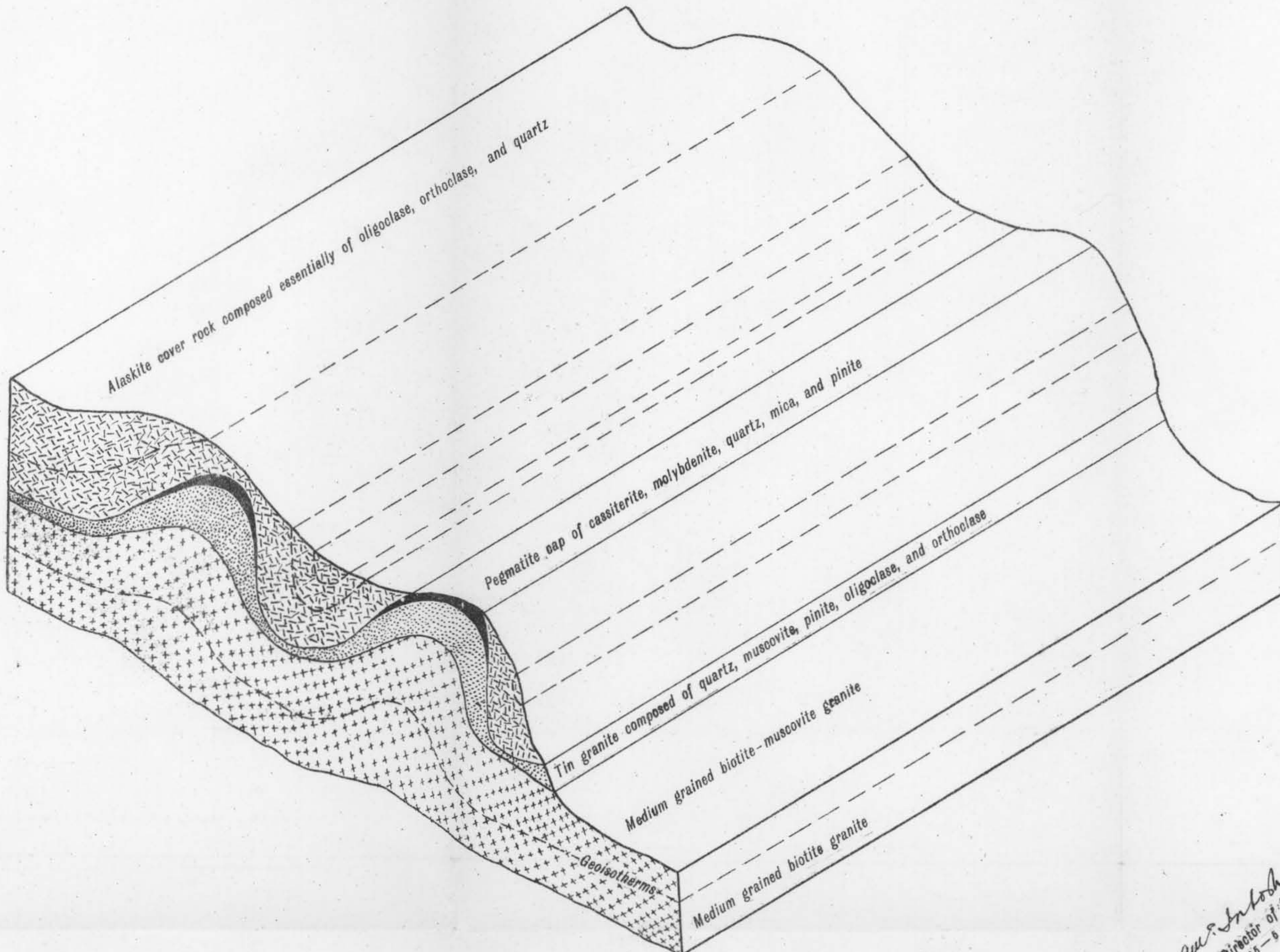
In the world to-day there is neither a visible surplus of tin nor a deficiency. The visible supply, including stocks in transit, is sufficient for requirements for six weeks only, yet shipments are so regulated that no dislocation of industry results. It may be affirmed that an actual increase of several thousand tons during 1928 is necessary to ensure the replenishment of stocks, which have been so greatly depleted during the past five years.

A. McINTOSH REID, Director of Mines.
Q. J. HENDERSON, Cadet Geologist.

29th May, 1928.

DIAGRAMMATIC SKETCH ILLUSTRATING THE ANCHOR TYPE OF ORE DEPOSIT

Q.J.H.



A. McIntosh Reid
Director of Mines
25—6—28

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GSB38

PLATE III

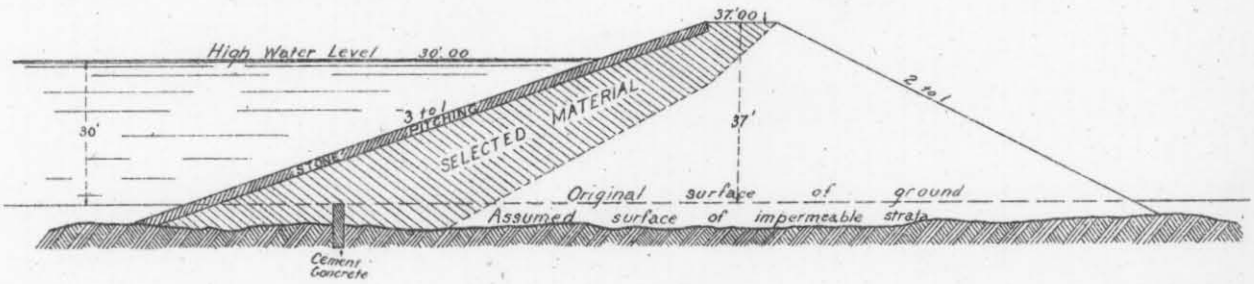
Sun Flat Reservoir

EARTH EMBANKMENT

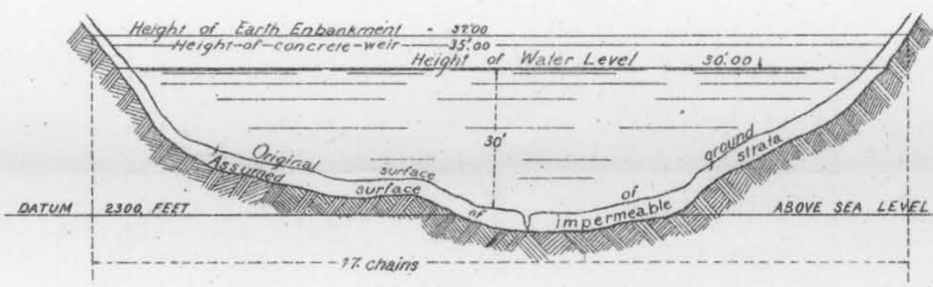
Q.J.H.

SCALE *Horizontal and Vertical 1 inch - 20 feet.*

CROSS SECTION



WEIR SITE



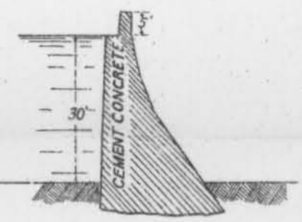
SCALES

Horizontal 1 in - 2 chains

Vertical 1 in - 20 feet

WEIR

CROSS SECTION

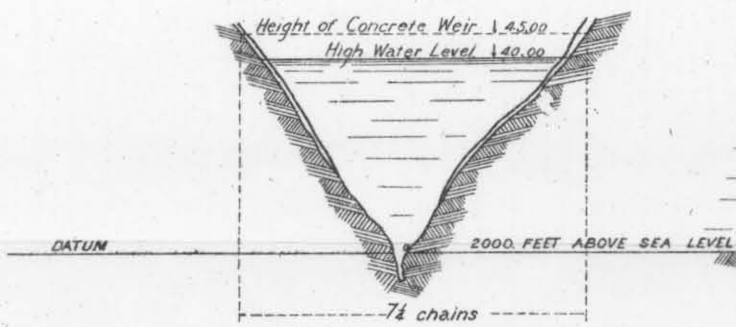


SCALE

Horizontal and Vertical 1 in - 20 feet

Compensation Reservoir

WEIR SITE



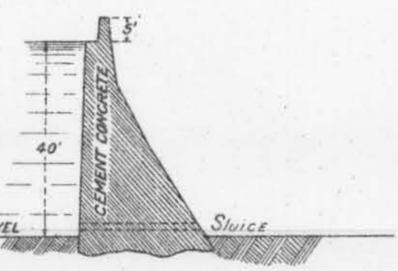
SCALES

Horizontal 1 inch - 2 chains

Vertical 1 inch - 20 feet

WEIR

CROSS SECTION



SCALE

Horizontal and Vertical 1 in - 20 feet.

Director of Mines 25th May 1929

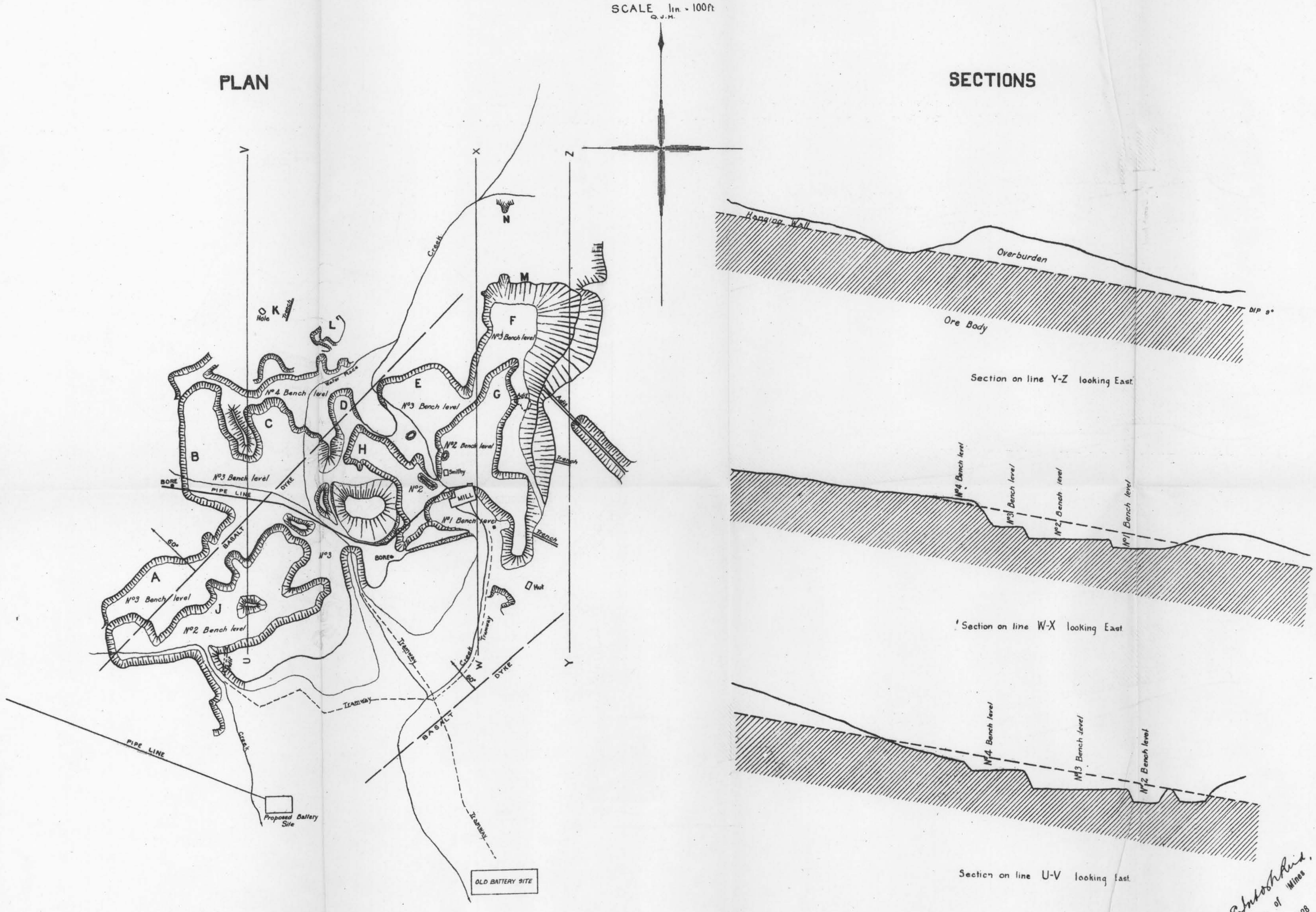
After Rahbek

JOHN VAIL, Government Printer, Hobart, Tasmania

BLUE TIER TIN MINES N.L.

OPEN CUT WORKINGS

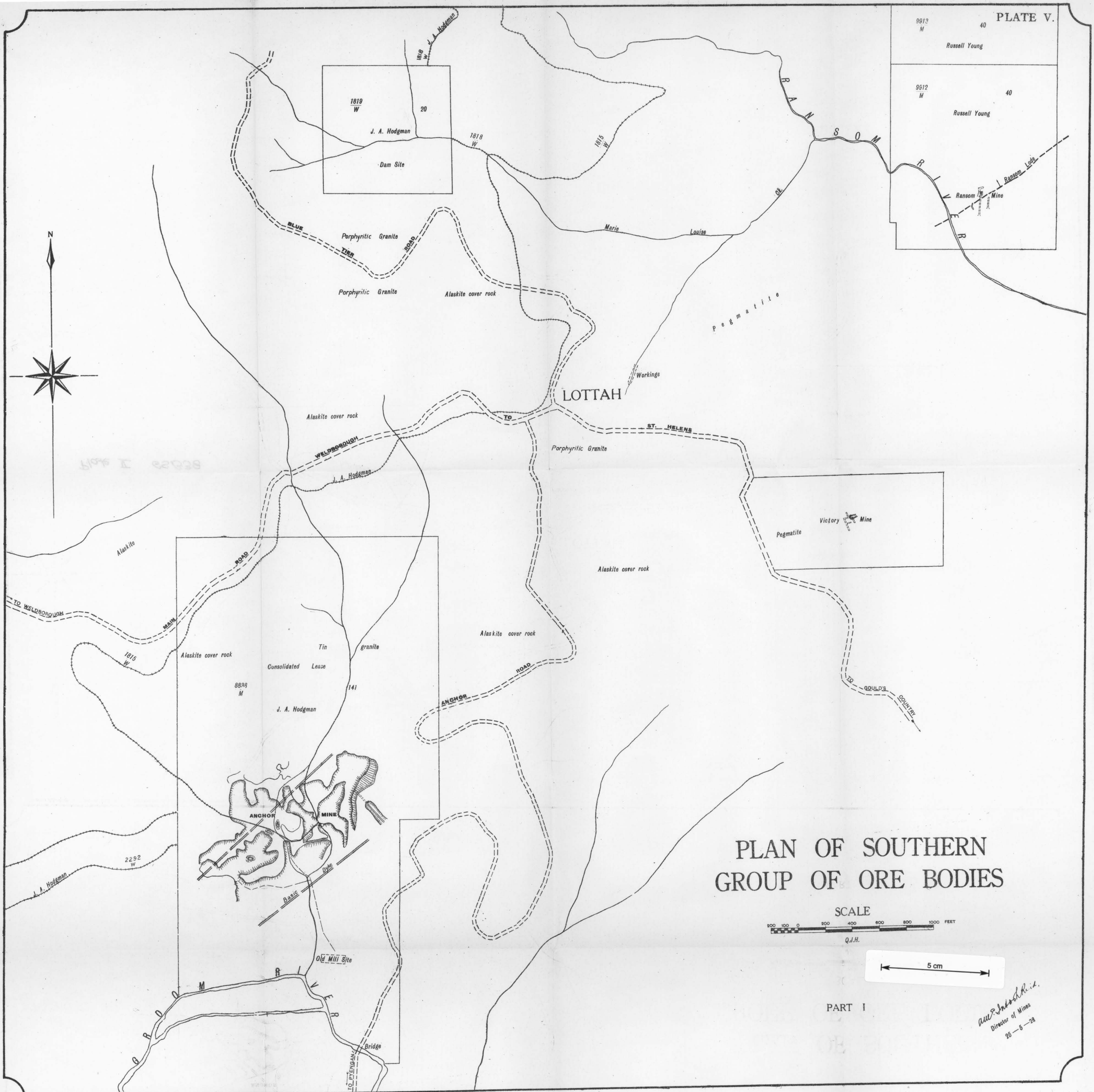
SCALE 1in. = 100ft



A. McIntosh Reid. Director of Mines 25-5-28

Photo Algraphed by JOHN VAIL, Government Printer, Hobart, Tasmania

PLATE V.



PLAN OF SOUTHERN GROUP OF ORE BODIES

SCALE

200 100 0 200 400 600 800 1000 FEET

Q.J.H.

PART I

A. McIntosh Reid
Director of Mines
25—5—38

Photo Algraphed by JOHN VAIL, Government Printer, Hobart, Tasmania

PLATE VI.

PLAN OF SOUTHERN GROUP OF ORE BODIES

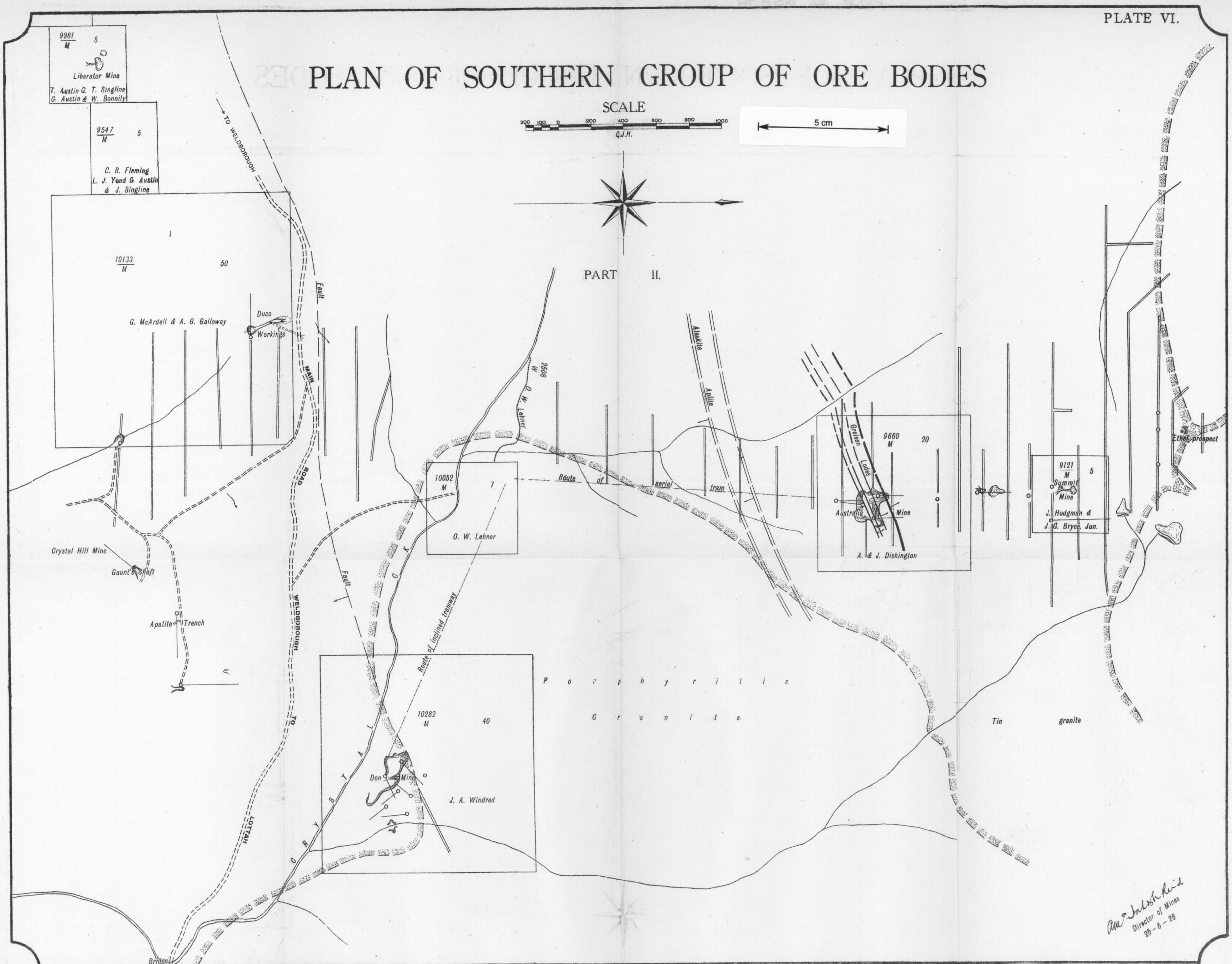
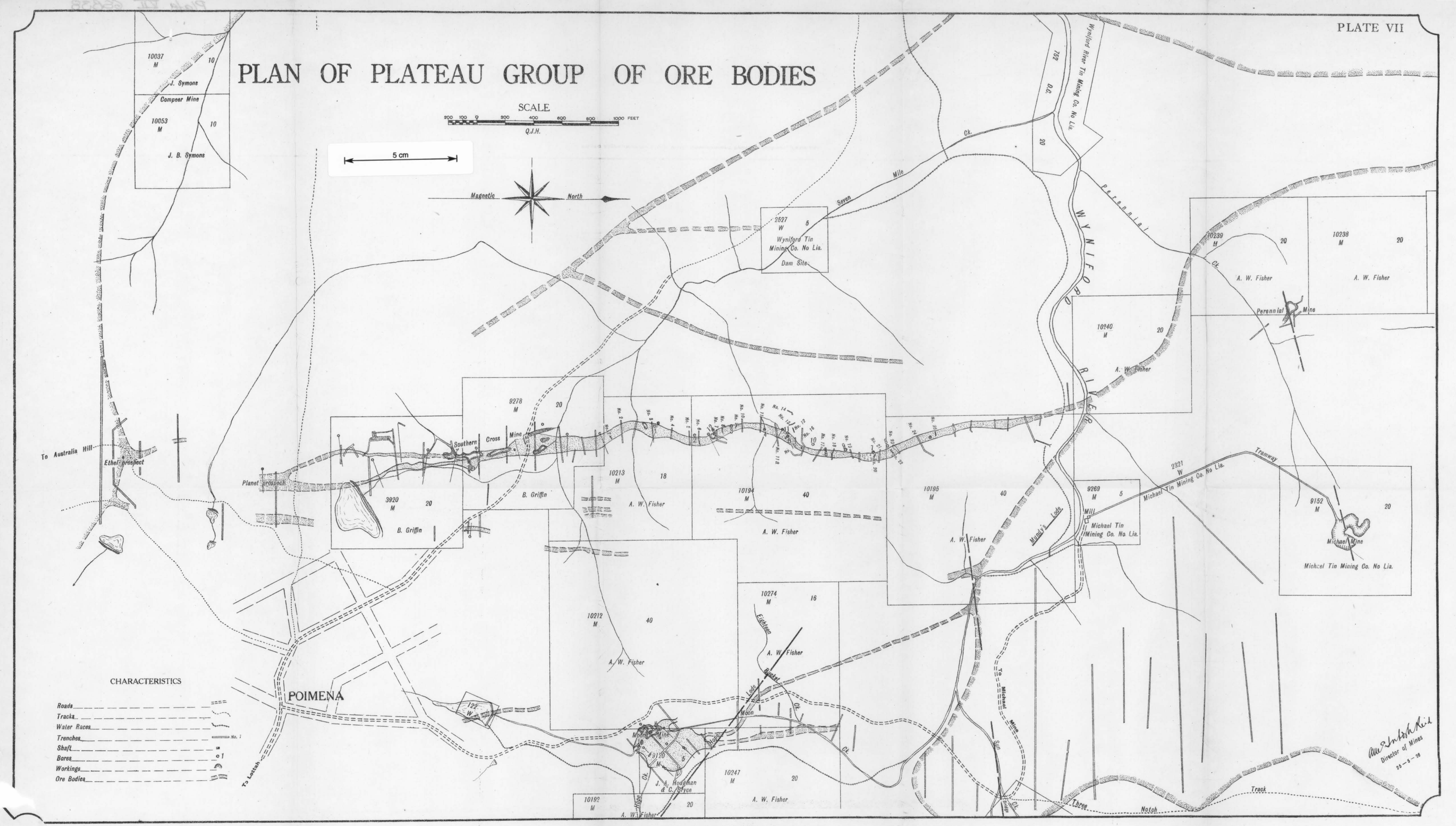


Photo Algraphed by JOHN VAIL, Government Printer, Hobart, Tasmania

PLAN OF PLATEAU GROUP OF ORE BODIES



Alex. McIntosh Reid
Director of Mines
23-5-28

Photo Algraphed by JOHN VAIL, Government Printer, Hobart, Tasmania

PLATE VIII
GS838

PLATE VIII.

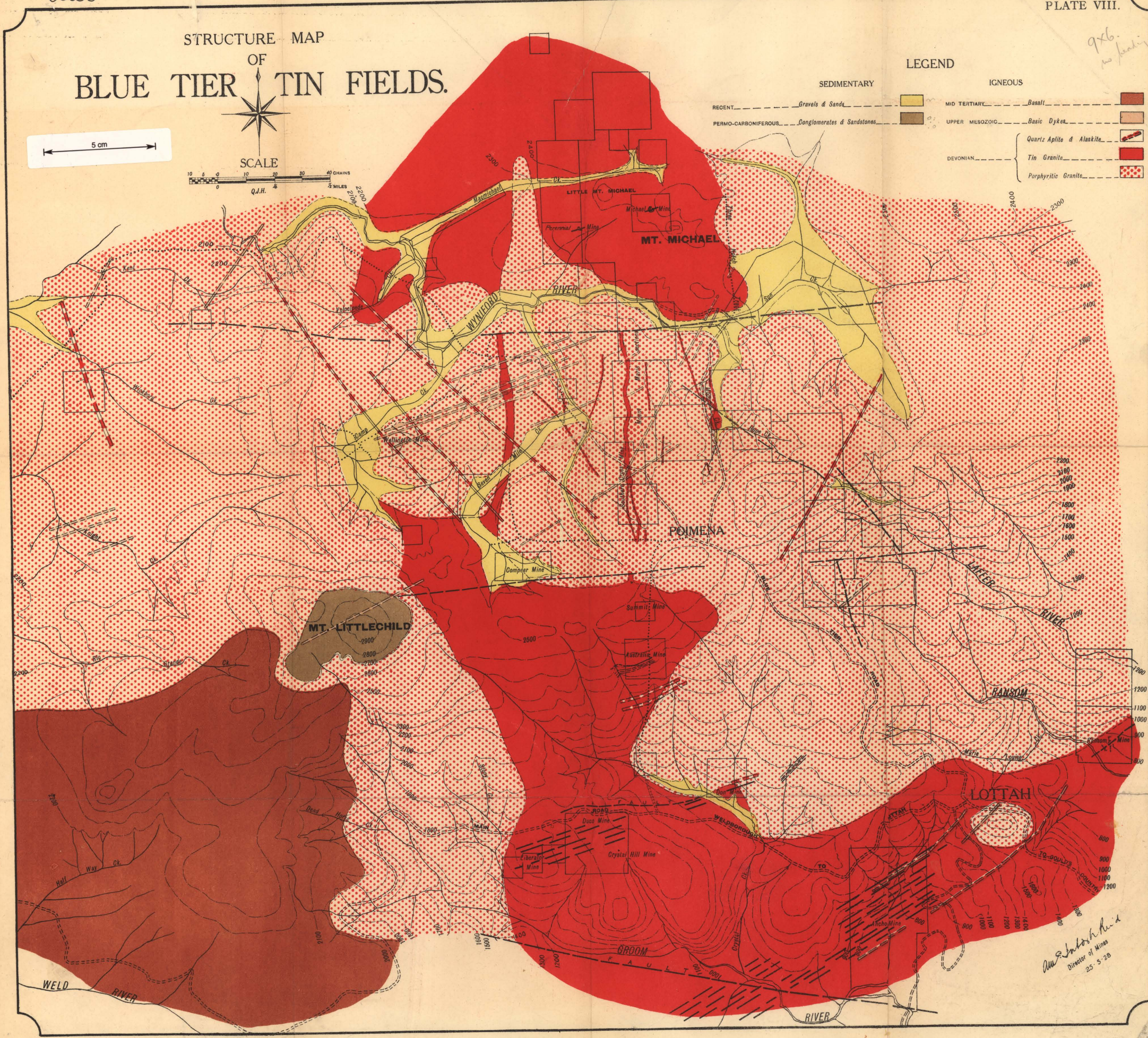


Photo Algraphed by JOHN VAIL, Government Printer, Hobart, Tasmania

PLATE IX.

GEOLOGICAL SKETCH MAP OF BLUE TIER TIN FIELDS.

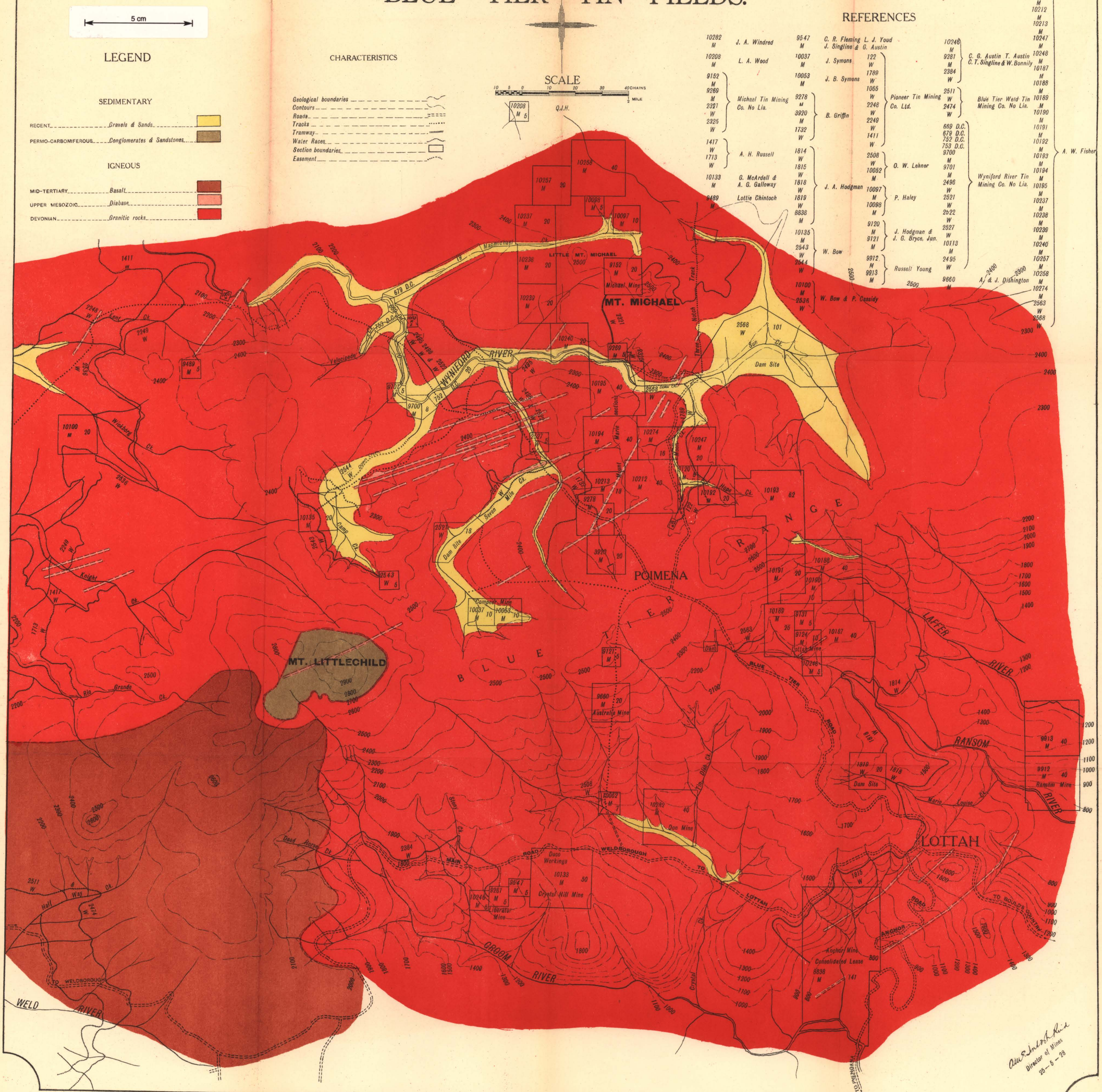


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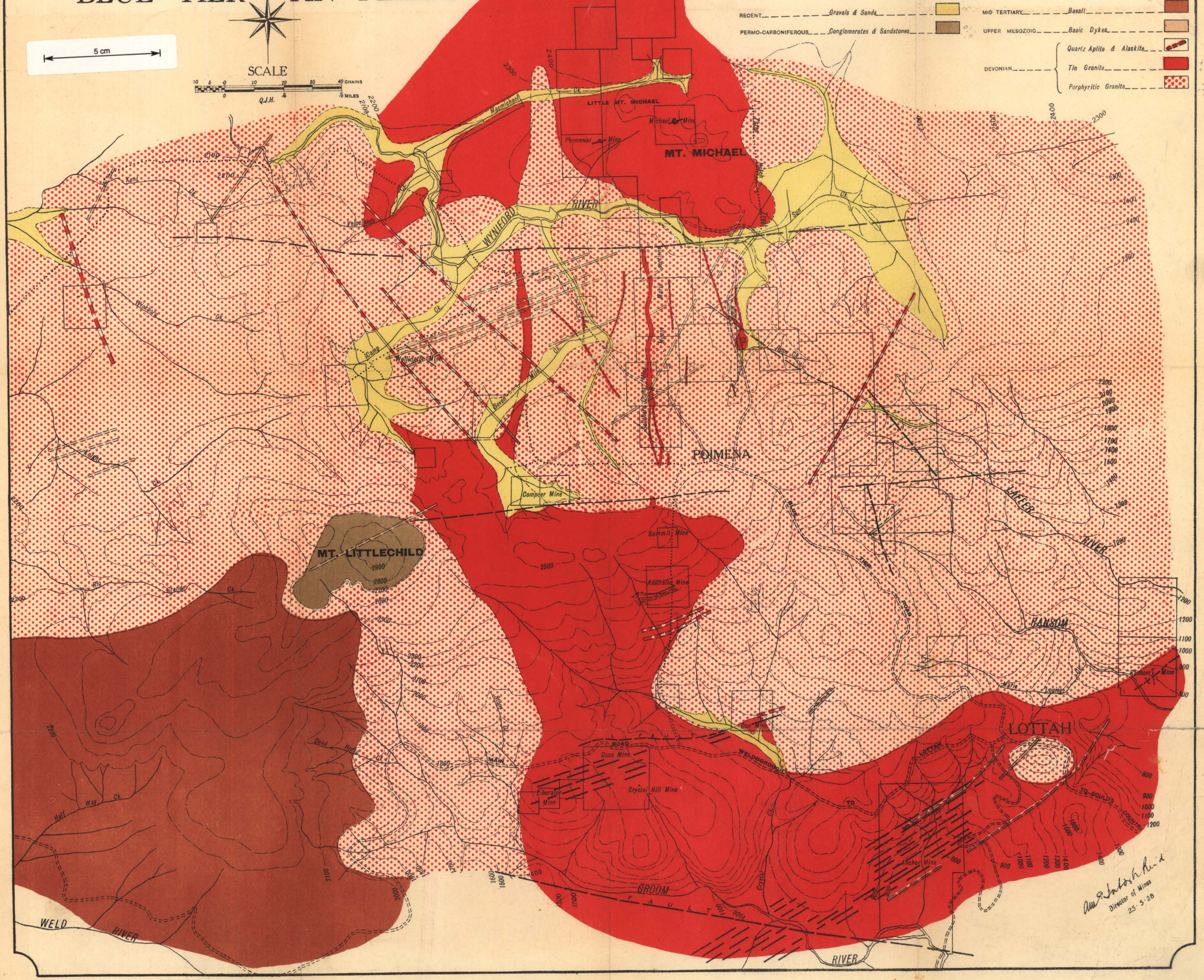
PLATE VIII
GS838

STRUCTURE MAP OF BLUE TIER TIN FIELDS.



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