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THE MOUNT FARRELL MINING FIELD

BY

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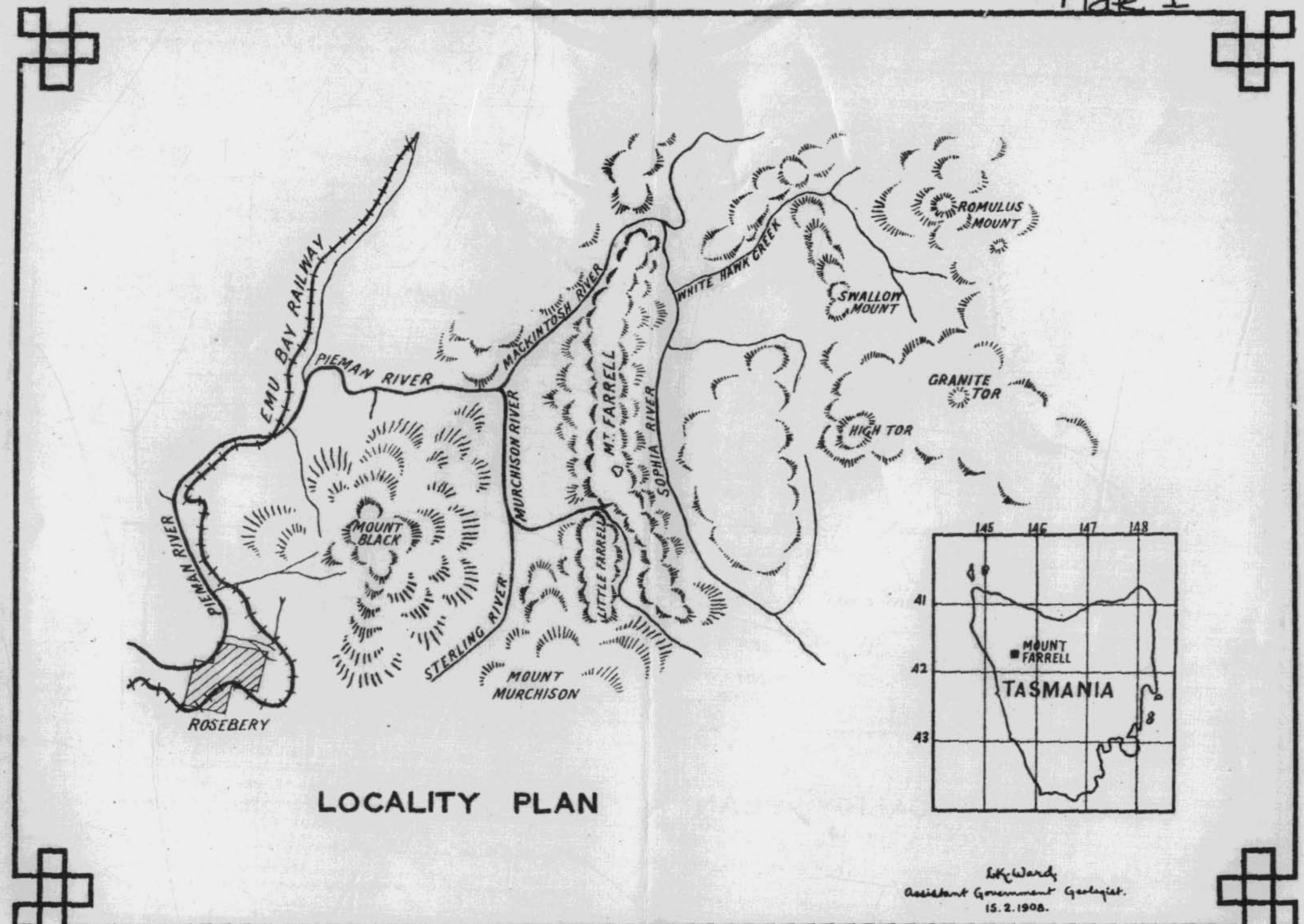
Plate I



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I.—INTRODUCTION.

(1)—General.

In the Mt. Farrell mining district, with which this bulletin deals, the writer has been allotted, for purposes of geological examination, a field which has recently attracted no little public interest.

The district can hardly be said to be a new one. It is rather a field to which the prospector has returned with fresh vigour.

The North Mt. Farrell Mine has been exploited with ever-increasing energy, and its output has been materially increased within the last few months. The faith thus expressed in the future of that property has done much towards the general expansion of the mining industry throughout the district.

The favourable condition of the metal market during the year 1907 also materially aided the work of prospecting; and, as a result, during the early months of 1907 there were floated two new propositions on the southern side of the Murchison River, viz., the Tullah and Thomas' Blocks; also, the first-discovered silver-lead mine of the district, T. H. Farrell's old reward claim, was reopened under the name of the White Hawk.

Besides these properties, which are being actively prospected, there have also been discovered other occurrences of ore at both the northern and southern ends of the field. The future of these latter discoveries will depend very largely on the success of the present prospecting operations.

During my visit to the field two fresh finds were made; and this fact serves to indicate that the district is still receiving the active attention of prospectors.

The position of Mt. Farrell—at the northern end of a series of districts notable for their mineral wealth—is also such that additional interest is attached to its geological examination.

The attempt has been made to define the features common to these several districts, so that they may serve as an indication that, where they recur, prospecting work may reasonably be expected to meet with reward; and this portion of the results of a geological examination must be that which is of more permanent value and wider interest. Special attention has therefore been given to the genesis of the lodes, the general types to which they conform, and their relation to the rock-formations of the district.

(2)—Geographical Position.

Mt. Farrell is situated at the point where the Murchison and Mackintosh Rivers unite to form the Pieman River. The latter finds its outlet to the ocean on the western coast of the island.

Measured in a direct line, the mining field is 35 miles from the coast-line, and it is about 4 miles east of the Emu Bay Railway line.

Mt. Farrell is situated north and a few points eastward of the main West Coast range, of which the culminating peaks are known as Mts. Darwin, Jukes, Huxley, Owen, Lyell, Sedgewick, Tyndall, Read, and Murchison.

The metalliferous belt of the western coast is found to follow closely the trend of the mountain range. The mining fields have therefore a meridional trend; and Mt. Farrell is the most northerly of a series of districts in which copper, gold, silver-lead, and zinc are represented by their several ores. From its geographical position, therefore, the district of Mt. Farrell demands considerable attention.

The only means of communication at present is by the Emu Bay Railway line. A horse tramway connects with the railway at a point 21 miles south of Guildford Junction. However, there is now in course of construction a steam tramway, which, when completed, will materially shorten the present route to the Emu Bay Company's line, and provide a more efficient means of transport to the mining township.

II.—PREVIOUS REPORTS ON THE FIELD.

The first occasion on which an official visit was paid to the field was in the early part of the year 1895, when Mr. A. Montgomery, then Government Geologist, passed through the northern portion of the district, and visited the properties now known as the Tullibardine and the White Hawk Mines.

It was Mr. Montgomery who gave the name of Mt. Farrell to the "rugged rocky range" (up to that time unrecorded), as a tribute to the undaunted endurance of the pioneer prospector of the district—T. H. Farrell.

At the time of Mr. Montgomery's visit no mineral discoveries had been made on the slopes of Mt. Farrell itself.

The report, therefore, of that gentleman on the area contains only his notes on the two properties above mentioned, and some short references to the general geology of the district.

In June, 1900, Mr. Twelvetrees made a short inspection of the district and the mines which were at that time in active operation. His visit was of only one week's duration, and necessarily too brief to admit of any detailed examination of the geology of the area. This report, which contains detailed accounts of the condition of the several mines at that period, is dated from the Government Geologist's Office, on 20th December, 1900.

The next visit paid to Mt. Farrell by a member of the geological survey staff was in March, 1904, when Mr. G. A. Waller made a brief examination. Mr. Waller's remarks on the general geology of the district are of great value, on account of his intimate acquaintance with the geology of the other mining fields of the West Coast range.

Mr. Waller draws attention to the fact that at Mt. Farrell there are found members of the same rock types as occur along the main axis of the West Coast range in an unbroken line from Mt. Darwin northwards. He suggests that the schistose igneous rocks of the district be termed "porphyroids," after the strikingly similar schistose porphyries of Europe. Of this matter more will be said later, when the rocks are treated of.

With regard to the massive conglomerate which forms the main mass of the ridge of Mt. Farrell itself, Mr. Waller's remarks are of particular interest. This formation has been studied by him in several localities on the West Coast, and he concludes that it should be referred to the base of the Upper Silurian. Formerly, it had been considered that the conglomerate was of Devonian age. Of this, also, further mention will be made in a later portion of this report.

III.—PHYSIOGRAPHY.

(1)—Topography.

The topography of the area is due primarily to the forces which have tilted up the strata to high angles, and secondarily to the natural denuding agencies which have developed the rugged outlines of the surface.

The ridge known as Mt. Farrell is long and very narrow, and owes its character to the nature of the central hard band of siliceous conglomerate. This weather-resisting formation rises at the top of the mountain abruptly from the softer rocks with which it is in contact to a maximum height of about 1600 feet above the junction of the Mackintosh and Murchison Rivers.

The outlines of the surrounding heights are different. Mt. Black, to the west, has well-rounded outlines, and the spurs spread out into the valleys on all sides. Mt. Murchison, which towers above all the surrounding country, shows a series of abrupt cliff faces, with long-graded slopes stretching away on either side.

To the west of the Mt. Farrell ridge lies a broad alluvial plain, which runs back far up the valley of the Sterling River, which occupies the depression between Mt. Murchison and Mt. Black. Its northward continuation is the valley of the Mackintosh River, which joins the Murchison at Mt. Farrell, and flows away westward towards the coast as the Pieman River.

Again, on the eastern side of the Mt. Farrell razor-backed ridge, lies a broad flood-plain—that of the Sophia River—which gathers in the waters of the White Hawk Creek, and joins the Mackintosh River at the northern extremity of Mt. Farrell.

The Murchison River differs from these other rivers in that it has cut its way right through the conglomerate ridge, and now makes its way north and west to join the Mackintosh a little below its junction with the Stirling.

The area drained by these rivers is very considerable, and they are never dry, although the variations in the amount of water passing along their channels are considerable with the seasonal changes.

At Mt. Farrell the average river level is a little over 100 feet below the flat surface of the button-grass plain which marks the old level of the flood-plain.

The region has been elevated since the establishment of this flood-plain, and the river systems are still actively engaged in once more cutting down their beds to the base level of corrosion.

The ancient flood-plain of the Mackintosh River affords some evidence to prove that the uplifting of the region was not effected by one simple movement, for there are still traces of two river terraces left in the undenuded river wash at a point a little north of the town, and west of the Mackintosh Mine.

On the steep banks, also, of the White Hawk Creek, above the old workings of T. H. Farrell, there are terraces of this old river wash.

This elevation of the country is not restricted to the particular region in question, for there are raised beaches at several points on the West Coast. At Strahan, the Tertiary beds are known to form raised beaches, and numerous terraces of gravel are recorded. Mr. Montgomery, in his report on the Corinna Goldfield in 1894, claims that these gravels are of marine origin. However, whether of fluviatile or marine origin, the present elevated position of these gravels is indisputable proof of elevation. It may be that the period of this upward readjustment was Post-Tertiary, and followed upon a Tertiary subsidence. Raised beaches of recent sediments have been recorded at Cox's Bight by Mr. Twelvetrees,* and it may be that some parts of the western portion of Tasmania are still undergoing elevation.

The age of the alteration of level in the Mt. Farrell area is not to be definitey determined from the evidence now available.

There is some evidence in the district which may be regarded as indicative of glaciation. In the neighbourhood of the White Hawk Mine there are very large rounded boulders of granite to be seen. These have been undoubtedly derived from the Granite Tor mass, but are now some miles distant from their source. They may possibly have been rounded in beds of the mountain torrents, but they now occur stranded high above the present creek beds. I noticed several on the flanks of Mt. Swallow, 1000 feet above the level of the White Hawk Creek bed at the mine.

These boulders certainly have the appearance of glacial erratics, but no other of the phenomena usually to be seen in glaciated areas were noticeable.

Mr. R. M. Johnston, in his paper entitled "The Glacier Epoch of Australasia,"† correlates the evidence of these boulders with that of the moraines, roches moutonnées, &c., of many other places to prove a former glaciation of the western highlands of Tasmania.

Taken in conjunction with other evidence, it may be admitted that these rounded boulders are true glacial erratics, and that the region has been subjected to ice action, yet the topography of the area has not been

* Report on Cox's Bight Tinfield, December, 1906.

† Royal Society of Tasmania, 1893.

seriously modified by such ice action. If other traces of glaciation were impressed upon the district they have since been obliterated by the action of other surface agencies, unless perhaps Lake Herbert represents a rock basin gouged out by the ice action.

The topography, therefore, of the Mt. Farrell district as a whole is that of an elevated region in which the erosion cycle has once reached maturity, but of which the features are now suffering a more rapid alteration, for a comparatively recent alteration has taken place in the general level of the district, and in consequence the river systems have been rejuvenated.

(2)—Meteorology.

The rainfall at Mt. Farrell is undoubtedly very heavy, although no statistics can be adduced to give an idea of the actual amount of precipitation. The following figures, taken from Walch's Tasmanian almanacs, show the total rainfall for a period of 12 months at some of the principal points on the West Coast of Tasmania.

Mt. Read is quite close to Mt. Farrell, but its elevation is considerably greater.

Total Rainfall 1st October to 30th September.

	1899–1900	1900–1901	1901–1902	1902–1903	1906–1907
Mt. Read	—	—	77·91	83·61	126·95
Zeehan	101·33	106·00	94·50	105·31	100·33
Mt. Lyell	94·48	131·20	114·53	118·71	117·23
Waratah	88·03	90·33	73·3	94·48	109·40

The township of Mt. Farrell is said to possess a milder climate, and a drier one, than other spots on the West Coast, on account of its sheltered position. Nevertheless, the annual rainfall is considerable, and is not very evenly distributed. The winter and spring are said to be the wettest seasons, while from the middle of December until March fairly fine weather is prevalent.

Of this rainfall, during the rainy seasons by far the greater proportion must run off the steep surface slopes to the rivers. The snow that caps the highest peaks lingers for a time, and then augments the supply of water to the mountain torrents.

Some small proportion of the rainfall must be held continuously by the surface mantle of soil and peaty growth. The so-called "button-grass" plains and slopes retain their dampness long after the rain has ceased by the action of this vegetable growth; otherwise, the return of the rain to the rivers is rapid, and the rise of a river is to be noted almost instantly after the rain has been observed to fall.

This heavy rainfall on a country of steep slope must necessarily cause a very considerable amount of rock-waste to be carried away downhill to the rivers, and prevent the accumulation *in situ* of any weathered rock-masses. The only retarding agent tending to arrest this downhill movement is the dense vegetation of the district, which exerts a strong binding influence on the surface-mantle of soil; and in the case of the button-grass growth, the whole of the underlying material is covered and protected from the denuding agents.

On the western slopes of Mt. Farrell the whole surface-soil can be seen to be creeping downhill where sections of the surface-soil are exposed by the numerous trenches cut there. The cleavage planes of the slates, which dip to the west in the undisturbed ground a foot or two below the surface, are seen at the surface dipping to the east. The slate is soft and cleavable, and it has been pushed so far by the general soil-creep that the dip of its cleavage planes is inverted.

(3)—The Effect of the Topographic Features on Mining.

Prospecting and Exploitation.—On the whole, the topography of the district may be said to be very favourable to the exploitation of the mineral belt. The steep grade of the western slopes of Mt. Farrell along which the mineral belt runs has indeed prevented the accumulation of the rich gossanous material which often caps the silver-lead lodes of other mining fields. In fact the downward soil-creep has in many cases quite covered up all traces of an outcrop, although the lode lies only a few feet below the present surface.

But the creeping surface-soil forms only a very shallow layer, since it is removed almost as soon as it forms, so the prospector has not much overburden to remove in most cases when trenching for the lodes.

The creeks cut across the country on these western lodes, and have therefore aided the prospecting of the main portion of the field very considerably.

On the other hand, on the south side of the Murchison River, the streams, on the whole, flow in a more northerly direction as they leave the northern slopes of Mt. Murchison, and run with the strata, rather than across; yet the

Tullah lode was picked up in a stream flowing westward from the slopes of Little Farrell.

Both the White Hawk Mine and the Tullibardine owe their discovery to the existence of these natural sections afforded by the creeks.

The Murchison River itself has cut across the rock-formations and laid bare several occurrences of ore, both of lead and of copper, to which reference will be made later.

Once located, the lodes have been readily exploited by adits driven into the sides of the mount; and these adits, driven towards the central core of the mountain, are usually nearly at right-angles to the strike of the lodes. The north Mt. Farrell Company owes the discovery of its "No. 1 lode" to its lowest level adit, which intersected this body of ore, which does not extend upwards as far as the surface. In fact, the aid afforded to mining by the physical configuration of the country will be apparent when it is remembered that there is not a shaft on the field that serves for the raising of ore to the surface.

Water-supply.—The narrowness of the ridge at the top of Mt. Farrell, and the steepness of the slopes, cause one serious drawback. In consequence of the small area exposed, and the rapidity with which atmospheric moisture leaves the mountain sides, the rainfall, heavy though it is, is, on the whole, insufficient to supply the needs of a mining community of the size of Mt. Farrell, if dependence is to be put only upon the rainfall on the western slopes of the mount.

At the present time there are only two concentrating mills on the field, and of these one is inactive.

The North Mt. Farrell Company's mill is supplied with water issuing from the underground workings of its own mine, and the Mackintosh; but this is inconsiderable in amount. The supply is augmented by a pipe-line that has been constructed to the top of the mount to carry down the waters of the small lake on the southern crest of the ridge. This lake is of small extent, covering only 10 acres, and its catchment area is also small, so that the present demands on its contents are all that can be met. The dry season of the year, for about three months after Christmas time, renders this lake supply a doubtful one for a plant in continuous action.

Races are cut to tap the several streams on the mountain side, but these, too, are apt to fail in the dry season, and the water from underground alone is left.

As regards the mines situated away from the Mt. Farrell ridge: On the south side of the Murchison River no concentrating is being done at the present time. In the event of developments underground warranting a milling plant, the machinery site will undoubtedly be chosen on the banks of the river. And indeed any concentrating mill of the future will need to be built on the river banks or in immediate proximity thereto.

As regards the White Hawk and Tullibardine properties, the water-supply offers no difficulty, should operations at these mines create the demand.

Power.—The configuration of the country is such that, were the quantity of water sufficient, all necessary machinery could be actuated by hydraulic power.

The North Mt. Farrell Mine utilizes its lake supply to drive a 9-foot Pelton wheel, and generates thus a part of the power necessary for driving the concentrating machinery. The lake supply is conveyed from the syphon by pipes and races to the top of the ridge, and thence descends direct in a pipe to the mill. At present this pipe is not full to the top, so that the available head could not be ascertained. A reservoir chamber is needed at the top of the ridge of such capacity that it can carry enough water to maintain a full head for the two shifts during which the mill is running.

The White Hawk Mine is very favourably situated as regards both water-supply and the available head at which it could be delivered with small expense, for the White Hawk Creek drains a large area of country and descends to the mine by a very steeply-graded gorge with several waterfalls.

IV.—GENERAL GEOLOGY.

(1)—The Rock Types represented on the Mt. Farrell Field.

The various rock formations which require description will be treated of under three heads—

(*a*) The igneous rocks.
(*b*) The sedimentary rocks.
(*c*) The metamorphic rocks.

A.—THE IGNEOUS ROCKS.

There are several groups of igneous rocks on the field, each of which must be looked at separately.

(1).—*The Porphyries and their Associates.*

The first group to be considered is the acid-intermediate series, of which so many different facies are present. These are all gradations from the granitoid varieties south-east of the main ridge of Mt. Farrell, to the porphyries and felsitic types further westward. On consideration of the many features shared in common by all these types, I feel convinced that they are to be taken together as one geological group.

The Holocrystalline Types.—The track from Mt. Farrell along the eastern bank of the Murchison River to the sections in the south-east affords several exposures of a medium-grained basic granite, or syenite, which merges by insensible gradations into a green porphyritic felsite, to be described later.

This syenite—showing to the naked eye equidimensional constituent crystals of dark-green biotite mica and hornblende, pink orthoclase felspar, and the pale greenish felspathic mineral, with an indistinct cleavage—appears like a granite, but the poverty of quartz in the rock is plainly apparent.

Microscopically the rock appears to be a fairly normal syenite, altered by dynamical stresses and masked by reconstitution. The hornblende still remains here and there in idiomorphic crystals, but most of it is altered, and its place taken by chlorite and epidote. The same alterations have taken place in the case of the biotite. In one section I noticed a mineral which appeared to have been augite, but was almost wholly altered into chlorite.

The felspars are clouded by kaolinization, and the plagioclase more so than the orthoclase. The latter has a faint reddish tinge in thin sections. As regards the exact member of the plagioclase series present, I was unable, through the decomposition of the rock, to obtain satisfactory extinction angles.

Quartz is present here and there in graphic intergrowth with the orthoclase. Apatite is common in stout unaltered idiomorphic crystals.

In crystallization, the plagioclase seems to have preceded the hornblende, while the orthoclase was subsequent to it.

The crushing has subjected all the minerals to a state of strain, and has even produced actual fracturing in many cases. Where the minerals have withstood crushing without actual rupture, and where they remain sufficiently undecomposed, their extinction is "shadowy" or "wavy."

These rocks are found in the southern and south-eastern portions of the field, at the Osborne Blocks, and at Kitson's. On the Section 2940, in the name of H. J. Kelly, a variety occurs that may be termed a true granite, from the greater prevalence of quartz.

The Felsitic and Porphyritic Types.—Intercalated with the sedimentary rocks all through the district are a series of porphyritic rocks which appear to me to correspond in general composition to the holocrystalline members above described, but to have consolidated under different physical conditions. By a series of chemical analyses this matter could be settled, but in the meantime the question cannot be definitely decided.

The southern portion of the field will, by reference to the geological map, be seen to consist very largely of these rocks, which form broad zones or very narrow bands in the slate.

From point to point their mineralogical constitution can be seen to alter even in the same continuous belt of rock. A felspar porphyry thus can be traced into a quartz porphyry or into a fine-grained felsitic rock wherein no crystals can be distinguished by the unassisted eye, and the texture is quite homogenous.

Variations in the structure are equally gradual. The uncrushed rocks are comparatively easily distinguished without miscroscopic aid, but in the field these simple types are found to merge into the schistose varieties so gradually that no divisional line can be drawn between the crushed and uncrushed portions; and uncrushed blocks of irregular lens-like shapes occur, quite surrounded by the crushed types.

Again, in the field one is often in doubt as to whether the cleavable schist under observation belongs to the igneous series, or whether it is a variant of the associated sedimentary rocks. In such cases the weathered surfaces of the schist afford some information, since the quartz crystals of the rocks, which were originally unmodified quartz porphyries, often resist the weathering agents that gradually disintegrate the rest of the rock, and so stand out in relief. In this way I found several doubly-terminated quartz crystals left in relief on weathered faces or edges.

By weathering these rocks have their appearance considerably altered in most cases. The aspect of the massive varieties is least affected, and the surfaces are clean and smooth where there is no surface-soil above. At one point, on Section 2864, the progress of weathering on the massive rock, which has an elaborate system of small joint planes developed in it, has produced a rude spheroidal structure.

In some localities, notably near the mouth of No. 4 tunnel on the North Mt. Farrell Mine, and a little to the east of the Langdon Mine, the rock weathers to a honey-combed aggregate, which has all the appearance of a lava with its vesicular cavities caused by the expansion of imprisoned gases at the moment of solidification. Some specimens were so full of these cavities as to resemble a pumice.

It is on evidence such as this that the conditions under which the rocks solidified are to be determined. That is to say, it is possible to judge whether these felsites and porphyries were true *effusive* rocks which poured out on the surface as lava flows, or whether they were *intrusive* rocks which forced their way between the other rocks which were already formed, by the observation of these peculiarities.

By the microscope it can be shown that these felspar porphyries near the North Mt. Farrell workings carry filled vesicular cavities. These are apparent on weathering as empty elongated spaces. The unweathered rocks show in this section these vesicles filled with calcite chlorite, and often a layer of chalcedonic silica.

The vesicles thus filled are considerably elongated, but always in one general direction. This evidence, when taken together with that of the presence of fragmental igneous rocks (to be described later), seems to me to point with certainty to the existence of volcanic action within but a short time of the period of sedimentation, during which the slates were formed.

None of these vesicular rocks were observed to the east of the slate series. They are always on the western side; and on Section 3263 at least the igneous rock was clearly intrusive into the slate, for tongues of the igneous rock can be seen protruding into the slate.

The western boundary of the slates would therefore seem to have been, in all probability, on the horizon of the former surface. The original surface is now tilted to a high angle by subsequent warping.

The effusive rocks which poured out on this surface would then be the surface representatives of the plutonic syenites and granites, and the intrusive porphyries.

A further sign of rapid cooling, such as would take place at the surface, was noticeable in the rocks close to the horizon of the tuff. In one thin section the micros-cope reveals a ground-mass of extremely fine grain, show-ing a considerable number of roughly concentric cloudy markings. These are, in my opinion, caused by the pro-gress of weathering along the perlitic cracks caused by the rapid cooling of a rock, once glassy, but since devitrified.

The schistose varieties of this igneous series weather to a grey rock with a very rough surface, especially where the edges of the planes of schistosity are exposed. The uneven hardness and resistance to solution are the causes of the rough surface, and on these weathered edges it is sometimes possible to distinguish uncrushed idiomorphic crystals of quartz.

One feature of some persistence, and especially noticeable wherever the schistose igneous rocks are found, is the occurrence of very numerous veinlets of quartz traversing the members of this series in every direction. The quartz is often coloured pink, and the veins consist in many instances of small crystals, whose longer axes are at right-angles to the length of these numerous intersecting cracks. The width of these veins of crystalline and massive quartz is small, the great majority being under half an inch wide, and very seldom are veins of over an inch met with. The silica has not been deposited solely in the veins, for it has in many instances thoroughly impregnated the rock, and caused it to assume the character of a chert.

This silicification, which is evidently of later origin than the rocks in which it forms so prominent a feature, took place after the main crushing of the region had been effected. For the veinlets are usually undisturbed in the schistose varieties of the porphyries. It is true that there are several occurrences of the fracturing and contortion of these veins, and in some cases I found the quartz crystals of the vein-filling deformed by a movement of the walls to which they are attached. However, these cases are exceptional. The elaborate fracturing of the porphyries may have been caused by the crushing forces which induced the schistosity, but the filling of the fractures with silica was for the most part of later date.

Microscopically these rocks show many features of interest, and of value in determining their relationships.

The massive porphyries display best the original mineral constitution of these rocks, for the development of the schistose structure has been attended by a reorganization of the molecules, and the original character is very largely masked.

The phenocrysts most common in the least altered types are of quartz and plagioclase felspar. Orthoclase felspar is present but not common, and of the plagioclase series the more acidic members are the ones commonly found.

Sericitization and mechanical deformation have in many cases made it impossible to determine the felspar which is present. But the low values for the extinction angles, when measured from the albitic lamellæ, render it clear that the plagioclastic felspars are commonly of the composition of oligoclase. Secondary albite is often present in small clear crystals in the reconstituted ground-mass.

The orthoclase is more frequent where quartz is present in addition to the felspathic phenocrysts.

In no cases are the felspars quite fresh, and they are frequently almost completely replaced by sericite or a quartz-albite aggregate.

The quartz appears sometimes with its crystal outlines well developed, but has more usually suffered corrosion by the magma, and has its boundaries embayed. Very seldom is the quartz free from the "shadowy" extinction consequent upon a state of strain.

Ferromagnesian minerals are rare, and never free from alteration; but in one specimen collected from near the Tullah town-side there was well defined hornblende only slightly chloritized. I also noticed a mineral, which may have been a pyroxene, present in the felspar porphyry of the Langdon section. In a few slides there are chloritized remains of a mineral which seems to have been biotite before its alteration.

Epidote is common all through the series, and is usually to be seen in granular aggregates.

The ground-mass is sometimes little altered, and is a fine-grained micro-felsitic aggregate, which has corroded its way into the phenocrysts.

There is no visible sign of fluxion, save for a slight tendency of the felspars to arrange themselves with their longer axes in one general direction. The quartz phenocrysts, being more equidimensional, do not exhibit any such tendency. The proportion of phenocrysts to ground-mass is very variable.

The crushed varieties of these rocks are clearly of this group as regards origin, when seen in thin sections, however widely their microscopic characters may vary from those of the typical porphyries.

The chief variation introduced by the crushing is the development of a wavy banding throughout the rock. This closely resembles the fluxion structure often visible in this class of rocks, due to a movement of the magma during the process of crystallization. Here, however, the uncrushed types show no such fluxion structure in any of the thin sections prepared for examination, and the banding is, in my opinion, of later date than the solidification, and due to dynamic stresses.

In the much-crushed types the phenocrysts have been shattered, and the fragments drawn out into *augen*, or they show signs in polarized light of being in a condition of considerable physical strain. The ground-mass becomes entirely changed into a quartz-albite-sericite aggregate, in which the sericite is strung out in wavy zones, and in some varieties a considerable amount of calcite is present in addition.

Chlorite is also common, especially in the rocks associated with the holocrystalline varieties at the Osborne Blocks and near Kittson's. It is sufficiently abundant to impart a deep green tint to the rock, which resembles anything but a quartz porphyry to the unaided eye. The chlorite in thin sections is strongly coloured, and is extended in wavy lines in much the same way as the sericite of other varieties.

Summing up the evidence collected with regard to these rocks, we may say that they all belong to one series of intrusives and effusives.

Their mineral composition indicates that they are not, in very many cases at least, typical quartz porphyries and felspar porphyries, but rather quartz keratophyres and keratophyres; for there is an almost constant predominance of the sodic over the potassic felspars.

With the description given here of the rocks of Mt. Farrell it will be interesting to compare the notes of Messrs. W. H. Twelvetrees and W. F. Petterd on "The Felsites and Associated Rocks of Mt. Read and Vicinity."*

Many of the rocks there described are identical with those from the Mt. Farrell district—occurring, as they do, in one continuous belt with these.

The crushed varieties of these keratophyres may well be termed "porphyroids," since they correspond in all respects to the rocks originally thus named in Germany. In fact, Professor Rosenbusch, the eminent petrologist, after examining some of the rocks of Mt. Read, has written:—†

"Undoubtedly we have here strongly dynamically altered forms of the acid eruptive rocks. The typical porphyritic structure, the nature of the phenocrysts, the still-recognisable fluidal structure, the nearly entire absence of dark constituents, the occasional spherulitic

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* Proc. Roy. Soc. Tas., 1898-9, pp 33-46.

† *Ibid.*, p. 43.

forms still recognisable in their replacement products (quartz, albite), all point with certainty to members of the quartz porphyry family, and, with great probability, not to quartz porphry in the narrower sense, but to quartz keratophyre and keratophyre. . . . The rocks greatly resemble our German occurrences in Westphalia, the Fichtelgebirge, and Thüringen, and especially the occurrence in Wales. These are the forms which in Germany were originally called porphyroids and flaserporphyries."

Mr. Waller, in his report of 1904, proposed the term "porphyroid" for the schistose rocks of this series. It has been adopted, to some degree, by the mining community, but is used quite without discrimination. The present detailed description of the schistose porphyries has been given in order to give a greater degree of definition to the term "porphyroid," and to indicate clearly the exact meaning of this word, which is used in the later portion of this bulletin. The rock is an important one in the Mt. Farrell mining field, and with the slates forms the common country rock of the lodes. Associated here and there with the green quartz porphyries of the Osborne Blocks are types which seen to be only variants from the rocks of this series, yet which are remarkable for the presence of actinolite.

One of these, from Section 2145, on the western side of the Murchison River, was examined microscopically, and proved to be an actinolite rock.

The actinolite showed tints varying from pale yellow to pale brown and pale green. Beyond the actinolite, which occurs in the form of allotriomorphic crystals or radiating bunches, there is only scattered iron ore and a sporadic prism or two of epidote.

The relation of such a rock to the more acidic members of the series is not clear, especially as no information was to be gained from the field occurrence. It may be that this type is merely a more basic segregation from the normal magma; but such a suggestion can be little more than a speculation in the present state of our knowledge of the district. The outcrop whence the described specimen was obtained was in proximity to the workings marked in the map. Hence it is possible that the actinolite is due to a local alteration of the quartz felsite by the agency of mineral-bearing solutions. And in this connection it may be mentioned here that coarse actinolite accompanies the occurrence of galena some distance to the south, on Section 2865.

The Fragmental Types.—On the extreme western flank of Mt. Farrell, at a point near the south-western corner of the northern section of the Mt. Farrell Company's leases, is a very remarkable rock, which appears to be an altered volcanic tuff. It is in immediate contact with the felspar porphyry which shows the vesicular cavities filled with chlorite calcite and chalcedony referred to above, but the actual junction could not be traced on account of the surface cover. The western continuation of this rock is entirely covered by the button-grass plain at the foot of the mount.

In appearance the rock is, on the whole, deep green in colour, but with grey and reddish blotches irregularly distributed. The varying splashes of colour are due to angular fragments, which are of different composition—some chalcedonic, others apparently fragments of the pink-coloured uncrushed porphyries.

At the junction of the Mackintosh and Murchison Rivers, still further to the west, a very similar rock is to be seen here and there; and the tramway cuttings afford sections which show that the fragmental varieties pass by quite insensible gradations into the massive porphyroid. We may look upon them as the fragmental porphyroids, or "clasto-porphyroids."

With microscopic aid it is still more apparent that these rocks are certainly fragmental, and yet possess many features in common with the other porphyroids.

The felspar crystals embedded in its mass are very considerably altered, with a great development of kaolin and epidote. In some the original crystal is replaced by an albite-epidote mosaic, with more or less silica and calcite in addition. The interstices between these altered crystals are filled with a mixture of chlorite, epidote, calcite, and kaolin.

In one slide there was visible an angular fragment of a glassy igneous rock. This piece seems to me to afford certain evidence of the shattering of an effusive rock by volcanic action. The glassy fragment is stained pale brownish by decomposition, but still shows a number of clear microlites possessing a straight extinction; and it possesses, in addition, a well-developed perlitic structure, which has been accentuated by the progress of weathering.

(2)—*The Granite Porphyry of White Hawk Creek.*

The sedimentary rocks of the White Hawk district—sandstone, limestone, and pebbly grit—have interbedded with them a dyke rock, which is a true "microgranite," or "granite porphyry."

It forms a broad dyke, which dips westward with the sedimentary rocks and outcrops on the eastern boundary of the leases.

The rock has a felsitic ground-mass, which is sometimes pink, sometimes green, and in which the porphyritic crystals of quartz felspar and biotite are set.

It is clear that considerable alteration has taken place since the rock first solidified—even to the naked eye. There is a considerable development of chlorite, by which in some cases the ground-mass, in others the felspars, are almost replaced by the secondary green mineral.

Where undecomposed the felspars are fairly large and pink.

Microscopically it is a typical microgranite, which is free from the effects of dynamic metamorphism, but altered by weathering. The ground-mass is a fine granular aggregate of quartz and orthoclase, in which are phenocrysts of quartz, biotite, orthoclase, and plagioclase.

The quartz has suffered considerable corrosion by the magma, and its borders are ragged, and sometimes deeply embayed. The felspars are also corroded, but not to the same degree as the quartz. The biotite shows usually its crystal outlines, and basal sections appear as cleanly cut hexagonal plates.

Decomposition has altered the biotite almost completely into chlorite—sometimes massive in form, at other times in tufted radiating aggregates.

The felspars are kaolinised or sericitized, and in some cases the decomposition has been attended by the introduction of iron and magnesium, and finely-divided chlorite penetrates the crystals. Epidote is present in small amount.

All through the ground-mass there is finely-divided chlorite, which imparts the prevalent green colour to the rock. The definite determination of the felspars is difficult, inasmuch as their alteration leaves little more than bare traces of original structure in most cases. They are quite commonly zoned, and both single and multiple twinning are still recognizable.

Whether this microgranite belongs in origin to the magma which has produced the plutonic mass of Granite Tor, or whether it is another variety of the series above described, cannot be determined from its mode of occurrence.

It lies in position between the two varieties of the igneous rocks, and nearer to the granite on the east.

The great distinction between members of the two groups is that the series already described all show more or less the effect of crustal movement.

Yet in the White Hawk area all of the rocks are noticeable for a freedom from the signs of mechanical deformation in a district of such considerable disturbance.

In age there is but little difference between the two groups of igneous rocks, so that the relative progress of decomposition is not of value as a criterion in distinguishing them.

The granite porphyry here described is quite uncrushed, the alterations that have been effected being simply the result of the work of surface agencies.

(3)—*The Granite of Granite Tor.*

On passing up the valley of the Mackintosh to the northward, an examination of the river gravels shows an ever-increasing proportion of pebbles of a holocrystalline rock quite different in type from the syenitic granite above described as occurring with the porphyries.

This other is a typical coarse-grained acidic granite in most specimens. Both muscovite and biotite micas are usually present, but some varieties show an almost complete absence of biotite and abundant silvery-white muscovite. The rock is coarser in grain than the syenitic granite of the Osborne Blocks, and often carries porphyritic crystals of orthoclase as much as an inch and a half in length.

This is the rock which occurs *in situ* at Granite Tor, and which has many features in common with all the other tin-bearing granites of Tasmania. Tin is reported to have been derived from this granite also.

Microscopically viewed, the rock is perfectly free from all signs of dynamic metamorphism.

The felspars, both orthoclase and plagioclase, are in a fair state of preservation, and only kaolin has resulted from their alteration. Their crystal outlines are well defined, and they have clearly preceded the quartz in crystallization. Muscovite and biotite are abundant, and the latter is sometimes chloritized.

This plutonic mass of granite appears to dip underneath the mica schists on its western border, and probably is connected in depth below the Mt. Farrell field with the other granitic outcrops of Mt. Heemskirk and the Meredith Range.

(4)—*The Diabase Pebbles.*

Among the pebbles which constitute the beds of the Murchison River and tributaries are some well-rounded ones of medium-grained diabase. This rock does not appear anywhere in the district *in situ*, and the pebbles must have travelled many miles from the eastward mountains by the agency of the surface-streams, and perhaps to some extent of glaciers. They are frequent in the pebble beds of the modern streams and in the older river deposits intersected by present streams or exposed by mining operations.

The diabase is known to occur *in situ* at Barn Bluff and at the Eldon Range, from both of which waters now flow westward by the valley of the Murchison; so these pebbles are probably derived thence, and have reached their present position by the transporting agency of the steep-graded streams.

B.—THE SEDIMENTARY ROCKS.

(1) *The Slate and Associated Crushed Grit and Conglomerate.*

These form the main sedimentary series of the central portion of the mining field; and although the lodes are not confined to the zones in which they are found, yet the productive lodes at the present time are situated in these old fragmental rocks.

There are all gradations—from the conglomerates, against which the harder and massive conglomerate of the central ridge of Mt. Farrell abuts, to the fine-grained slates further to the west. The grain is coarser on the eastern side of the belt than on the western.

The coarse varieties are easily recognised by their rounded pebbles of quartz, many of which have resisted the crushing forces. Some of the pebbles are drawn out into "eyes," and the whole rock structure is altered. The crushed grits of grain intermediate between that of the conglomerates and the true slates are at times very difficult to distinguish from the porphyroid, especially from the more markedly schistose varieties of the latter.

All varieties of this series show unmistakable signs of crushing, and the attendant reorganization of their contents, so that they cleave readily into flakes. The coarse kinds part in roughly parallel directions, while those of finer grain show a clean slaty cleavage for the most part.

At a few points in the neighbourhood of fracture-planes there has been an impregnation with silica, and the slates become hard, massive, and non-cleavable.

Where mining operations have penetrated these slates and exposed them it can be easily seen that there has been considerable alteration of both the structure and composition in the immediate vicinity of the lodes. The No. 4 tunnel of the North Mt. Farrell Mine has penetrated the altered zone, and runs far into the unaltered slate beyond. This latter at this place is a dark cleavable slate with fine-grained iron pyrites along the parting-planes. I could not perceive any visible graphite in the slate; yet where the lodes traverse the rock the appearance of graphite is noticeable, and the iron-bearing mineral is the carbonate, not the sulphide.

The structure of the slate near the lodes is also different. The even slaty cleavage is replaced by a remarkable contortion and brecciation of the whole rock. The cleavages appear to dip in any direction, and the lines of parting often appear intricately folded, fractured, and overthrust. These phenomena indicate that much of the stress which produced the fractures now filled with ore must have been of the nature of compression.

The majority of the rocks of this series are dark in colour, but there are some associated light-coloured rocks which, in my opinion, are to be classed with them.

To the west of the lode-bearing slates in the Mt. Farrell, North Mt. Farrell, and Mackintosh areas is a narrow strip of this pale clay schist or slate. The belt is distinguished from the ordinary slate in the geological map and section herewith.

At the North Mt. Farrell Mine there is a narrow belt of the dark slate still further to the westward; but in this case, as in all other visible sections along this belt, there appears to have been some degree of movement between the light and dark slates at their contact. The relation between the two is therefore not definitely certain on the evidence available. The persistence of the belt will be seen by reference to the map to be remarkable. I traced it northward as far as the Mackintosh River in Section 2909. Southward the rock is to be seen near the mouth of the main lower-level adit of the Mt. Farrell Mine, and extends till it is hidden by the button-grass plain.

An entirely similar rock is the country rock of the Tullibardine copper property, where it is obviously interlaminated with the dark slates on either side.

In the South Murchison section the eastern tunnel has been driven in a pale-coloured slate of a somewhat similar appearance. Here the pale slate is interlaminated with the darker, the junction being visible at the mouth of the adit. Between the ordinary dark slate and the paler variety there is no unconformity nor any plane of separation. The colour changes abruptly, and the slaty cleavage becomes less well marked.

The rock from the Mt. Farrell Mine was sectioned, and shows a number of small quartz granules strung out in wavy lines, and between them undulating bands of sericite and kaolin.

A specimen from the South Murchison section was also examined microscopically. It showed an even more homogenous texture. The sericitic bands are so fine as to be nothing more than strings. Calcite has made its way in along the planes marked by the strings of sericite, and forms eyes here and there.

With regard to the structural features of the members of this series, a very strong distinction should be made between the bedding-planes and cleavage-planes.

The two are being constantly confused on the field, and may lead to serious misunderstanding of the geological structure.

The slates especially are very seriously contorted at times, and the cleavage-planes are always the prominent feature, whereas the bedding-planes are not visible at all in the great majority of instances. In fact, it is an extremely difficult matter on this field to determine the dip of these sediments, when the beds are considered as a whole. The mining operations have given one or two exposures of the divisional lines between the members of the slate series and between the porphyroid and the slate; but in all such cases there has apparently been some degree of movement between the two rocks in contact, and the passage of meteoric water along these planes has masked the relationships of the rocks. In such cases as were open to observation the dip of the rocks seemed to be to the westward, and at an angle of from 60° to 70°.

At the South Murchison Mine the contact line between the pale and dark slate is nearly vertical, but inclining to the west.

The planes of schistosity dip almost always to the west, but there are great local contortions of these rocks, both near the lode fractures and in the unproductive zones; for instance, above the workings of the Farrell Blocks, on Section 2397, the planes of schistosity strike north-west and south-east, whereas their normal strike throughout the field is parallel to the main axis of the Mt. Farrell ridge.

(2)—*The Massive Conglomerate of the Mt. Farrell Ridge.*

The core of the Mt. Farrell ridge is a rock which in its typical development is a coarse conglomerate, but with which are interbedded finer-grained sandstones, or even shales. These rocks are obviously all members of one great period of sedimentation, and must be treated of together.

The conglomerate is usually of a pinkish colour, and almost wholly quartzose in composition. The pebbles consist of all varieties of quartz—massive, banded, and chalcedonic—and of a quartz schist or quartzite schist. This latter schist is nearly all quartz, with very little pale-coloured mica, and the layers of mica are often contorted.

The cementing medium in the conglomerate is also siliceous, and usually very small in amount when compared with the large bulk of the rock that is composed of the pebbles. The sandstones also are almost wholly of silica, and are stained red by oxide of iron.

The strike of the beds is practically the strike of the mountain ridge, but it varies widely at one point near the fault-plane which traverses Section 2796.

The bedding-planes are not decipherable where the massive form is met with, and neither strike nor dip can be ascertained; but the coarser type passes over abruptly into the finer, and the structural relations become visible. There is a band of the finer-grained sandstone running the length of the mountain, from the south end to the fault-plane, almost on the very centre-line of the ridge; and on the eastern slopes, towards the valley of the Sophia River, the finer-grained sediments can be seen outcropping here and there through the button-grass.

The southern end of Mt. Farrell shows a great local thickening of the conglomerate, and a south-east spur of the mountain, which extends along the eastern bank of the Murchison River, is wholly of conglomerate and its associated sandstone.

The Murchison River breaks across the conglomerate at the southern end of the mount, and on the south side of the river the same beds are to be seen as on the northern; and "Little Farrell," as the portion south of the Murchison River is called, has the same general aspect as the larger part on the other side of the river.

Viewed from the top of the southern end of the mount proper, the structure of Little Farrell is plainly visible. The same massive beds of coarse conglomerate are apparent, with the interbedded sandstone, but the finer-grained varieties of the eastern slopes of Mt. Farrell are not seen on the southern side of the river.

The structural features presented by the rocks of this series are of some interest, as they assist considerably in explaining the structure and geological history of the district.

The strike of the main series of beds varies from N. 5° W. at the south end of the mount to N. 10° W. above the Farrell Blocks trenches; and approaching the fault-plane, whose strike line has a bearing of 112°, the strike of the finer beds is continually making towards the westward, till it bears N. 45° W. Northward, beyond the fault-plane, the strike is N. 10° E.

At the southern end of the mount, where the spur runs out in a south-easterly direction, the strike-lines follow the spur round till their bearing is N. 30° W.

The dip of the beds which form the ridge of the mount, above the chief mining centre of the field, is practically 90°, and as the ridge passes southwards this vertical structure of the main beds is preserved.

The finer-grained beds on the eastern fall of the mount are mostly covered by button-grass, but appear to dip to the west.

Passing northwards, the main séries of conglomerates acquire an inclination to the eastward as the fault on Section 2796 is approached, and on the south side of the fault dip east at 80°. Across the fracture-plane the structure is different. The more westerly members of the conglomerate series lie at an angle of 30° with the horizon, while the eastern beds, from the centre of the ridge eastwards, dip east at 70°.

The change of dip is abrupt, and I think it is due, not to a movement of the crust after the formation of the whole series, but to a tilting of the region during the process of sedimentation.

The main fault that intersects the series is a dip-fault, and its effect can be clearly seen from Innes' track along the foot of the mountain on the western side.

The weathering of the bent strata and the breaking-off of blocks of rock across the joints and bedding-planes makes the sediments, when viewed from the track, appear to dip east on the west of the ridge at the south side of the fault gorge, and lower down on the same cliff faces to dip to the westward. However, the writer's observations showed that the dip was always to the east, or rather north-east.

The conglomerate series rests unconformably upon the complex of slates, porphyries, and porphyroids, with an unconformity between the two formations. The best position for observing this contact is from the south end of Mt. Farrell, and looking across the gorge of the Murchison River at the cliff section exposed on the southern side.

The vertical beds of coarse conglomerate on the western boundary of the series abut directly against the crushed conglomerate, which is the coarsest facies of the older crushed sediments. The divisional line is very sharply defined, and the older conglomerate has its planes of schistosity dipping away to the west at an angle of about 70°. The conglomerates are seen to continue right down into the bed of the river.

From the south side of this gorge, and looking northward, the beds appear vertical at the top, and yet as they approach the river seem to bend slightly and dip a little to the east. The inaccessibility of this portion of the mountain on the north side of the gorge prevented me from verifying this distant observation at closer quarters.

The conglomerate certainly comes right down to the river at this point, but the vast amount of boulders which have been broken away by the surface agents of decay and disintegration completely hide the actual contact of the conglomerate and the adjacent rocks at low levels. For the hard siliceous fragments broken away from the mountain crest do not easily disintegrate to form fine rock waste that can be borne away by the rivers, and accumulate at the foot of the gorge as a jumble of angular blocks of all shapes and sizes.

From the point where the river cuts through it, the conglomerate thins out on the south side, and disappears altogether not far to the east of the Tullah property.

At the northern extremity of the mount the same difficulty is experienced in finding the relations of the conglomerate to the rocks on which it rests, for the fragmental blocks conceal the junction.

The mountain seems to be split in two at its northern end by a strike fault. I could not find the actual fracture-line, for the cover of button-grass conceals everything. A trench on the gap between the two bluffs of conglomerate shows the underlying rock to be of the slate series, and one or two outcrops of slate appear on the slopes of the gap leading down to the river at the extreme north end of the mountain. The western portion of the conglomerate here seems to have been separated from the eastern by a fault. If so, the fault has the effect of producing an increasing downthrow of the displaced portion as we go north. No trace of the split is to be found southwards, and the conglomerate is, on both sides of the gap at the north extremity of the mountain, of the most massive type, so that the bedding-planes cannot be distinguished.

The conglomerate bluffs weather to bold, bare, rounded knobs, and support no vegetation. The button-grass has crept up high on the slopes, and even covers part of the ridge, but on the whole the outcrop is bare and sharply defined.

Fragments of all sizes of the conglomerate occur along the valleys of the Mackintosh and Murchison Rivers. These are, for the most part, just blocks which have reached their present position by the relative lowering of the rest of the region by the action of the rivers.

However, I noticed some large boulders, notably some of several tons weight near the Farrell Siding, distributed here and there at all altitudes throughout the district.

In a region whose river systems have been continually undergoing modification, these blocks may have reached their present places by river action, but there remains the possibility of comparatively recent glaciation to account for the distribution of these as erratics.

This conglomerate is similar in character to that which forms a capping on so many of the West Coast mountains; and in all probability the beds at Mt. Farrell belong to the same period of sedimentation as the other entirely similar conglomerates. However, there are, of course, many breaks in the continuity of the series, yet none so great that they cannot be explained by the existence of either original breaks or gaps since formed by crustal deformation and surface degradation.

With regard to the origin of the conglomerate at Mt. Farrell, there are several points of interest to be considered.

It has been stated that the massive type consists almost absolutely of well-rounded pebbles of quartz, and that these are considerable in bulk when compared with the interstitial sand and cement.

This uniformity in the composition of the pebbles, their general uniformity of size by the sorting-out of the finer material, the considerable regularity of the stratification along the original strike-line—all these argue for a local derivation by the action of the sea.

Contrast with them the pebble-beds forming at the present time in the channels of the Murchison and Mackintosh Rivers, and these features, especially the uniformity of size and composition of the pebbles, will be the more apparent.

The absence of pebbles of the porphyries and syenite seems remarkable, for the conglomerate admittedly overlies the complex of slates and porphyries uncomformably, so that these latter might well be expected to have contributed towards its bulk.

The quartzite and quartz schist pebbles seem to have undoubtedly been derived from the great masses of these rocks on the eastern side of the valley of the Sophia.

One is inclined to suppose that a tilting of the region took place at the time of the formation of the conglomerate which brought the sea-level to a line at the base of these quartzites, and below which the slates and porphyries were so far submerged as to be beyond the range of wave action. I am not aware of the nature of the rock formations which lie east of the quartzites, other than the mica schists (to be mentioned later) and the granite of Granite Tor.

Whatever be the mode of the origin of the conglomerate, there have been some changes since its formation. The tilting referred to above, and the fracturing of it, are subsequent; and in addition to these major movements, there has been a minute shattering of the whole series, and a later infiltration of silica. The whole of the formation is characterized by a complex of small intersecting veinlets of silica, which often cut through the pebbles and cementing matter as well, and the matrix seems to be rendered more dense by a siliceous impregnation.

With the silica is a certain amount of specular hematite. In spite of some rumours to the effect that galena was present, the only metallic mineral I found was this hematite.

At the level of the track passing through the gorge cut by the Murchison River, at the south end of the mount proper, there seems to be a tendency for the conglomerate to assume a schistose habit.

This is no doubt due to the stresses that have produced the tilting, and supports the idea that the beds have been bent upwards rather than that the whole series has been tilted as a block, and supports also the observations made from Little Farrell with regard to the structure of the series as a whole.

(3)—*The White Hawk Sandstones and Limestone.*

The White Hawk district, at the north-eastern extremity of the area examined, consists of a series of sedimentary rocks intruded by the granite porphyry dyke rock above described.

These sediments consist of three formations—a bed of limestone lying between a sandstone on the west, and a sandstone which has coarser pebble-beds interstratified with the finer material on the east.

The upper sandstone (western) of the series is fairly uniform and fine in grain. The dip is apparently in harmony with that of the other associated beds, viz., westward. The dip angle is 47° where it junctions with the limestone, but rises to 75° on the western boundary of the central White Hawk lease. The strike is about 10° east of north.

These beds proved fossiliferous at a point north-west of the original outcrop of ore discovered by Tom Farrell. The fossils have been referred to Mr. Robert Etheridge (Jun.) for description, and the remarks of that gentleman on them are appended.

The limestone is a massive one of a dark bluish-grey colour, wherein part of the calcium carbonate has recrystallized. On weathering the surface of the rock becomes irregular from inequalities in the rate of solution, but the ridges found on a weathered surface show no signs of organic structure. The bed at its lower side where it rests upon the lower sandstone has a westward dip of about 40°.

There are very perfectly developed joint-planes, of which the best-marked series dip eastward at an angle of from 50° to 60°. The action of surface-waters in dissolving out portion of the carbonate along these joint-planes renders their presence very prominent near the surface, and the rock seems at first sight to be dipping eastward.

As is usual in limestone areas, there are many cavities of solution visible at the surface, which have been gradually enlarged until they form caves. Most of these lead down into the heart of the rock through the progress of rock-solution along bedding-planes.

Their influence on the mining has so far not been serious, for the work done has been at shallow depths. The White Hawk Creek, at the mine, is running on the limestone just at its junction with the lower sandstone, and the water cannot but be a great hindrance to future working at a greater depth.

The drainage from the hill to the west of the mine also can be seen to find its way in part by underground channels to a lower level.

The lower sandstone formation consists of a series of normal sands and a course pebbly grit. Portions of the formation, especially on its lower side, have been silicified into quartzites.

The thickness of the whole series is only from 130 to 150 feet, but as the slope of the eastern side of the creek gorge almost coincides with the dip of the rock the thickness appears to be much greater.

Fossils were obtained from this horizon also, and with the others from the upper sandstone were submitted to Mr. Etheridge, whose remarks are:—

"I have examined the specimens referred to in your letter, and although very poor impressions, I believe them to be as follows:—

"(*a*) Sandstone below White Hawk limestone contains impressions of one of the varieties of *Rhynchonella borealis*, Schlotheim, a well-known and widely-spread Silurian species.

"(*b*) Sandstone above White Hawk limestone contains many impressions of the brachiopod I have from time to time identified from Tasmanian strata as *Rhynchonella capax*, Conrad, and named var. *meridionalis*, and still believe to represent that species. In America it is one of the fossils characteristic of the Hudson River Group."

So the age of this sedimentary series is definitely fixed as Silurian.

There are two points of interest in the geology of this area when considered together with the rest of the district. It is noticeable that the coarser sediments—the pebbly grit referred to above—are on the extreme east of the series where the formations rest against the granite porphyry. This feature is in harmony with the relationship of the older crushed sediments—slate and crushed conglomerate—to the structure of the district.

Further, the still more noticeable feature of these rocks that distinguishes them from the other rocks of the district is the freedom from the signs of intense crushing.

While it is true that the small area here considered has not yielded to the intense crushing to the same degree as the rocks to the west and south-west, the series must have had a very great pressure to withstand; for to the west lie the slates and porphyroids, that bear witness to dynamical stresses in the immediate neighbourhood.

The whole block of country of which these strata form but a portion may have successfully withstood the crustal movement, and though the rocks have been tilted their particles may not have been forced over each other and drawn out in lenses. The nature of the rocks is such that the crushing stresses could have left but little traces; yet the block may have been part of the "foreland" against which the crushing of the other rocks has taken place.

But even so, the proximity of the highly altered rocks to the west makes one reflect further on the remarkable preservation of the original characters.

In my opinion the simplicity of the chemical composition of the sandstones and limestones has had a good deal to do with the absence of alteration.

Contrasting these rocks with the porphyroids we see a chemical composition of marked simplicity as against the equally marked complexity of the constitution of the igneous rocks.

Mention has already been made of the fact that all the members of the syenite-felspar porphyry series are probably very closely related in chemical composition, although their texture and mineral constitution varies continually. And these variations are beyond doubt due to varying physical conditions imposed upon the different facies at the time of their solidification. A variation of the physical conditions after consolidation, namely the subjection of the rocks to intense lateral pressure, has caused a secondary readjustment of the molecules, and the reorganised porphyries become porphyroids.

The several minerals of secondary origin, notably epidote, calcite, albite, and quartz, all take their origin by variations in the physical conditions to which the rocks are subjected.

But in the case of rocks that are almost wholly composed of calcium carbonate or of silica, no such molecular readjustment is possible. The originally finely divided calcium carbonate may crystallize and form a crystalline limestone, but no further change can result.

(4)—*The River Gravels.*

The only remaining sedimentary rocks of the district are the river-bed deposits, for the most part unconsolidated. The present rivers have cut their way down through an older alluvial accumulation that bears strong resemblance to that forming in the flatter reaches of the rivers now. The broad plain that lies at the foot of the western flank of Mt. Farrell is dissected here and there by streamlets that make towards the present-day rivers.

The deposits of this old flood-plain are a series of beds of gravel and sand, with the coarser beds at the bottom and the finer above them. The pebbles are of all sizes, and of very varying composition, although the quartose ones predominate. Many of these have undoubtedly been set free from the conglomerate of the ridge of the mount; and there are pebbles of the conglomerate itself containing several of the older pebbles and their cement all smoothed down together to form the single pebble of to-day.

These river alluvial deposits are restricted mainly to the broad plains through which the main rivers run, but I also came across a few small terraces on the White Hawk Creek which were formed of river gravel.

C.—THE METAMORPHIC ROCKS.

The alterations that have been effected by regional metamorphism in the rocks of both sedimentary and igneous origin have already been described in dealing with those groups.

There remain only some types whose unaltered state is now not so clear that we can trace the nature and degree of alteration from the original condition.

The Quartz Mica Schists.

These metamorphosed rocks form a fringe along the eastern boundary of the district, and are of chief interest in that they have contributed so largely to the formation of the massive conglomerate of the mountain.

Their relations to the slates are not to be seen on account of the broad flood-plain of the Sophia River and its dense cover of button-grass. However, there seems to be some definite continuity between them and the sedimentary series of the White Hawk district.

The writer was able to make no more than a cursory examination of this outer fringe, but it may be well to record the observations that were made.

Ascending the north-western spur of Mt. Swallow, which rises from the White Hawk Creek at the mine (see the sketched locality plan), the granite porphyry becomes a little finer in grain, and then a white quartzite is met with, which contains a little pale mica here and there.

The massive quartzites and the micaceous varieties or quartzitic schists seem to be inextricably intermixed, and their extent towards the east is considerable—about 2 miles. The only mineral contents of this belt with which I met were a small blow of hematite on the Mole Creek track, on the north-west side of Mt. Swallow, and a little disseminated arsenical pyrites further south.

Following the Mole Creek track eastwards the quartzite gives way on the eastern side to a broad belt of rock, which becomes more and more micaceous. Bands of the almost pure quartzite recur, but the rock here is normally a mica schist, which in some places becomes so fine in grain as to resemble a normal slate. These mica schists are quartz-biotote-muscovite aggregates, and show some local contortion of the bands. The planes of schistosity usually dip west.

This rock continues right up to the acid granite of Granite Tor, and seems to overlap the granite at the contact. Southwards from Mt. Swallow the Mole Creek track passes over the same quartzites and quartzite schists, and the bare bluffs on the eastern walls of the valley of the Sophia River are of the same material.

The granite porphyry is met with on the track a good deal further east than the White Hawk occurrence, and the quartz mica schists also seem further east. On the present visit I was unable to determine whether the strike takes a south-easterly bend on passing south, or whether the granite porphyry widens on its southward continuation, or whether a dip-fault has displaced the series.

The only other occurrence of similar rock types in the field is at a point between the White Hawk Mine and the Tullibardine.

A series of low, sharply defined ridges, running a little east of north, on the eastern side of the Mackintosh River, are formed of a dense quartzite, which carries a little pale green mica.

The western scarps of the ridges are very steep, and are covered with disintegrated blocks of this quartzite. This boundary suggests that there is a fault-plane striking north and south, but the button-grass completely covers all the surrounding country. To the east lies the upper sandstone of the White Hawk series, and to the west are the slates of the Tullibardine area, but the junction-lines are invisible, and the presence or absence of any intervening strata undetermined.

(2)—The General Sequence of Events leading to the Present Geological Structure.

The following are the principal events which have succeeded each other in the area under consideration. They are presented in the order of their occurrence, as far as can be ascertained from the study of the rocks themselves and their field relationships.

1. *The First Period of Sedimentation.*—The series of sedimentary rocks, of which the slates of Mt. Farrell form the most considerable portion, appear to be the oldest rocks on the field. The passage from a conglomerate on the east through grits to the slates on the west seems to indicate a gradual submergence of an old basin. The old floor on which these sediments were laid down is not now recognisable; unless it be the quartzites and mica schists which outcrop on the eastern side of the valley of the Sophia River.

As regards the age of the slates, it can hardly be fixed as yet. Lithologically their resemblance to the Dundas slates is marked. These latter are fossiliferous, and of Ordovician age. But at Mt. Farrell no fossils have been recognised in this formation.

The slates may quite possibly have been contemporaneous with the sediments of the White Hawk area, now known from fossil evidence to be Silurian.

2. *The Intrusion of the Older Igneous Rocks.*—While it may be that these rocks are, in part at least, older than the slates, the writer considers the bulk of the evidence points to their later appearance.

The rocks which now appear as diverse types seem to me to belong to one great series, and to have resulted from one magma. The syenites, quartz porphyries, felspar porphyries, and their schistose derivatives show a remarkable difference between the south-eastern and the western portions of the district. In the former there are the holocrystalline types, between the two are the evidences of intrusion into the slate series, and on the west are the volcanic members. The suggestion at once presents itself that we may have here the various phases of a great intrusion of igneous material, of which the portion which remained far below the surface solidified and formed the holocrystalline syenites. Portion may have spread laterally in the form of sills through the slates, and another portion again may have reached the surface to form lava-flows and volcanic tuffs.

It is certainly possible that the intercalated sheets of porphyroid were contemporaneous lava flows; but some of them are certainly intrusive, and some also are effusive.

At least two horizons of the fragmental type of porphyroid were detected—one near the main road of the Tullah township, and one at the junction of the Mackintosh and Murchison Rivers. The great thickness of the porphyroid to the west of the slate appears to be due to a great succession of lava flows.

The relations of these igneous rocks to the slates will always be somewhat obscure, on account of the subsequent alteration. There are very few visible outcrops of the junction lines, and the distinction between the two groups is sometimes very difficult in the field.

If this hypothesis be correct—and there are no discrepancies between the evidence afforded by either the igneous rocks or the associated sediments—the eastern portion of the field, now at the level of the surface, must have been deeply buried. The coarser sediments of the slate series would thus be the lowest beds of that series, and the syenites typical plutonic rocks.

3. *The Inversion of these Rocks before the Formation of the later Conglomerate.*—The newer conglomerate and its associated finer-grained sediments show a marked structural contrast to the older sediments on which they lie unconformably. The eastern beds in the newer conglomerate are the finer, and the western beds are coarser. And the appearance presented by the conglomerate as a whole gives the impression that the western beds were the first formed of that series. This being so, the whole of the pre-existing formations must have been completely inverted by folding. If the igneous rocks are, as considered by the writer, older than the conglomerate, they must have shared in the folding.

In this tremendous crumpling of the crust a very considerable degree of schistosity must have been developed in the folded rocks, and at a date prior to the formation of the newer conglomerate.

This folding may have produced the fractures which have later served as circulation channels for the metalliferous solutions.

4. *The Formation of the Newer Conglomerate.*—Following upon the lastmentioned folding of the region came the submergence of the area and the formation of the conglomerate (and the sandstones of the same series).

The submergence may have been such that most, if not all, the igneous rocks were below the reach of wave action, and if so the absence of pebbles of these rocks would be accounted for.

The age of this rock formation is considered by Mr. G. A. Waller to be Upper Silurian.* He refers the red conglomerates of the West Coast to the base of the Upper Silurian, since the fossiliferous strata of the Upper Silurian period rest conformably on them at Zeehan.† Also on Mt. Jukes the sandstones interbedded with the conglomerate contain Upper Silurian fossil remains.‡

There are sediments of Upper Silurian age in the White Hawk area of the Mt. Farrell district; but their relation to the massive conglomerate of the mountain is not yet known.

During the formation of the conglomerate and its accompanying sandstones there was at least one further tilting of the region. For the eastern beds at the northern end of the mount are not conformable with the western. The eastern beds dip towards the western, but there is no folding. I believe the change of dip is purely an unconformity, not a synclinal fold. At all events, I could not see any repetition of the coarser beds, as might have been expected if a fold were present.

South of the fault which traverses Section 2796 the dip of the eastern beds is less easily recognised, on account of the cover of button-grass on the east side of the ridge.

5. *The Folding of the Region in Late Silurian or Devonian Time.*—After the formation of the sediments of Upper Silurian age, the region suffered yet another lateral thrust. Under the stress the crust was again buckled, and the tendency of the movement was to restore the older sediments (of the slate series) to their former position.

The conglomerate of Upper Silurian age was by this movement tilted almost upon edge, for the greater part of its extent at Mt. Farrell.

A great fracture occurred during or after this folding, and is marked by the fault plane near the northern extrem-

* G. A. Waller: "Report on the Mt. Farrell Mining District," 1904, pp. 2 to 6.

† *Ibid.*, p. 4. ‡ *Ibid.*, p. 6.

ity of the mount. And the rocks south of the fracture plane have been pushed to a higher angle than those to the north of it.

This crustal movement would undoubtedly cause the development of a schistose structure throughout the region, and all rocks of greater age than this period would be affected by it. The conglomerate appears but little affected. The slates and igneous rocks, which may have already, as explained above, been rendered schistose, would have their schistose character still further intensified. The direction of the strike of the planes of schistosity in general conforms to the axial strike of the mountain, although local variations do occur.

At this period, if not at a still earlier date, the shales became slates. The pebbles of the older conglomerate were drawn out, and a schistose mantle formed round the felsitic rocks. The holocrystalline rocks, too, were crushed, but the signs are less apparent.

Accompanying the minute crushing there may have been developed at this period some at least of the fractures, which later became impregnated with metallic ores. The siliceous rocks of the mountain, the conglomerate and sandstone, are fractured in all directions, and are recemented by a later infiltration of silica.

The sedimentary rocks of the White Hawk area are tilted, but otherwise unaffected, except perhaps by the development of a few fractures, the position of which is very hard to determine.

6. *The Intrusion of the Devonian Granite of Granite Tor.*—The plutonic mass of granite at Granite Tor intruded at a date later than the crushing of the older rocks of the district. It is a granite which is distinctly more acidic in composition than the members of the older igneous series. But still more marked than the difference of composition is the freedom from signs of crushing in this more acid granite.

I was not able on this visit to examine in detail the relation of this granite to the remainder of the rocks of Mt. Farrell and the neighbouring districts. However, in my opinion, it is more than probable that the outcrop at Granite Tor is merely one point where the agents of denudation have laid bare portion of a huge granitic mass which possesses in depth unbroken continuity.

We do know of the outcrop of an entirely similar granite at several other points, namely at Cox's Bight, Heemskirk, the Meredith Range, Hampshire Hills, and the Dove

River. Moreover, at the Renison Bell Mine, near Rosebery—a locality intermediate between the points where the granite outcrops—there are tourmaline-bearing quartz porphyry dykes. In the same neighbourhood, at the Colebrook Mine, there occur the borosilicate minerals axinite, datolite, and danburite. These occurrences both point to the existence of the granitic mass below the surface. For the tourmaline quartz porphyry dykes are the apophyses of such a mass, and the borosilicates are beyond doubt the result of the reaction on the country rock of the boric emanations given off from a cooling granitic magma.

From this it appears that the Mt. Farrell district is underlaid in depth by the granite which appears to the east at Granite Tor and to the west at the Meredith Range and Heemskirk. And the existence of the mica schists lapping over the granite on the sides of Granite Tor supports this view. For these mica schists appear to be sediments of varying grain altered by contact metamorphism, and the granite dips under them where I investigated the junction of the two rocks on the western flanks of Granite Tor.

The period of the intrusion of this deep-seated mass of granite, which has certainly liberated the mineralizers and given rise to the ore deposits at the localities abovenamed, must have been later than the Upper Silurian and previous to the Permo-Carboniferous.

In deciding this matter of age, it is necessary to regard the various outcrops of this uncrushed granite as outcrops of a single geological unit. For my part, I consider that we are justified in doing so. The evidence regarding the age is conclusive, and may be briefly cited under three heads*.

(1) The rocks of greater age than the Upper Silurian are folded and rendered schistose by the disturbance of the region. The granite in question is free from such foliation.

(2) The granite is known to be intrusive into the ultrabasic igneous rocks of the gabbro, pyroxenite, and serpentine types at Trial Harbour. These ultrabasic rocks are intrusive into the Upper Silurian strata at Heazlewood and Zeehan. The granite and gabbro may possibly be two extremes of differentiation of one original magma; and the granitic veins in the

* See G. A. Waller: "Report on the Zeehan Silver-Lead Mining Field, 1904," p.p. 11 and 12.

serpentine may be the result of final stages in the consolidation of the one main mass. However, even if this is so, the gabbro-granite magma has intruded into strata known from fossil evidence to be of Upper Silurian age. Also, the granite intrudes into the peculiar sandstone, which has been called the "pipe-stem" or "fucoid" sandstone, at the Dove River, and the River Forth, in the Middlesex district.

(3) On the other hand, the granite is not intrusive into the Permo-Carboniferous strata, but exists in the form of rounded pebbles as a constituent of the conglomerates of that system; and at Ben Lomond the Permo-Carboniferous strata have been observed to rest upon the denuded surface of the granite.

7. *The Period of the Deposition of the Ores.*—After the main period of crushing of the country rocks of the field came the filling of the fissures, which were either already prepared for the impregnation by the previous crushing, or were superinduced upon the crushed rocks by later stresses. We know that this filling of the fissures was of later date than the crushing, as we find fragments of the crushed rocks cemented into the uncrushed lode matter. Yet by this statement it is not intended to convey the impression that all movement had ceased at the time of the filling of the fissures. For it will be seen later that the lodes themselves show signs of movements which have brecciated their metallic contents.

The filling of the fissures must have taken place at more than one period, for there seem to be two distinct types of vein-stuff.

The first impregnation appears to have been a siliceous one, and to have produced quartz-veins free from metallic minerals other than iron pyrites.

Later, there must have been still further strains developed in the rocks of the district, and a fresh set of fractures resulted. Some of these cut across the original quartz-filled fissures, as may be seen in the section exposed by the open-cut of the North Mt. Farrell Mine. It is to this later filling, with its prevalent gangue of iron carbonate, that the productive lodes are due.

The age of the fissure-filling I believe to be that of the intrusion of the Devonian granite; and I believe the introduction of the metallic ores to be due to the intrusion of that mass. It is now a firmly established fact that the later stages of the consolidation of a deep-seated mass of granitic composition are accompanied by the emission of highly heated vapours, which, under such conditions of high temperature and pressure, have the power of holding in solution metallic compounds.

On their expulsion from the igneous rock, and during their ascent into the upper regions of the earth's crust, they experience a fall of temperature and pressure which eventually suffice to cause precipitation of the metallic contents in the channels which are serving at the time to carry the vapours or solutions upwards.

It is, I believe, to the Devonian granite that we must look for the immediate source of the metallic compounds of the Mt. Farrell district; and the age of the impregnation is therefore that of the final stages of the granitic intrusion.

8. *The Events subsequent to the Formation of the Lodes.*—The events of later date than the vein-filling, which have modified the geology of the district, are two in number:—

(1) Further movements have taken place between the already fractured segments of the crust. These readjustments have modified the structure of the lodes themselves, since the former fissures have remained planes of weakness, and the strains have been relieved by their reopening and the differential movements of the walls.

(2) Surface agencies have operated on the region, and carried away much material, and deposited the river alluvials. These agencies have not been uninterrupted by movements of deep-seated origin, for we find the older river flats cut into by the warping of the region since their formation, with the consequent revival of the corrosive power of the streams.

V.—ECONOMIC GEOLOGY.

(1)—The Relation of the Ore-bodies to the Several Rock Types.

When any one single mining property on the Mt. Farrell field is considered apart from the surrounding leases it may appear that the ore-bodies are restricted to a certain lithological group.

In other words, the nature of the country rock may appear to have influenced the lode in the several particulars of width, mineral composition, richness, or even position.

It is a matter of most vital importance to the field that this matter should be carefully considered.

The guidance of the present development work on the mines is not the only point at issue. The whole feature of the district, and the further prospecting for the yet undiscovered lodes, are concerned with the correct interpretation of the geology of the known parts of the field.

And in the examination of these known facts it is absolutely necessary to regard the field as a whole. The several properties are dealt with separately in a later part of this report, and their particular features noted. At present the matter of the lode phenomena exhibited by the field as a whole will be discussed, and the changes in the composition and structure of any one single lode at different points along its course taken into consideration; for the boundaries marking-out the mining sections are artificial, and have no place in the general discussion of natural phenomena.

This matter may seem perfectly obvious, and not worthy of mention; yet it is owing to an exaggeration of the value of local phenomena, and the attempt to make these of general application, that no little energy and capital have been fruitlessly expended on the Mt. Farrell field.

It is an old-established view held by many mining men that the metallic contents of ore deposits have a genetic relationship to the country rocks with which they are associated.

The practical aspect of this statement means that if the country rock, which is usually of great extent as compared with the lodes enclosed in it, and easily found, be sufficiently diligently searched, the possibilities of the discovery of lodes are great; and, moreover, it is held that in some classes of country rock lodes of one composition will be found, and in other rocks there will be lodes of different composition.

It does not seem possible to separate this view from the idea, even if no actual expression is given to it in so many words, that the country rock is responsible for the formation of the lodes; that is to say, that by the action of some process or processes the country rock has actually provided the metallic contents of the lode. The ore-bodies are thus thought to be merely the metallic contents of their country rocks gathered together in a concentrated form.

And there are many occurrences of the metallic ores that lend colour to this view, and which will lead the prospector astray unless he is careful to distinguish between the great classes of the country rocks enclosing within their boundaries the metallic minerals sought by the miner, viz.:—

(*a*) The country rock which is part and parcel of the same rock-mass from which the ores also have been derived, *i.e.*, which has certain definite genetic relationships with the ores.

(*b*) The country rock which has had fissures formed in it by the action of internal or external causes, or which has from the time of its formation held certain cavities which may act in the same way as superimposed fissures.

These cavities, in this class of associated country rocks, supply only the empty place for the lode-filling, which is introduced from without in solution. These solutions are now generally admitted to be ascending hot solutions similar to those which appear at the surface in volcanic regions, or which have been tapped by mining operations.

That they derive their aqueous content, their heat, and the metallic salts in solution from some deeply seated igneous rock is now also admitted by most mining geologists.

The deposition of the metallic ores in the cavities through which these solutions circulate on their ascent, is due to definite physical and chemical laws; the chief causes of precipitation being the decrease of the temperature of the solutions in their ascent, and the lessening of the pressure to which they are subjected.

(*c*) The country rock which has has held disseminated through its mass a certain small proportion of some metallic compound, and from which meteoric waters have leached out the metallic content, once widely disseminated, and have redeposited it in more concentrated form in the larger cavities or fissures.

When once the prospector has realised that these several classes exist, he must learn to interpret the phenomena of the field with which he is concerned, and to decide the class to which the ore deposits of the district belong; for the genesis of the lodes is the most important point to be decided when future operations are being planned.

Applying the above generalities to the case of the Mt. Farrell lodes and their surroundings: The relationship cannot be that of the first class above mentioned, in that we find lodes, whose general similarity will be indicated later, occur in rocks of widely different origin, viz., the slates which are undoubted sediments, and the porphyries or their derived schistose types which are certainly of igneous origin.

Although the occurrences of tin and some other ores, and perhaps even some silver-lead ores, are of this character, the lodes of Mt. Farrell cannot possibly be considered to bear this relationship to the rocks within which they are contained.

It remains then to decide between the other two types.

The criteria by which we are able to judge whether the lode-material was introduced from without, or whether it was gathered together from within the enclosing rock-mass, are several.

Of greatest importance for this purpose are a series of exact analyses to determine the amount and distribution of the metals in the country rock, and the state in which they exist there; that is to say, whether the metal is present uncombined, or in combination with sulphur, or as a constituent of the rock-forming silicates. This work has not been attempted with regard to the field in question; but extremely valuable and laborious chemical work has been performed on other mining fields, from which general conclusions have been drawn.

The great majority of metalliferous lodes may, by the application of these methods, be shown to owe their metallic content to the introduction of the material from sources outside of the immediately enclosing rocks. This is a general statement that is applicable to most ore veins, and the so-called "lateral secretion" theory cannot be made applicable to more than very few mineral occurrences.

In the disproving of the views of the believers in lateral secretion, the most elaborate work that has been done was performed at Freiberg, whose lodes offer several points of similarity in composition to those of Mt. Farrell.

In making the above general statements it is assumed that the lodes of Mt. Farrell do not differ as regards origin from those of other similar mining fields.

There are certain other features presented by the lodes and the country rocks which point to their mutual independence.

Lodes of the same character, possibly even different portions of the same lode, are found to occur in both the massive felspar porphyry and the schistose porphyroid on the south side of the Murchison River. Whether the lode that is now being prospected by the Thomas' Blocks Company extends northward into the slate belt is not determined so far. If it does, the example taken becomes still more instructive, and proves, for that part of the district at least, that lodes are not restricted to the igneous rock and its derived schist.

We know, for the more northerly part of the field, that the productive lode of the Murchison River Mine is in the porphyroid, and those of the North Mt. Farrell mines are in the slate.

It is true that in the case of the Murchison River Mine the presence of the porphyroid seems to be necessary for the existence of the lode. This is one of the cases which calls for further investigation.

In a later portion of this report it will be seen that the Murchison River lode is one the strike of which varies considerably from that of the other lodes of the field, and the course of which cuts obliquely across a narrow belt of porphyroid enclosed within the slate. The productive zone in the lode is restricted, as far as has yet been determined by mining operations, to the zone which is enclosed between walls of porphyroid. The lode-fissure extends beyond the porphyroid band on both the northern and southern side; but it has obviously pinched at each end, and the small amount of prospecting work done in these two directions has not yet disclosed an ore body of sufficient size to be payable.

Yet the lode-channel is continuous, and galena is visible on its track, as well as the siderite which so commonly accompanies the lead ore on this field.

With regard to these phenomena, the writer is strongly of the opinion that the existence of the broad ore-shoot in the porphyroid and the relatively narrow track of the ore in the slate is due, not to the difference in composition between the two rocks, but to the difference in the behaviour of these rocks when they were subjected to the strains which resulted in the fissure now traceable by its ore-filling and the development of characteristic minerals along its course.

There are no two rock-masses of the earth's crust which can be expected to behave in exactly the same way under strains sufficient to produce deformation; and in this case the physical dissimilarity between the two rocks is considerable. The porphyroid at this spot is a very massive type, with few of the markedly schistose characters. It appears to have broken, under the deforming stresses, along a plane, in the same way as a brittle object might break if submitted to such treatment.

But in the case of the slate, the trace of fracture, though quite distinct, is not clean cut as in the porphyroid; it is rather a fracture zone. Moreover, the two walls of the fracture appear to be different in the two rocks where the lode is in porphyroid; the alteration of the country rock and its impregnation with the lode-matter is slight and the wall is clean. On the other hand, the slate carries the lode-material disseminated through it beyond the actual fracture.

All this evidence points to the fracture having been one of actual displacement when it was formed in the porphyroid, and to its having been a "distributive" break in the slate; that is to say, although the total result may have been the same, the single fracture has its place taken by an elaborate system of minute dislocations. This fracturing was of prior date to the utilization of the cavities by the metalliferous solutions.

The nature of the fractures has undoubtedly had a great influence in governing the distribution of the circulating metal-bearing solutions; but beyond this the influence of the country has not been effective in the control of ore-deposition.

Another case that calls for investigation, as it seems to have given rise to a belief that change of country has been accompanied by change of the lode-filling, is that of the copper lode exposed by trenches on the northern section of the Mackintosh leases.

This occurrence of copper is situated in the narrow belt of pale-coloured clay schist very close to the slate boundary. Now, in the same mining section in the south-west corner the slate contains the galena lodes which have been worked, off and on, by tribute parties; and in this case the pale clay schist lies a little to the west of the lodes, so that the impression is given that the lead lodes are present in the slate and the copper in the clay schist.

I regret that no work has been done to try and expose the geological structure between the two occurrences mentioned. Still I am of the firm belief that they are both on one and the same lode-fissure, and that this lode-channel traverses at a very small angle the junction-line between the clay schist and the slate.

The occurrences spoken of are directly in the line of several other outcrops, and it seems to me more than probable that the series are on a continuous fracture system.

As regards the change of composition of the lode-filling with the change of country, the alteration is neither so abrupt nor so considerable as is generally thought.

All through the field there is present, in constant association with the galena, a certain amount of copper pyrites. In all the mines it is noticeable, and at times is found in considerable bunches, even in a mine so free from other metallic minerals than galena as the North Mt. Farrell.

The same variation in the lode-filling is noticeable with respect to other minerals, namely, in the distribution of zinc-blende and the antimonial ores.

The inference to be drawn from these local concentrations of one or other of the metallic minerals is that from point to point along one lode-channel or along the general line of fissuring in the district there have been variations in the relative proportions of the different metallic elements present in the solutions which have brought the ores into the fissures; and these variations have occurred during the primary filling of the fissures, and are not secondary phenomena caused by the leaching-out from the lodes of one or more other mineral constituents, for the variations are noticeable where the lodes are perfectly free from all signs of weathering, leaching, or secondary deposition.

The common feature shared by both the copper and lead deposits on the Mackintosh northern section is the development of siderite as a gangue mineral. This fact affords additional evidence that the mineral-bearing solutions in each case have been of the same character, although the proportion of the metals present has varied.

And still more conclusive is the fact that in the south-west corner of the Farrell Blocks section, north and adjoining the Mackintosh property, there is a lode-formation which I take to be the continuation of this same series, and in which both galena and copper pyrites occur. Here the lead content seems to be once more asserting itself, and is noticeable further north on the Farrell Blocks property, and in the section, No. 2909, further north.

Again, it should be pointed out here that in the case of the prospecting work that has been done on the Tullibardine property a few miles further north, the same alternations of lead and copper ores are to be found; and some parts of this area show both lead and copper occurring together.

Where the two metals seem most cleanly separated from each other on the Tullibardine lease, the country rock is the same—the pale clay schist.

With this evidence of actual facts of occurrence before us, the control of the country rock on the lode-filling can be hardly appreciable, as regards primary ore-deposition; and the Mt. Farrell district does not show any feature which is not open to question in favour of the interrelation of the lodes and the walls enclosing them.

Before leaving this subject there remains the question as to whether the silver content of the galena in the White Hawk Mine is affected by the fact that the lode is in limestone country. I have heard it stated on the field that a high, or even average, silver content could hardly be expected on account of the presence of limestone, and parts of the Zeehan field were mentioned as affording similar instances.

This has been recorded by Mr. Waller, in his report on the Zeehan field (page 17).

It is a question which requires a good deal of detailed investigation before any explanation can be given of the phenomena. As regards the White Hawk property, the ore from which low silver returns were obtained is thoroughly oxidised, and the progress of weathering may alone account for a relative impoverishment in silver.

There is no doubt but that the silver content of the ore would be removed more rapidly than the lead by oxidation and leaching; and I have seen assays of the White Hawk galena which are of normal tenor. Whether these show the average value of the ore remains to be seen. At least some of the ore is not below the average of the field, and it may prove that the low values obtained from the gossans are due to weathering; and in limestone country it is well known that oxidation proceeds to a very much greater depth than in other rocks less permeable to meteoric water.

(2)—The Ore Bodies of Mt. Farrell.

It is found that metallic ores are almost invariably discovered grouped together in certain definite associations with each other, and with certain characteristic gangue minerals. These constant associations give a few well-defined paragenetic groups or lode types. And the lodes of Mt. Farrell, while differing among themselves, conform strikingly to some of the well-known lode types.

A.—LEAD ORES.

The Spathic Lead Ores.

Beck defines this type in the following words* :—

"In this class the gangue consists essentially of the carbonates, calcspar, brownspar, rhodochrosite, siderite, and quartz. The ore minerals are argentiferous galena, argentiferous sphalerite, and less often, pyrite, marcasite, tetrahedrite, both with and without silver, together with high-grade silver ores, especially ruby silver and argentite.

"The structure is usually imperfect, and but seldom well branded. The ore minerals frequently occur sprinkled through the gangue."

It is to this type that the main producing lodes of the district belong. The lodes that have been worked on the Mackintosh property, the North Mt. Farrell and the Mt. Farrell leases, all conform closely to the type.

The only feature in which these lodes differ at all from the description of the general type is this—that there is uniformly present in the lead ores a certain amount of copper pyrites, and more of the copper than the iron pyrites.

This copper pyrites is sometimes very prominent in bunches, but usually occurs as small irregular blebs scattered through the lode.

On the south side of the Murchison River the same general lode type is the characteristic one, and the ore of Thomas' Blocks shows the features best.

The Tullah Mine exhibits a difference of lode-structure that may seem to mask its mineral composition, but the same lode type is undoubtedly represented.

To the north of the main productive area, the type again recurs where the lead is found on the Tullibardine property.

With regard to the gangue minerals that are associated with the galena the carbonates are practically always strongly predominant. (Reference is being made here to the lead lodes, not to the barren siliceous quartz reefs.)

There is usually a little silica either restricted to a certain zone or in irregular veinlets and bunches in the gangue.

The carbonate mineral is usually siderite, but minor amounts of calcite, dolomite, and intermediate varieties like ankerite also occur.

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* Weed's translation: "The Nature of Ore Deposits," Vol. I., p. 243.

These carbonates containing less iron are noticeably present where the enclosing walls are freer from iron, as where the lodes traverse the pale clay schist or the porphyroid.

The proportion of lead to zinc sulphide varies very much in even the same mine; yet zinc-blende is not such an important mineral as in the sulphidic ore of the Murchison River Mine.

Of the antimonial ores there seems to be a very irregular distribution. They occur rather in pockets and bunches in a lode, the general character of which is quite normal. These bunches usually afford high returns on account of the fahl-ore, which carries silver, as a rule. The occurrence of this class of ore seems most common in the Central Farrell and the Murchison Extended (lately North Murchison) leases, Sections 1980 and 1075.

I have been informed that ruby silver ore has been seen at various times in small amount on several of the mines, but did not meet with any specimens during my examination of the field.

At Thomas' Blocks there occurs, in addition to the carbonates, a small amount of white and purplish fluorite on the walls of the lode.

The Pyritic Lead Deposits.

Beck's description of the type is this*:—

"In the pyritic lead veins, quartz, galena, sphalerite, pyrite, arsenopyrite, and chalcopyrite are most abundant. As accessory constituents of the gangue we have hornstone, jasper, ferruginous quartz, calcspar, siderite; more rarely, brownspar and chlorite . . . The vein-filling has a prevailingly massive structure, in which the vein minerals occur, either commingled or in separate compact masses. More rarely the ingredients are arranged in bands."

To this description the ore of the Murchison River Mine answers almost in every particular. In addition to the sulphides mentioned, pyrrhotite is common. The blende seems the most abundant of the sulphides, but the others all appear predominant in various parts of the lode.

Among the gangue minerals there is usually a little siderite near the walls, but it is inconsiderable; and in one spot in the centre of the formation there was a small

* Weed's translation: "The Nature of Ore Deposits," Vol. I., pp. 235 and 236.

clean pocket of barytes. The ore also carries gold in small amount.

Other Occurrences of Lead Ores.

Here and there, on the south-eastern portion of the field are occurrences of galena associated with chalcopyrite, and no traces of walls are visible. The country rock is chloritized quartz keratophyre or quartz felsite, and the ore occurs as scattered blebs in the rock.

These deposits, as far as can at present be determined, do not seem likely to produce much ore.

Yet another type of occurrence is to be seen on the slopes of Mt. Murchison, on Section No. 2865, where the galena is associated with barytes and actinolite, together with calcite and quartz.

This may possibly correspond to the type of veins called by Beck the 'barytic lead veins."*

"In this class of veins," according to Beck, "the gangue consists of predominant barite, with fluorspar and quartz or jasper, besides calcspar. These minerals are generally intergrown in a remarkably thin-banded structure. The barite especially occurs in finely-crystalline crusts (calc-barite); the fluorspar in diverse tints, but mainly green and yellow. The ore minerals, which either form thin crusts or appear sprinkled through the gangue, consist of argentiferous galena, often developed in large flakes, pyrite and marcasite; also zinc-blende, copper pyrite, gray copper, and at times rich silver ores."

In the occurrence on Section 2865 no sign of fluorite was seen. However, it may have been present, as there was only a very small excavation to examine at the time of my visit.

The gangue is a mixture of quartz and barite, and iron pyrites is associated with the galena. Coarse columnar actinolite is associated with the gangue on the borders of the metalliferous area; but there is far too little done on the work to determine anything more than the presence of the minerals mentioned.

The other occurrence of lead ore is that between Kitson's workings and this last-described deposit. The galena occurs as fine dust-like particles in a very pure barytes. There is no sign of an economically valuable lead deposit here. The barite is treated of in a later portion of this report.

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* Weed's translation: "The Nature of Ore Deposits," Vol. I., p. 258.

B.—COPPER ORES.

The Cupriferous Veins.

The most considerable amount of copper present on the Mt. Farrell field is found in veins of a rather strange type, to which some reference has been already made.

In the opinion of the writer, they are closely connected genetically with the spathic lead ores, and are due to variations in the composition of the ore-bearing solutions at different points along the fracture system.

Both quartzose and spathic copper ores are well-known types found in many parts of the world. The occurrences at Mt. Farrell resemble to some extent the spathic ores described by Beck in these terms*:—

"The gangue of these veins includes some quartz, but often consists chiefly, and sometimes entirely, of various carbonates, particularly ironspar, as well as calcspar and dolomite.

"Barite is very common, and is at times accompanied by fluorspar. The ore minerals are chalcopyrite, bornite, glance, tetrahedrite, and pyrite. Cobalt and nickel ores and various other ores also occur as accessory minerals."

This description applies to parts of the cupriferous bodies at Mt. Farrell; but the usual gangue is almost wholly quartz with small stringers of carbonate, and the primary ore is almost always, if not always, chalcopyrite.

If the views stated above are correct, viz., that these copper occurrences are local variations from a somewhat similar lead type, the gangue is apt to become very much more siliceous where the copper is present.

Both the Mackintosh and the Tullibardine ores are strikingly similar, and are of this character: In immediate proximity to each, galena is to be seen, both alone and in association with the copper pyrites.

Unfortunately, both properties are but little developed, and future operations will afford much more information on this subject.

The Disseminated Ore of the South-eastern Sections.

The Osborne Blocks and the more southerly sections show several minor occurrences of ore which do not appear to be fillings of the usual types of fissures. They seem rather to be lenses of ore disseminated through the somewhat altered country rock.

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* Weed's translation: "The Nature of Ore Deposits," Vol. I., p. 226.

One such occurrence on the Osborne Blocks is in immediate proximity to a large blow of hematite; but whether the two have one origin it is impossible to say.

In these cases the copper ore is almost always chalcopyrite. Some bornite is present at times, and fine specks and facings of galena are usually associated with the copper. These remarks apply to the occurrences of the Osborne Blocks, and to some extent to the small pocket of chalcopyrite visible on the slope of Little Farrell on C. Thomas' section. In the latter case there is quartz showing more prominently than in the other cases.

On the northern slopes of Mt. Murchison there is another of these hematite blows which shows stains of copper sulphate where it has been cut by a short tunnel, and the neighbouring porphyroid is flecked with green spots of malachite.

C.—ORE DEPOSITS OTHER THAN THOSE OF LEAD AND COPPER.

Between Kittson's workings, in the section now charted in the name of L. Jolly, and the two 40-acre sections, there is a very well defined reef of almost pure barite, which seems to occupy a fissure of considerable length.

Its possible value as a source of salts of barium is dealt with later.

At Kittson's workings, Section 2829, there are several small veins running in all directions, which contain a mixture of iron and copper pyrites, with some specular iron ore. In addition, at one spot there is a fair quantity of native bismuth and a small amount of a steel-grey sulphide of copper, lead, bismuth, and antimony—probably lillianite.

Some rich silver ore is stated to have come from this spot. The mineral containing it could not be detected in the workings at the time of my visit.

In mentioning other ores it is well to remember that tin ore has been recovered from the granite of Granite Tor not far from the White Hawk Mine.

D.—THE QUARTZ REEFS.

There are some well-defined barren quartz reefs at Mt. Farrell which have caused much waste of time, energy, and capital on the part of prospectors.

By very many on the field they are still regarded as possible sources of lead ore, and this idea is well shown in the term "main lode" applied to one of these reefs on the Mt. Farrell Mine.

A matter of great importance to the central productive portion of the Mt. Farrell field is the correct interpretation of these quartz reefs.

Their definition is usually excellent, as they occur for the most part in the slate, which readily weathers away from the reef or carries numerous "floaters" of quartz to mark their presence.

Their horizontal extent is considerable, and the width sufficient to suggest large bodies of stone in depth; but it is their relation to the lead ores that is the important point to decide.

As regards age, there is excellent evidence to show that the lead veins are of later date than the quartz reefs.

Looking at the face of the open-cut in the North Mt. Farrell Mine from the north, the most striking feature is the clean-cut intersection of the quartz by the lead ore bodies. The "horses" of mullock left standing, in the exploitation of the ore, are belts of slate traversed by very numerous veins of quartz, which dip rather flatly to the west. These veins seem to be part of a more massive body of quartz, which is seen at the surface in more solid form a little further north (at the north end of the open-cut). This body of quartz is typical of the others on the field and here at least is intersected at a small angle by the lead ore veins.

The quartz reefs being older, we may well expect them where fractured to be traversed by the lead ores, and to *contain lead ores where this later impregnation has taken place.*

This is well shown in the case of the Mt. Farrell Mine, with its rich shoots of ore enclosed in quartz. For on this latter section the quartz body is full of vughs, partly filled in many cases with crystalline quartz. A long line of vughs, connected in depth with the main fissure by which ascending solutions have brought up the metallic compounds, seems to have served as the cavity necessary for the deposition of the ore. Where the continuous line of ore-filled vughs joins the main fissure, or how it is connected, remains as yet unknown. The facts that are certain are—that the ore is entirely surrounded by quartz; that other lines of empty vughs occur—empty, because the ascending solutions had no access to them from below—and that where the lead ore occurs siderite is always visible, whereas the quartz away from the galena-siderite veinlets is quite barren, and contains only undigested fragments of slate.

The same phenomena are exhibited by similar quartz reefs in slate on the sections south-west of Thomas' Blocks south of the Murchison River.

The fractures which have admitted the filling of quartz have remained, perhaps, still planes of weakness; and during subsequent fissuring and impregnation a fracture parallel with the original one, or even coincident with it, has formed and been filled. But the ore-filling is of a totally different type to the quartz impregnation, and the characteristic mineral of the later invasion of material is the carbonate of iron.

Whether the minute fissuring of the porphyroid and felspar porphyry previously mentioned is a part of the phenomena of, and simultaneous with, the filling of the larger fissures with quartz is not certain from the evidence gathered. However, on the Tullah Mine and at the Langdon the silicified igneous rock has been refractured and penetrated by metal-bearing veinlets; and this impregnation show some close resemblance to the secondary filling of the bodies of quartz. The felspar porphyry has preserved more of its character during silicification than the slate; for the quartz reefs seem to have almost completely replaced the slate, and only small fragments of the latter remain here and there embedded in the solid quartz.

E.—THE IRON ORES.

There is a considerable amount of hematite, of both specular and compact varieties, in many parts of the field. Much specular ore is scattered through the conglomerate of the Mt. Farrell crest in association with the quartz veinlets.

There is on the north-western flank of Little Farrell a considerable mass of the older schistose conglomerate almost completely replaced by a compact red hematite.

Other very massive outcrops appear in the chloritized quartz keratophyre and quartz felsite of the Osborne Blocks; and yet another similar to these is the porphyroid on the northern slope of Mt. Murchison, in Section 3070.

So the impregnation of iron ore is of later date than the alteration of the porphyries, and perhaps of later date than the conglomerate of the mountain ridge. It is certainly younger than the latter if the impregnation of all the rocks has been simultaneous.

(3)—The Distribution of Ore in the Lodes.

The internal structure of all the lodes of the field is in most cases very complex, and the ore minerals share in the complexity.

At times there is a distinct banding of the veins, and usually the several bands are parallel to the general direction of the lode. The clean hand-picked "firsts" are obtained from these portions of the lodes. But any one lode will often show both the banded structure and a brecciated structure as well in the same face; and the ore in this crushed portion is usually scattered through the gangue, and the mixture constitutes the average "seconds."

When banded there is not a noticeable alternation of ore and gangue. It is rather a parallel arrangement of galena of varying grain in the majority of cases. In no case did I observe a separation of galena from blende in the banded portions of a spathic vein.

The galena in the pyritic vein of the Murchison River Mine is partly as clean banded ore, which is sometimes well over a foot wide, and part is distributed through the other sulphides.

In the Mackintosh southern section, where J. Geddes is working, the clean ore forms a series of overlapping lenses on the footwall.

The fahl-ore is irregularly distributed through the lodes, even in those where it seems more common.

The copper veins show an even more patchy distribution of the metal through the gangue in the small faces exposed by present workings.

In the North Mt. Farrell Mine, of which the workings are the only considerable ones on the field, there seemed to be no definite pitch of the richer shoots of ore.

There are undoubtedly shoots, for the lode-fracture often is traceable by a seam of pug and the development of siderite on one or both sides in the slate country beyond the point where the galena is present in sufficient amount to be payable.* This is shown by the "No. 1 lode" of the North Mt. Farrell Mine.

Still, the workings are as yet shallow, and more definite information will be available later.

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* "Payable ore" is difficult to define for these mines. It may be reasonably stated to be ore of such grade that from 12 to 15 tons of ore will give 1 ton of galena concentrates, *i.e.*, with a width of lode of from 6 to 8 feet.

The way in which the rich patches of first-class ore cut out abruptly is remarkable in this mine. From visit to visit each face shows considerable changes, both in the total amount of ore and the proportion of firsts.

In my opinion, the presence of the rich bands and pockets of ore is due mainly to the structure of the main and subsidiary fractures in the country rock, and the degree of access to these fractures that has been afforded to the mineralizing solutions.

In the Murchison River Mine this structural peculiarity (referred to above in discussing the influence of country) is so pronounced that the whole of the payable ore is in one great shoot enclosed between porphyroid walls, while the fracture continues beyond on either side. In this case the shoot is pitching southwards at an angle of 55°.

With regard to other variations in the ore, there has already been mention made of the change from a lead to a copper-bearing type along the line of the Mt. Farrell-North Mt. Farrell-Mackintosh fracture. I feel confident that this is one continuous fracture system, that extends right to the Mackintosh River, although its mineral character alters.

Variations of the ore in a vertical direction cannot be said to have been proved by present workings. There is apparently no sign of a progressive impoverishment of the lodes, nor of the galena being replaced by other sulphides. The North Mt. Farrell Mine is again the one from which most information is to be gained; and even here workings are as yet not below the level of the button-grass plain. Still, the lowest workings show no visible falling-off in the amount of first-class ore, even if the assay returns of the firsts average slightly poorer.

The Langdon Mine shows a very abrupt passage of galena into almost pure resin blende in a very short vertical depth, but the workings are very small, and no generalisation could be made applicable to the district from this occurrence alone. Moreover, future operations might reveal at this spot a return of the predominance of lead ores over zinc.

(4)—The Structure of the Lodes.

Fissure Veins.

The majority of the lodes of the Mt. Farrell district are what are commonly known as fissure-veins. The term is used here in a purely general sense. The nature of the filling, whether metalliferous or not, is not implied, nor the manner of the filling, nor the amount of actual filling and the proportion of ore due to metasomatic replacement.

It is merely implied that the veins have, on the whole, a tabular form, and that their present location is governed by the existence of pre-existing fractures, which have served as circulation channels to the ore-bearing solutions. These channels have been chosen by the vein-forming solutions as affording the easiest path to regions of lower pressure.

The fissure veins of Mt. Farrell are in no case single simple ones which fill one clean fracture.

The fracture systems are usually complex, and the ore veins are the same.

There may be a single main fracture with subsidiary ones leading into it at various angles. This is so with regard to the Murchison River Mine and the south workings (J. Geddes' tribute) on the Mackintosh leases.

And the main fracture itself is generally rather complicated, consisting of the actual plane of separation and the crushed zone of country alongside. This crushed zone is usually crumpled and contorted to a high degree, and the metallic minerals, galena and blende, together with the siderite, quartz, and remnants of crushed slate, make up the main bulk of second-class ore.

Slickensiding is usually to be seen on the walls of the main fracture, and indicates a relative movement between the walls in a vertical direction. The main fracture usually has a certain amount of pug.

As regards the origin of the fractures, little information can be ascertained yet. The slate in the neighbourhood is much contorted, and overthrust faults can be seen on a small scale; yet how far compressional forces have contributed to the actual fracturing is hard to say.

The fissures, once formed and filled with ore, have certainly reopened in some places, and the further movements have resulted in the brecciation of the lodes. This lode material of brecciated galena and quartz with pug is well shown on the No. 2 level of the North Mt. Farrell Mine at the extreme north end of the workings, where the soft wet puggy ore runs in on the drive.

The "sheeted zones" or "lode formations" which carry the ore in the Tullah Mine and the Tullibardine are similar, save that the fracture is a distributive one rather than simple. A broad belt of the country suffers simultaneous impregnation.

As to whether the limestone country of the White Hawk district carries any fissures of longitudinal continuity, I was not able to determine at the time of my visit.

The galena in the quartz of the Mt. Farrell Mine forms in a sense a fissure vein of lead ore. It is, however, rather different from the other cases in that there have been two distinct periods of filling. The first period was characterized by an absence of metallic ores, and partial cavities, or "vughs" were left in the quartz then introduced. Some of these cavities, of which the directions and dimensions varied a little, were in continuity with each other. They were also continuously connected with the fractures by which the metallic ores were introduced at a later date; so that, while the lead ores are, in the main, deposited in a separate system of fractures, the older fractures have also served as loci for the deposition.

The ore in the Mt. Farrell Mine has been deposited in the heart of the quartz body. On the southern section of the Mackintosh lease (J. Geddes' tribute) the quartz forms the footwall. The fracture in this latter case has re-opened along the western edge of the quartz, which has adhered to and given stability to the footwall. The subsidiary fractures which lead from the main fracture are all on the hanging-wall (western) side of the lodes.

Disseminated Ores.

The disseminations of copper pyrites and galena show no structural characteristics at all. In one case, near the Osborne Blocks' cage, the joints in the chloritized quartz felsite cut across the ore, and are clearly of later date. The primary ore does not follow any visible divisional plane or cavity in the rock.

(5)—THE STRIKE AND DIP OF THE LODES.

There appear to have been several main directions of fracturing of the crust in the district:—

(1) The main lode-line, which extends from the Mt. Farrell Mine northwards through the North Mt. Farrell and Mackintosh sections, and the Farrell Blocks. The trend of the fracture is, on the whole, a few degrees (9°) east of north; and the dip is between 60° and 70° to the westward.

(2) The Central Farrell and Murchison Extended (North Murchison) Mines are situated on a

fracture system which trends almost due north and south, or a degree or two to the west of north. The dip is west 60°-70°.

(3) The Murchison River lode bears N. 28° E., and thus offers a sharp contrast to the others. It is practically a vertical lode.

(4) On the south side of the river the fractures strike almost invariably west of north. There is little work done, and the figures given must be used with great caution, since they are observations made over very short lengths of lode outcrops, or short development drives. Thomas' Blocks lodes strike about 25° W. of N. The Tullah lode strikes 8° W. of N. at the surface. Foy's lode, near Kittson's, strikes N. 21° W.

(5) The Langdon Mine, to the west of the Tullah town-site, is remarkable in that the lode there strikes due east and west. The dip is to the north.

(6) The northern occurrences at the Tullibardine are very difficult to judge as regards strike, but the prevalent direction of the fractures seems to be east of north about 20°.

With regard to these characters there are a few points of further interest.

The striking feature of the whole system of fracturing is the abrupt change of strike in the case of the Langdon Mine. The existence of an east-and-west fracture in connection with a north-and-south series in this district would not appear remarkable. Here, however, the east-and-west fracture alone appears. There are certainly in the immediate vicinity a few very small fractures running at different angles, but no north-and-south series is visible. The presence of such a fracture system may yet be proved, and its presence seems quite probable from the general structure of the rest of the district.

In the Mt. Farrell Mine the south workings on the western lode show a remarkable series of changes in the strike. From the main adit the lode-channel is driven on for 145 feet on a bearing of 23°. The next 50 feet of driving have a bearing of 9°. Then the lode resumes almost the old course, and is followed for 25 feet on a bearing of N. 25° E. Here a split occurs, and the western drive bears 25° for another 50 feet. The two portions reunite and continue for 100 feet on a bearing of 26°; and then the lode again returns to its former course of 9°, along which 125 feet of driving has been done.

There seems, then, to be two main directions to the course of the lode—9° and 25°; and the reason for this lies probably in the fact that the slate has a distinct "grain." Some part of the break runs with the grain and some portion across it.

(6)—The Alteration of the Wall-rock of the Lodes by Mineral-bearing Solutions.

Coincident with the introduction of the metals into the fractures, and consequent upon the chemical activity of the solutions which have been the carrying agents, there has been usually some marked degree of alteration of the wall-rocks in immediate proximity to the lodes. The change has been caused by the introduction of fresh material from without, or the the partial alteration of the minerals already present in the country rock.

In the North Mt. Farrell Mine the slate, in its least altered form—away from the lodes—is seen to be a pyritic one; yet near the lodes the iron mineral is seen to be the carbonate. Pyrite is to be seen in the lode itself, but the slate seems to have been freed from the sulphur content near the lode fissure.

The iron carbonate may possibly have been all introduced by the lode-forming solution. But if it has, the pyrite has all been removed from the slate. It seems more probable that the iron has been provided by the pyrite, and that siderite is the result of carbonated solutions reacting upon the sulphide.

Besides this alteration there is a notable development of graphite in some places where the lodes occur in the dark-coloured slate.

The graphite may be an original constituent of the slate, but I could not find it in any spot where the lode-forming influences have not been at work; still, in no case did I observe it in any other rock than the dark slate.

The other characteristic alteration effected in the rocks enclosing the lodes is the development of a waxy micaceous aggregate, which has a smooth or even greasy feel in some cases.

This aggregate is perhaps best termed pinite, in that it answers to Dana's* description:—"A general term

* "A Text-book of Mineralogy." Edition 1899, p. 466.

used to include a large number of alteration products, especially of iolite; also spodumene, nephelite, scapolite, felspar, and other minerals. In composition, essentially a hydrous silicate of aluminium and potassium, corresponding more or less closely to muscovite, of which it is probably to be regarded as a massive, compact variety, usually very impure from the admixture of clay and other substances."

The dark-coloured slates are not visibly altered in this way. No microscopic examination has been made to find whether the alteration has been effected, even though not visible to the naked eye.

In the pale-coloured clay schists, however, the change is well defined. The rock already contains a considerable amount of sericite,† but this is materially augmented, and a yellow to green waxy product results.

This is to be seen on the Mackintosh and Farrell Blocks sections, as well as with both the lead and copper veins of the Tullibardine; in fact, wherever the lodes traverse this clay schist.

The porphyroid suffers an entirely similar alteration, and the spathic type of lode is accompanied by a greater degree of change than is the pyritic.

The country of the Thomas' Blocks main lode is this porphyroid which has been strongly attacked in this way.

In this section the rock still shows the idiomorphic and embayed quartz phenocrysts, but almost the whole of the rest of the rock has been replaced by the pinitic aggregate.

The same is true to a less degree of the country rock enclosed in the lode-formation of the Tullah Mine.

This is the type of alteration which has been termed "sericitization."

Yet another alteration has taken place in the case of the disseminations of lead and copper ore on the Osborne Blocks.

Here a silicification of the chloritized quartz felsites is the characteristic accompaniment of the ores. The silica has proceeded into the quartz felsite, and filled up the minute cracks, and has bodily displaced the igneous rock as well. The invasion of quartz is gradual, and there are no clearly defined lines between the unaltered and altered quartz felsites.

† *Vide supra*, p. 22.

(7)—THE SECONDARY ALTERATION OF THE LODES.

One of the striking features of the Mt. Farrell field is the small amount of oxidised ore that has been formed by the action of the meteoric water upon the lodes.

The outcrops, where they are visible, are covered with a very thin rusty coat, which shows a little—very little—lead sulphate or carbonate.

As a rule, the outcrops are only laid bare in the stream beds. On the other portions of the hill-slopes the soil-creep brings a cover of the country rock from higher up the slope, till the lode outcrop is completely hidden.

So any oxidised crust that could form would tend to join the surface material on its downhill path, and the conditions necessary for the accumulation of a gossan have not existed since the present physiographic cycle began.

A few ironstained lumps of ore with a core of galena can be still picked up in the creek beds, but no gossans are to be found of any value or extent. Even the pyritic mass of the Murchison River Mine has a very small capping of gossan.

Lead carbonate is practically not to be seen. There are a few crystals on the Murchison Mine in the ironstone near the surface. I saw a little on the surface of the North Mt. Farrell and Mt. Farrell Mines. The White Hawk Mine contains a little more; but there the country rock is limestone and far more permeable by surface-waters.

In no case was there visible any silver chloride or other secondary silver ores.

The quartz reef of the Mt. Farrell Mine containing the vughs filled with lead ore has arrested the downhill creep of the ore, and the result is that secondary processes have there been operative. The unfilled vughs have assisted by enabling an active circulation of surface waters to attack the upper portions of the deposit. Some of the contents of this upper portion have been leached out, carried downwards, and redeposited at lower levels. The lead is redeposited in the form of octahedral crystals of galena, whereas the first-formed ore is invariably cubic in form.

The octahedral galena is found either deposited upon the cubical metal in the heart of vughs, or embedded as fairly-perfect crystals in a greenish kaolin occurring in pockets along the borders of the primary fillings of the vughs. A similar deposition of secondary octahedral galena upon the primary cubical mineral is mentioned by

Van Hise as occurring in the lead deposits of the Mississippi valley.*

But for this case, the lead ores of the field show no sign that can be taken as undoubted evidence of secondary concentration.

The existence of rich shoots of secondary ore has not been proved; and this point is one of great commercial interest. It is frequently stated on the field that the mining operations are as yet "too shallow." The apparent inference is that deeper workings will lay bare richer ore; but such richer ore is only to be confidently expected when a zone of leached ore has been passed through in the upper workings.

The bulk of the lead ore at Mt. Farrell is, even at the surface, practically fresh and undecomposed, and, with the single exception indicated, free from leaching, and not enriched by secondary processes. Still, this fact carries much comfort to mines like the North Mt. Farrell, whose first-class ore can be therefore confidently expected to descend. It is not the result of a local concentration, nor due to the formation of a zone of secondary enrichment that might be expected to give place to poorer ore with deeper development.

The copper deposit on the Tullibardine lease has suffered some degree of alteration, and the copper that has been leached out of the upper portions of the lode has been redeposited, in part at least, in the form of native copper.

This native copper is in a very fine state of division, and is distributed through the ironstained clay schist between the seams of cupriferous quartz.

Its quantity will probably not prove to be considerable. The zone that has, by the leaching processes, provided the native copper is not more than a few feet in depth; and the total bulk of copper ore in the formation cannot be expected to produce much secondary ore.

(8)—The Underground Waters.

Before venturing to formulate an account of the mode of origin of the lodes of Mt. Farrell, it will be well to consider the phenomena now presented by the underground waters. For the ores have been undoubtedly deposited from solution, and the origin of the ores is involved with the origin of the solutions which brought them to their present position.

* Van Hise: "A Treatise on Metamorphism," pp. 1145 and 1146.

When the rainfall at Mt. Farrell is taken into consideration the underground workings appear to be remarkably dry. The water that is met with is restricted to the planes of movement of the rocks, and the rock-masses between these fracture-planes are dry.

In the North Mt. Farrell Mine practically the only water that finds its way into the workings is to be seen where the clay schist is in contact with the dark slate.

The lodes are always damper than the country rock. For instance, the Mt. Farrell south workings on the western lode show a good deal of water, and the neighbouring crosscut in country rock is nearly dry throughout.

Moreover, the water makes its way downwards in every case which I observed, with the exception of an occurrence in the Mt. Farrell Mine. This is in the quartz body which contains a number of vughs, as already explained. The main adit on the northern workings has cut across the quartz reef, and a bubbling spring of water appears in the sole of the drive. This spring is directly below the main line of ore-filled vughs mentioned above. But the spring-water is fresh and cold, and is clearly the surface-water that has an intake at some point higher up the hill. The exact channel by which it has travelled is not visible; yet there is probably a main cross-fracture dipping west and connecting in depth with the cavity in the quartz by which the water ascends..

The circulation at this point appears to be free, and the flow considerable; yet it must be remembered that this freedom of circulation was impossible until mining operations penetrated the fractures at a level below their intake. Before mining began the natural circulation must have been very much more restricted.

Even now there are cases that show how "tight" the lodes are. The Mt. Farrell northern workings contain a shaft beneath which a drive on the lode has been put in; and during my visit to the field, lasting over nine weeks, the water had not drained out of the shaft.

It is stated on the field that the amount of water that drains away from the mines does not vary much with the seasonal changes. My visit to the field was too brief to judge this matter by personal observation.

There is no evidence at Mt. Farrell at present available to show the existence of any other water in the mines than that which has fallen on the surface as rain, and which has made its way downwards under the influence of gravity alone. Yet it cannot be granted that this surface-water can have been the agent whereby the lode-matter has been introduced into the fractures.

For the alterations that have been effected in the wall-rocks, as well as the insolubility of the lode-forming minerals in pure and cold water, lead us to believe that the solutions which produced the lodes were hot, and that they contained salts in solution; and further, that these solutions ascended from deeper portions of the crust by paths of considerable downward continuity. These circulation-channels which offered the least resistance to the ascending mineral waters were the main fracture planes of the district.

The surface-waters have had very little to do with the lodes. Their effect in modifying the mineral composition of the lodes which the ascending waters have deposited has been dealt with under the head of the secondary alteration.

The unoxidised ore being found almost at the surface, it is not remarkable that no line can be drawn to show the "ground-water level." This line, which marks the level below which any excavation remains permanently full of water, may be said to almost coincide with the ground-surface in most portions of the field.

In the White Hawk limestone it is naturally at a lower level, but how far down below the adit level it exists was not determined when I visited the property.

(9)—Summary of the Genesis of the Lodes.

As the result of the consideration of the facts dealing with the Mt. Farrell district which have been gathered together, and the comparison of these facts with those now known concerning other mining fields, a brief outline may be formulated of the most probable origin of the lodes. The views of the writer on this subject must be held to be neither original nor unusual. An attempt is made here to apply to the Mt. Farrell field the results of conclusions arrived at by many mining geologists, especially in America and Germany, concerning the origin of ore deposits.

First of all it becomes apparent from what has been said above concerning the independence of country and lode, that the proximate source of the ores must be sought outside the rocks in which they now occur.

The question arises then, "To what portion of the earth are we to look to discover their origin?" And in answer to this question it should first be stated that metallic ores which are the fillings of cavities or fractures in rocks at a date subsequent to the formation of the rocks themselves (*i.e.*, the so-called *epigenetic* ore deposits) have almost invariably been introduced from below.

Looking downwards, we are at a loss to see any rock-mass which differs from that which contains the lodes on the surface, for the development of the mines in depth can hardly be said to have been started yet.

Here the geological structure observed is of assistance.

The only rock-mass which can be considered to underlie the rocks of the field in depth is the granite which outcrops at Granite Tor, and appears there to be dipping below the mantle of mica schist towards the west.

The majority of mining geologists are of the opinion that the ore deposits of deep-seated origin derive their metallic contents from plutonic igneous magmas, and that granitic magmas especially are the proximate sources of the metallic minerals. The granitic magmas during their solidification, give off a quantity of mineralized vapours and solutions, which ascend by the most accessible channels, and deposit their metallic contents during the ascent.

We know that there is a very large area of Western Tasmania underlaid by a granite mass, which at its outcrops at Hampshire Hills, Middlesex, Cox's Bight, and Heemskirk is stanniferous.

The country overlying this granite is mineralized in many places, for it is a much-folded, and therefore much-fractured area; and some of the minerals found with other ores show characters which help to connect them genetically with the tin ores. Such minerals are those which contain boron and fluorine.

The discovery of fluorspar at Thomas' Blocks is of great importance in this search for the origin of the Mt. Farrell lodes, for fluorspar is a mineral most characteristic of the lodes, either in granite or in immediate proximity to granitic masses. It is, for instance, a common gangue mineral in the Middlesex tin-wolfram deposits, and on the north-east tin-fields is common near the lodes.

The only other mineral which occurs at Mt. Farrell, and which is a common associate of the typical ore-veins of granitic areas, is native bismuth, which is quite plentiful at Kittson's workings in the south-eastern portion of the field. So we may reasonably infer that Mt. Farrell owes its mineral impregnation to the granite which outcrops at the places mentioned.

The agent by which the metallic contents of the lodes were borne to their present position was undoubtedly, in the main, water; but the solutions rising up the lode-fissures were probably of complex composition, and, like the waters of the hot springs of to-day, they probably contained sulphur in the form of sulphides or sulphates of various elements, together with carbonic acid, free and combined. Such heated rising solutions would cause the alterations of the wall-rocks that have been mentioned.

The confinement of these ascending solutions to the main deep fracture-planes is explained by the fact of their deep-seated origin. The deeper fractures would be the ones which would offer paths of less resistance to the imprisoned vapours.

Once formed, the lodes have shared in the general degradation of the region by surface agencies. They have been attacked to some extent by the processes of oxidation, but the accumulation of the oxidized material has been prevented by the physiography of the lode-bearing zone.

VI.—THE MINING PROPERTIES.

(1)—The North Mount Farrell Mining Company, No Liability.

The sections held by the company are the following:—4116-93M, 68 acres; 2722-M, 40 acres; 1074-M, 20 acres; 3262-93M, 76 acres; 1867-M, 80 acres; 2351-M, 75 acres; 292-W, 10 acres; and 82-W, 4 acres.

Of these sections, that which is numbered 3262-93M is much the most important, and carries the principal workings and the concentrating mill.

From the accompanying geological map it will be seen that the lodes worked by this company are situated on the western side of the slate belt, and close to the narrow band of pale clay schist.

There are four main levels at which work has been carried out. These are named respectively No. 1, No. 2, No. 3, and No. 4, and are separated by vertical distances of about 60 feet. The workings have disclosed the presence of three main lodes, which converge towards a point situate in the neighbourhood of the open-cut.*

Of these lodes, the eastern one, called by the management the No. 3 lode, seems to be undoubtedly the principal one. It conforms, on the whole, to the general direction of strike of the fracture which runs southwards through the

* See plan of mine workings, Plate IV.

Mt. Farrell ground and northwards to the Mackintosh River. Its continuity is much more pronounced than the other two, and the distribution of ore more uniform. The other two lodes are nevertheless valuable assets, for although the present output is being maintained mainly by the No. 3 lode, the No. 1 and No. 2 lodes will almost certainly provide much ore with deeper development.

The No. 1 lode, situated almost on the edge of the main body of slate, and in immediate proximity to the clay schist, strikes about N. 35° E., and dips westwards at about 60°. It is a very broad lens of ore, which was first encountered in driving the No. 4 level crosscut.

On development it was found not to extend upwards very much above the No. 3 level, where it splits into two bodies separated by mullock.

All the ore has been stoped out of this lode above the No. 4 level, with the exception of a small pillar above this drive.

There has beeen a large body of ore removed, as the total length of this ore lens is, on the No. 4 level, 240 feet, and it has been stoped out for a width of 35 feet in places.

All of this ore having been removed, I was unable at the time of my visit to inspect and note its characters.

There have been drives put in northward on the line of this lode, which is marked out by a slight development of the carbonate of iron in the country rock; but on both levels a blank of about 120 feet was met with.

A crosscut driven west on the No. 3 level, at a point a little south of the intersection of this barren channel with the No. 2 lode, met with an ore-body, which is now being prospected. Assay returns, showing 82 per cent. of lead and 60 ozs. of silver per ton, have been obtained from the galena at this point.

This body is now being prospected northwards on the No. 4 level, and a lode 4 feet wide has been proved. A little first-class ore is showing, and the footwall is deeply slickensided. On the No. 3 level the grooving of the wall-rock was noticeable on the hanging-wall side of the lode, and no defined footwall was visible.

A short crosscut was put in to the westward on the No. 4 level to test the width of the formation. Some galena was met with, but no defined wall. Work is proceeding along the line of the lode.

It may be that this ore-body is a continuation of the No. 1 lode, but it seems more likely to be a separate branch lode from which some ore has been won at the surface a little further northwards on the No. 2 level.

The only other work done upon the western ore-channels is a winze sunk from the No. 4 level on the No. 1 lode. It has been sunk some 30 feet, but was full of water at the time of my visit.

I am informed that the ore on the No. 4 level for the whole length of the ore-shoot was of good quality; and there seems to be every reasonable prospect that deeper workings will expose a continuation of these values in depth.

The No. 2 lode has a strike about N. 17° E., and the westward dip is steeper than that of the other lodes. This lode has been productive of ore, especially above the No. 2 level, whence stopes have been carried to the surface for 750 feet in length. Recently the track of the ore-channel has been driven on at the No. 1 level, and the strike changes through a wide angle rather abruptly. The fissure seems to be making towards the No. 3 lode-channel as if it would unite with it.

Between the Nos. 2 and 3 levels this central ore-body has been productive for about 400 feet, for which length stopes have been carried for nearly the whole height. Between levels No. 4 and No. 3 there are stopes for a length of 250 feet, but the southern extension of the lode-channel shows ore of poorer grade.

On the No. 4 level the same abrupt change of strike is noticeable as on the No. 1, and there seems no doubt that this ore-channel will join that of the No. 3 lode if traced out in future workings.

The No. 3 lode is the principal source of the ore which is being won at the present time. It is a lode from 15 to 22 feet in width, and a brecciated zone about 6 feet wide on the footwall side.

No hanging-wall at all is to be seen. The boundary of the lode on that side is arbitrarily fixed by the grade of the ore. There seems to be a definite footwall with a seam of pug, but ore is often obtained beyond this wall.

The pug sometimes carries ore, a fact which seems to indicate later movement in the lode-channel. The veinlets of metal in the main body of ore are irregularly disttributed; but the larger seams of firsts run with the direction of the channel.

The strike varies in the portion developed from a few degrees west of north to about the same amount east of north.

The dip is between 60° and 70° to the westward.

In developing this lode the prospecting drives have been pushed forward in the brecciated zone on the footwall, and have been timbered. The ore is broken out from the lode later, and this ground needs very little timbering.

From this No. 3 lode there still remains much ore to be won from that portion which is already being worked.

On the No. 4 level it has been stoped out for 120 feet south of the main crosscut to a height of 15 feet. Then, on the northern side of the crosscut, there are about 540 feet of stopes from which 18 feet of ore have been removed.

On the No. 3 level there is not so much work done at the southern end. At a point 30 feet north of the rise which runs from the No. 4 to the No. 2 level the stopes begin, and reach a height of 30 feet at a distance of 180 feet from the rise. In the next 180 feet their height rises to 50 feet, and continues at that level above the drive for another 75 feet, where the rise is taken from No. 3 level up to the open-cut. North of this point there is hardly anything more than development work done.

Vertically above these stopes last mentioned (with a vertical height of 50 feet from the level) there is a block stoped out to within a few feet of the open-cut from the No. 2 level, but no further stoping is done on this level. The ore above the drive is practically unknown, and trenches are being put in on the surface to endeavour to locate the outcrop. Since my departure from the field it has been reported that the lode has been picked up.

At its northern end this lode encounters the quartz, which appears to pitch S.S.W. from its outcrop in the open-cut. Beyond this it has not been followed on the No. 4 level, but a drive has been continued northwards past the quartz on the No. 3 and No. 2 levels.

The ore-body changes in character after traversing the silicified zone, and consists mainly of a wet running pug charged with brecciated fragments of quartz, galena, and slate. This is especially noticeable on the No. 2 level, where the ore-body has run in on the drive. This ore resembles that which is worked about 150 feet further north, in the Mackintosh section. The galena is said to be finer in the North Mt. Farrell workings, but the ore does not appear different in general character.

At the south end of the present workings on this lode there is a silicified zone of the slate met with, and the lode seems much disturbed and poor. Still, the channel of the circulation is there, and the development of this end of the property should reasonably prove further payable ore in this direction. The grade of the ore cannot be expected to remain quite uniform throughout, and it should be remembered that during the earlier days of the mine this No. 3 lode was passed through in a crosscut which penetrated into the country 35 feet beyond the lode, and the presence of the lode was not detected.

At the present time the No. 4 level crosscut is being driven eastwards, and has attained a total length of 900 feet from the mouth of the adit. It is being driven in the hope of meeting with further lodes to the east of the present system.

The grounds for supposing that any ore-bodies occur on the property in such a position that they might be cut by this tunnel seem to me insufficient. The occurrence of lead ore in the quartz reef on the Mt. Farrell Mine is one possessing many singular features, and it would apparently be remarkable indeed if the North Mt. Farrell Mine met with any similar body of ore. As indicated above, and referred to again below, the existence of the vughs filled with ore requires a very exceptional chain of circumstances, and the existence of a separate lode system of any magnitude further to the east is not yet proved.

There is, it is true, a small veinlet of ore on the south-eastern boundary of the open-cut; but I regard this as purely a subsidiary fracture, and not likely to possess any great horizontal extent.

The quartz masses in the slate have been shown to be of separate origin from the lead ores, and the quartz reef on the Mt. Farrell property bends sharply to the north-east, and then disappears on entering the North Mt. Farrell lease. There are other quartz outcrops further north, but while of similar origin to the main masses, their continuity with these is doubtful.

The North Mt. Farrell output is largely made up from their second-class ore. The proportion of first-class ore to seconds is shown in the table below. The concentrating mill has lately been enlarged, and it is estimated that it is now capable of treating from 65 to 70 tons of ore per shift of eight hours.

Mill Scheme.—From the bins the ore goes to the jaw-crusher, which reduces it to a size of 1 or $1\frac{1}{4}$ inch. Thence it passes to trommels, which separate the fines. The latter go straight to the tables, and the coarse material passes to two topping jigs.

Thence the ore passes to the coarse rolls, which crush it to $\frac{3}{8}$-inch, and deliver it to the first sizing trommel. The oversize passes to the second rolls, and the remainder is elevated to the jig-trommels.

There are four screens, whose apertures are as follows:—$\frac{1}{4}$-inch circular, $\frac{3}{16}$-inch circular, $\frac{3}{32}$-inch circular, and $\frac{3}{8} \times \frac{1}{32}$-inch slots. These screens control the supply to the first four jigs; and the fines which pass through the last screen go to the tables.

The middle products of the jigs go to the second rolls.

These second rolls feed the sizing-trommel on the other side of the mill. The oversize (above $\frac{3}{8}$-inch) is returned by an elevator to the rolls. The remainder of the ore passes to the jig-trommels. There are four jigs on this side also, and the material they treat is sized by screens with the same apertures as on the other side of the mill. The fines pass to the tables. The middle products of these jigs go to the dump.

The tables include two Cards, one Wilfley, and one Sperry.

In addition, it is proposed to put in a regrinding plant to deal with the middle products from the tables and second jigs. This addition will undoubtedly greatly improve the efficiency of the mill.

The value of the mine and mill products may be seen from these figures, which are the averages of the assays between the months of July and October, 1907.

	Lead. per cent.	Silver (ozs.) per ton.
No. 3 tunnel, firsts	62·3	64·9
No. 4 tunnel, firsts	58·9	62·8
Jigs	51·1	47·9
Slimes	55·2	44·9

The North Mt. Farrell Mining Co., No Liability.

Comparative Statement, showing Average Results for the Last Seven Half-years.

	October 31, 1904.	April 30, 1905.	October 31, 1905.	April 30, 1906.
Crude ore, total quantity handled	6356·77 tons	6237·13 tons	7838·95 tons	10,294·92 tons
Crude ore, quantity handled for each ton of marketable ore produced	7·24 tons	7·70 tons	9·66 tons	8·75 tons
Crude ore, silver recovered, per ton	9·45 ozs.	9·61 ozs.	6·39 ozs.	6·02 ozs.
Crude ore, lead recovered	8·40 per cent.	8·50 per cent.	6·15 per cent.	6·17 per cent.
Marketable ore, quantity produced	876·79 tons	809·52 tons	811·28 tons	1175·5 tons
Marketable ore, total value at mine	£7393 3s. 5d.	£8905 15s. 3d.	£7371 10s. 0d.	£11,5[illegible]8 1s. 9d.
Marketable ore, net value per ton at mine	£8 6s. 4d.	£11 0s. 0d.	£9 1s. 8d.	£9 15s. 9d.
Marketable ore, average silver assay	68·42 ozs.	74·10 ozs.	61·82 ozs.	52·87 ozs.
Marketable ore, average lead assay	60·83 per cent.	65·51 per cent.	59·51 per cent.	54·07 per cent.

	October 31, 1906.	April 30, 1907.	October 31, 1907.	—
Crude ore, total quantity handled	12,091·53 tons	12,282·05 tons	13,506·1 tons	—
Crude ore, quantity handled for each ton of marketable ore produced	8·51 tons	8·1 tons	7·6 tons	—
Crude ore, silver recovered, per ton	6·19 ozs.	6·33 ozs.	6·91 ozs.	—
Crude ore, lead recovered	6·71 per cent.	6·54 per cent.	7·36 per cent.	—
Marketable ore, quantity produced	1420·68 tons	1501·6 tons	1778·91 tons	—
Marketable ore, total value at mine	£15,872 12s. 10d.	£17,574 9s. 4d.	£21,505 11s. 10d.	—
Marketable ore, net value per ton at mine	£11 3s. 5d.	£11 14s. 0·7d.	£12 1s. 9·4d.	—
Marketable ore, average silver assay	52·69 ozs.	51·1 ozs.	52·47 ozs.	—
Marketable ore, average lead assay	57·16 per cent.	53·53 per cent.	55·91 per cent.	—

(2)—The Mt. Farrell Mining Company, No Liability.

This company holds the following sections:—2409-93M, 80 acres; 2410-M, 80 acres; 2656-M, 10 acres. The main workings are situated on Section 2409, and are situated on the northern and southern boundaries of the section.

There is one well-defined lead-bearing lode on the property, and this is, in my opinion, undoubtedly that which continues northward through the North Mt. Farrell and Mackintosh leases. On this property it is referred to by the management as the "western lode." A considerable quantity of ore has been recovered from the occurrence in the strong quartz reef, which is a filling of a line of vughs with lead ore, and at both the northern and southern workings on the Section 2409 the quartz mass has been prospected.

The Northern Workings.—The main adit starts from the northern boundary, and runs in some 725 feet on a bearing of 109°. It is situated 180 feet above the No. 4 tunnel of the North Mt. Farrell Mine.

The tunnel was started in massive porphyroid, and continued in this for 289 feet. Then followed 49 feet of pale clay schist; and then 225 feet of slate were passed through before the "western lode" was met with.

This lode was driven on northwards for 23 feet. It shows quartz and siderite, and carries some milling ore here and there over a width of 3 feet.

Southwards the lode has been driven on for 175 feet, and in the last few feet a deviation to the east was made to carry the workings under a shaft formerly put down on the surface. Some 20 feet back from the face of this drive, the workings were again carried southwards for 53 feet on the lode. The lode contains from 2 to 3 feet of milling ore, in which bunches of firsts are to be found. There is a well-defined footwall on this lode, which dips to the west at 60°. The hanging-wall was good up to the point where the drive deviated to the east. As in the case of the North Mt. Farrell No. 3 lode, the footwall country here sometimes carries ore behind an apparently sharply defined wall.

The strike of the lode here is between 22° and 25° east of north. As mentioned above, the lode-fissure has two prominent directions of strike in this section, viz., 9° and 25° east of north; and the northern workings conform to the latter direction.

On driving the main crosscut another 88 feet eastwards a big quartz formation with a total width of 50 feet was met with. It dips west at 70°. The hanging-wall is well defined, and the quartz is massive on this side; but on the footwall side there are numerous vughs and fragments of undigested slate in this quartz.

A drive has been carried southwards along the hanging-wall of the quartz on a bearing of 185° for a distance of 159 feet. A little galena was visible now and then at the junction of quartz and slate.

When the main crosscut had been driven 44 feet past the hanging-wall of the quartz body some second-class lead ore was met with. The crosscut was continued another 30 feet, and finally abandoned in a dense pyritic slate like that intersected by the No. 4 level crosscut of the North Mt. Farrell Mine east of the lodes.

From the point where the second-class ore—siderite and galena—was met with, a rise was put up. For the first 16 feet only payable seconds were met with, but these gave place then to clean first-class ore, which continued to within 10 feet of the surface. This remarkable ore-body turned out to be due to the filling of a long line of vughs in the quartz with lead ore. The ore is entirely surrounded by quartz, and the central cavity of the vughs was not completely filled with ore.

The vughs pitch in all directions, and the ore-channel has a most irregular form. The ore from this pipe carries a little carbonate of iron and a compact green mineral, which I take to be a mixture of sericite and kaolin. Octahedral (rarely with dodecahedral modifications) galena occurs on the outer surfaces of the mineral crust, having apparently been deposited on the cubical galena by secondary processes. It also occurs in very perfect crystals in the soft pug and brecciated quartz sometimes found on the borders of the vughs. The whole of the ore at this place shows a brownish stain from the presence of limonite.

At the top end there is some zinc blende with the siderite and green sericite-kaolin aggregate. Most of the ore had been removed from this rise at the time of my visit. A little remained on the level on the north side of the main crosscut in a mixed gangue of quartz and carbonate of iron. There is a spring of water bubbling up on the level from below at this point.

From the south drive on the hanging-wall of the big quartz formation, at a distance of 68 feet from the main adit, an eastern crosscut was driven through the quartz for 46 feet. An empty vugh was passed through at 21 feet. At 40 feet a body of quartz and siderite was met with, and a rise was put up on it for 69 feet. At the lower end of the rise very little metal was showing, but at the top good seconds were found. The rise was abandoned at 69 feet from the level on account of bad air. A candle would only just keep alight at the time of my visit. This rise was later connected with the upper workings by sinking from the intermediate level.

At a distance of 100 feet from the crosscut just mentioned another eastern crosscut was started from the south drive. It was in some 37 feet at the time of my visit, and was in a silicified zone of slate carrying clean quartz veins.

On the surface above these workings some considerable prospecting has been done. An open-cut 12 feet deep and 18 feet wide has been broken out at a point 40 feet south of the first rise. Veins of clean ore occur in the quartz at this place, and some firsts have been bagged. To prove the occurrence an adit was driven 30 feet lower down, and met with the ore distributed irregularly through the quartz; and 8 tons of firsts were recovered in the work.

Some 15 feet below these workings a short intermediate level has been driven, and good ore proved. These workings are 85 feet above the lower level.

In prospecting the good second-class ore south of the first rise a fresh body of firsts was met with similar to that in the first rise. The work done on this has resulted in the proof of the continuation in depth of this ore to the second rise put up from the lower level. The upper workings are now connected with the lower by this rise also.

This occurrence of ore has been mentioned in an earlier part of this report. It seems to me to be undoubtedly due to the passage upwards of mineral-bearing solutions through long lines of connected vughs in the quartz. The two rises are similar in general structure, but the No. 1 rise carried much more first-class ore. At the intermediate level the ore seems to have been more scattered through the quartz. There appears to be, on the evidence of the two rises, a shoot of first-class ore pitching north at a steep angle.

There is nothing to show the existence of another line of ore-filled vughs, and the present system of prospecting (from the lower level south drive by crosscuts across the quartz body) does not appear to me to be either the least expensive or the most likely to prove the existence of other pipes. I should recommend that the prospecting in a southward direction for the ore contained in the quartz be continued on the intermediate level, where the track of the ore is better defined. Any apparent downward continuation of ore could then be prospected at a lower level without the uncertainty which exists at present.

At the lower level I should recommend that the prospecting work be done by driving on the line of the two rises already located, rather than by crosscutting from the drive on the hanging-wall of the quartz-mass. This latter method is nothing more than blind stabbing, and the small horizontal extent of the pipes makes it a very easy matter to miss the ore when within even a few inches of it.

The question of prospecting northwards on this level is worth considering carefully. The ore-shoot appears to pitch in that direction, and the northern boundary of the section is about 400 feet distant.

A shaft was sunk at the outcrop of the western lode for a depth of 50 feet, and abandoned. It contained water at the time of my visit, but was being gradually drained by the south drive on the western lode below it.

At the surface there is some good milling ore, said to be from this shaft, but I could not see the ore *in situ.*

The Southern Workings.—The upper adit level has been put in for a distance of 236 feet on a bearing of 107°. At 207 feet from the entrance a short drive has been put in northwards for 51 feet bearing 21°, and a crosscut driven westwards for 21 feet on a body of second-class ore. The main workings on this level are 29 feet further east, where a drive runs north for 102 feet on a bearing 25°. A rise has been put up for a few feet on ore, and a couple of narrow stopes 3 feet wide taken out. I saw a couple of inches of firsts on the footwall here.

No work was being done on this level at the time of my visit.

The main adit is driven on a bearing of 57° for a total distance of 342 feet. A short drive has been carried northward (bearing 14°) from the end for 25 feet. No ore was met with in this end of the adit. At a point 263 feet from the mouth of the adit the "western lode" was driven on. For 145 feet the bearing is 23°, then for 50 feet it is 9°. At this point a crosscut was driven eastwards.

Beyond the crosscut the course of the western lode is N. 25° E., and at 25 feet past the crosscut the lode splits with a "horse" of slate between the two portions.

The western drive of the two runs on for 50 feet past the split on a bearing of 25°. Here there is a rise, which has been put up for 40 feet, and two stopes have been taken out for a distance of 60 feet on fair milling ore.

Then the two arms of the lode rejoin, and the lode is followed for another 100 feet on a bearing of 26°. The course then returns to 9°, and the face at the time of my visit was 125 feet from the bend.

Taken all through its length, the western lode represents about 3 feet of milling ore, and the lode-channel is well defined always.

It is to this ore-body that the company must look for the main bulk of the milling ore of the future. There may be other more concentrated bodies of ore discovered in the quartz reef, but their presence is so far unproved.

Further prospecting of the quartz has been done on this level. At a point 196 feet from the main adit on the western lode drive a long crosscut has been put in eastwards for a total length of 334 feet on a bearing of 105°. At 217 feet the quartz body was met with. At 264 feet a few splashes of galena were met with, and short drives were put in for 25 feet northwards and 15 feet southwards on a bearing of N. 15° W. The metal cut out, and work was abandoned.

At 287 feet on the eastern boundary of the quartz another short drive was started northwards, but abandoned after being carried for 10 feet.

The eastern crosscut was continued for 50 feet past the quartz, and abandoned in dense pyritic slate.

The prospecting was continued on this level from a point 15 feet west of the hanging-wall of the quartz, and 202 feet from the western lode drive. There a drive has been carried northwards for 100 feet on a bearing of 2°, and from that point the drive turns to the east to cut the quartz body. Occasional splashes of galena are to be seen in the quartz here, but always associated with siderite.

The milling ore from the mine is stacked separately on the tip to provide a nucleus for future milling operations.

A little work has been done below these main southern workings on the northern boundary of Section 2410, but nothing more than slate carrying carbonate of iron is visible. At a point 30 feet from the south-west corner of the northern section, and on the line between the two sections a tunnel was started to test the western portion of the property. It runs for 80 feet on a bearing of 66°, but only chloritised porphyroid, in which some hard silicified zones were found, was penetrated. Some quartz and iron carbonate were visible, but no ore. The tunnel is now used as a magazine.

On the southern section a little surface-trenching has been done at two other spots. On the eastern boundary a little galena is visible in the creek, which crosses the line in several places. This spot is very close to the line of the lodes met with in the Central Farrell property, and the ore-channel may be connected with that fracture system.

Further south a trench 2 chains long has intersected an indefinite formation. The trenches are narrow and shallow, and consequently do not afford much information. There is a certain amount of gossan carrying pockets of carbonate of lime, and in this gangue a few splashes of fahl-ore and copper pyrites are visible. The country rock, to judge from the weathered material intersected by the trench, is slate.

Appended is a table which will give an idea of the grade of ore from this mine. It has been compiled from the sale notes of the company.

SALE NOTES OF ORE FROM THE MT. FARRELL MINE.

Date.	Net Weight.			Assay Value.		Total Value per Ton.			Metal Quotations.			
				Lead.	Silver. (oz.)				Lead (per Ton).			Silver (per oz.).
	tons.	cwt.	qrs.	per cent	per ton.	£	s.	d.	£	s.	d.	d.
Nov. 27, 1906 ..	6	15	3	71·8	91·9	27	8	7	19	5	0	35·54
Jan. 7, 1907....	31	19	0	69·6	94·6	27	11	10	19	18	9	34·80
Feb. 8, 1907....	22	10	1	67·5	91·0	26	2	5	19	13	9	33·85
May 3, 1907 ...	16	12	1	70·0	92·7	26	18	2	20	5	0	32·97
May 3, 1907 ...	17	19	3	69·1	97·6	27	8	0	20	5	0	32·97
May 27, 1907 ..	12	4	1	65·0	90·5	25	3	11	19	15	0	32·77
June 7, 1907 ...	14	12	3	67·5	90·0	26	6	4	20	7	6	33·50
July 17, 1907 ..	8	16	0	60·4	80·0	23	5	1	20	2	6	33·30
July 17, 1907 ..	8	17	3	56·2	74·0	21	17	1	20	10	0	33·51
July 22, 1907 ..	8	19	3	56·4	76·9	17	18	8	20	12	6	33·71
Aug. 28, 1907 ..	19	12	2	54·4	72·2	16	6	10	19	12	6	33·70
Oct. 31, 1907 ..	13	13	3	67·9	97·1	21	16	4	20	1	3	31·82
Oct. 31, 1907 ..	7	11	1	66·4	92·3	19	5	3	18	5	0	30·28
Dec. 13, 1907 ..	5	4	3	57·0	72·1	17	12	11	15	15	0	28·85
Jan. 16, 1908 ..	5	6	2	53·2	74·6	16	7	9	14	11	3	27·80

(3)—The Murchison River Silver and Lead Company, No Liability.

The company's leases are the sections thus numbered:—3263-93M, 60 acres; 1980-M, 80 acres; and 1286-M, 5 acres. The latter is the mill site.

Of the two sections on which mining operations are carried on, that numbered 3263 carries the principal workings.

The lode which has been exploited on this section has a strike of N. 28° E., and is very nearly vertical, dipping if anything to the east; so its structure is quite distinct from that of any other of the lodes of the field thus far exploited.

The lode-fissure traverses obliquely a belt of porphyroid, which is at this point 70 feet wide, and strikes due north. On either side of the porphyroid is slate, and the dip of the igneous belt is about 70° to the west. The productive portion of the lode-fissure is that which is enclosed within the walls of porphyroid. The lode-channel extends into the slate at both ends, but little has been done to prospect these northern and southern continuations.

The lode has been worked by means of an open-cut and two high-level adits near the outcrop, and one low-level adit which starts almost on the level of the button-grass plain and intersects the lode some 87 feet below the level above.

At the time of my visit the mine was inactive, pending the reconstruction of the company.

The recent work has been restricted to the open-cut and the block of ore between the No. 3 and No. 2 levels.

Above the No. 2 level almost all the ore has been stoped out.

No. 1 *Level.*—The adit at this level was driven eastwards on a bearing of 279°, and was continued right through the main lode into the country beyond.

The main lode matter has now been removed. Further to the east there were two minor veins of ore from which a little mixed blende and galena have been obtained. These are apparently branches of the main lode, and their dip is towards the latter.

No. 2 *Level.*—The adit was driven on a bearing of 277°, and 40 feet below the upper one. The ore above this level has been almost wholly stoped out.

No. 3 *Level.*—The main crosscut was driven eastwards on a bearing of 260°. Its total length is 513 feet, of which the first 450 feet were in slate and the last 63 in the porphyroid. At this point the lode was cut, near the northern extremity of the shoot. A drive has been carried both north and south on the ore-channel.

At a point 27 feet north of the main crosscut the ore-shoot was left, but driving was continued for another 75 feet. The lode-fracture is well marked by a seam of pug an inch wide. There is a little galena on the footwall, but no payable ore was met with. At the northern end of the drive a short crosscut was put in to the west, and the porphyroid encountered, but no galena was visible, and work at this end of the drive was abandoned.

The south drive has been extended for 109 feet on a bearing of 210°. The lode pinched out when the porphyroid country was left at a point 106 feet south of the main crosscut. The lode thus extends for 133 feet in a horizontal direction. At a point 53 feet south of the main crosscut a crosscut was driven west for 25 feet on a bearing of 305°. There a short drive was started north and south parallel to the main drive. Some blende galena and siderite was here visible for a width varying from a few inches up to 2 feet. The metal seems to make towards the main ore-body, with which it should junction about 20 feet above the level, the dip being easterly.

The ore in these short drives (12 feet on either side of the eastern crosscut) is displaced by a slide, which is also visible in the main drive. The slide dips south at an angle of about 50°, and the displacement of the lode is apparently about 4 feet. The lower portion of the ore is moved to the west of the upper portion by this amount. The eastern crosscut was continued for another 45 feet eastwards. The porphyroid country was left at a point 48 feet east of the south drive, and the rest of the crosscut is in slate.

These eastern workings were abandoned, as the only ore met with (in the east drive) was lost after being followed a few feet.

At a distance of 109 feet from the main crosscut the south drive turns slightly, and from this point to the end the bearing is 184°. This change of direction is noticeable, as the drive followed the lode-fracture all the way. It would appear that the fissure which traverses the porphyroid at an angle of about 30° from the north-and-south line is merely a local variation. The fracture in the slate does not differ materially in strike from other fissures in the field. This matter is, of course, important in future prospecting work, both in this section and those adjoining.

At the bend in the south drive a winze has been put down on ore for a vertical depth of 56 feet, and a drive 20 feet long put in northwards at 50 feet.

The winze was full to the collar of water, and I could not inspect these workings. It is stated that a slide was met with at this point; and possibly it may be the same slide visible on the level 56 feet north from the winze, and pitching in this direction.

At a point 29 feet south of the winze an easterly crosscut was put in some 10 feet without meeting ore; and 8 feet further south another crosscut was driven west for 17 feet with similar results. Beyond this latter crosscut the south drive extends some 24 feet. The face shows carbonate of iron with galena and blende. The dip is to the westward, at an angle of 60°. The footwall is dense and hard slate, but the hanging-wall slate is graphitic, and the carbonated zone extends into this crushed graphitic slate for about 4 feet.

The main ore-shoot, *i.e.*, that portion of the lode-channel enclosed within the porphyroid, is said to have given excellent ore all along the level. The average width of first-class ore is said to have been 10 inches, while 30 inches of clean ore were met at a point 20 feet north of the winze.

This being correct, there remains a fair bulk of good ore to be yet extracted below this level.

Above the No. 3 level, and between it and the No. 2 level, some ore has been stoped, but the greater portion yet remains untouched. It does not extend to the surface, however, for the shoot is pitching to the south at an angle of about 55°.

The shoot was met with on the No. 3 level, at a vertical depth of 87 feet below the No. 2 level, some 60 feet further south than the corresponding point above.

The width of the lode exposed in these stopes varies from 4 to 7 feet. I saw some good first-class ore along the western boundary of the lode-formation, but the bulk of the ore consists of massive mixed sulphides of the type known as a "pyritic lead ore." The mineral composition has been noted above.

The work done up to the present has proved a roughly rectangular block of ore, extending from the surface to at least the No. 3 level, and from 4 to 7 feet in width. The other dimension is about 100 feet; but the pitch of the shoot makes the length appear some 30 feet greater when measurements are made along a horizontal line.

It yet remains to be proved whether the structure of the lode will alter in depth when the porphyroid zone is penetrated. The nature of the fissure in this rock seems to have entirely controlled the circulation of mineral-bearing solutions, and the slate contains but little mineral matter; but the fissure, of which the upper portion is in porphyroid, must, if its strike and dip continue uniform, pass through slate in depth.

A trench has been made to the south-east of the open-cut for a length of a chain. Some vegetable soil containing a little bog iron ore is exposed. I do not think this is the capping of a lode.

The company has erected a mill on the button-grass plain to concentrate their second-class ore.

Mill Scheme.—The mill is divided into two sections—coarse and fine. From the bin the ore goes to a jaw-crusher, and thence to a trommel, the screen of which carries holes of 13 m.m. diameter. The fines run on. The coarse goes to a picking-table and then to the coarse rolls. There is a topping-jig below taking the "roughs" from the first sizing-trommel (screen apertures 13 m.m. diameter). The tails from the jig are elevated to the coarse rolls, and pass again down the mill. The four sizing-trommels have apertures in the screens of 13 m.m., 9 m.m., 5 m.m., and $2\frac{1}{2}$ m.m. in diameter respectively.

From that which holds the material over 9 m.m. in diameter the ore passes to two jigs. Each of the other two trommels feeds a separate jig. The ore before reaching these latter fine jigs is passed through an upward current separator, and the fines go on to the tables.

Below the last trommel are two spitzkasten, giving two grades of ore. The coarser goes to a Wilfley, and the finer to a Phoenix-Weir table.

Middlings from the table are elevated, and pass to the water-classifier on the fine side of the mill, and are again passed over a Wilfley table.

On the fine side of the mill the procedure is this:—The second products from all the jigs are wheeled back to the elevator, and thence go to the fine rolls, and then the second series of sizing-trommels, the screen apertures of which measure 4 m.m., $2\frac{1}{2}$ m.m., and $1\frac{1}{2}$ m.m. The ore that is caught by the 4 m.m. trommel is returned to the fine rolls by the elevator. The other two trommels supply ore to two jigs.

The ore leaving the last trommel runs to an upward current classifier. The coarse product is treated by a jig and the fines pass to the spitzkasten, and then to a Wilfley table. The middlings from the table are returned to the spitzkasten, and then again to the table.

The concentrates from the mill are mixed with the hand-picked ore to constitute the saleable ore. No distinct grades of mill concentrates are made.

The following assay returns will give a reasonable representation of the value of the mine products. They are from the assay books of the company, and the assays were made during 1907:—

Description of Ore.	No. of Assays Averaged.	Lead.	Silver. (oz.)
		per cent.	per ton.
Gossan (from open-cut)	6	..	34·5
Crude ore	14	5·9	11·6
Hand-picked ore	9	51·9	67·4

Sales of Ore by the Murchison River Silver and Lead Co., N.L.

Date.	Quantity of Ore.			Lead.	Silver. (oz.)	Gold. (oz.)	Net Value. (per ton.)		
	tons.	cwt.	qrs.	per cent.	per cent.	per ton.	£	s.	d.
May, 1907.	12	7	3	43·75	57·1	·045	12	10	1
May, 1907.	57	0	1	47·85	64·1	·043	14	1	3
June, 1907.	80	14	3	42·8	55·55	·07	12	6	3
June, 1907.	32	9	1	43·8	55·75	·057	12	8	10
July, 1907.	33	18	0	43·95	59·15	·06	13	4	6
July, 1907.	16	17	1	41·3	55·6	·078	12	8	0
Aug., 1907.	31	7	3	28·5	40·9	·095	8	11	9
Aug., 1907.	29	8	1	34·825	47·15	·09	10	8	6

The other lease held by the company, viz., No. 1980, is that which was formerly known as the Central Farrell.

On this lease there are two parallel lodes, which have been prospected at two levels; and a trench has been cut for a chain where a creek has cut across the outcrop.

The lodes are separated by a narrow band of porphyroid, and are themselves in slate. The dip of the country is westward, and the lodes follow this dip, which is from 60° to 65°.

At the surface the strike seems to be about N. 4° W., but the underground workings show the strike to be due north and south.

The creek section shows slate on the western side, with a lode 2 feet 6 inches wide to the east of it; then 9 inches of slate, followed by 10 feet of porphyroid. The footwall of the porphyroid shows quartz, which may mark the position of the eastern lode; but the work has ceased at this point. The lode formation shows a little fahl-ore, now much decomposed and discoloured.

The upper tunnel is driven eastwards on a bearing of 266°, and passes through slate and crushed grit. The total length of this crosscut is 234 feet.

At a distance of 126 feet from the mouth a drive runs due north on the first ore-body. A rise has been put up for 15 feet at a point 110 feet from the main crosscut, where a little metal was met with. Some 34 feet north of this point a winze has been put down. It was full of water at the time of my visit.

At a distance of 29 feet north from the winze a cross-cut has been driven for 23 feet, where the second lode was encountered, and driven on for 20 feet northwards. This lode is 4 feet wide, and has well-defined walls. The lode-matter is graphitic slate, with numerous veinlets of carbonate of iron. The footwall is a hard siliceous slate.

The main drive was carried for 33 feet north, past the eastern crosscut, and still on the lode-channel, which shows quartz, siderite, and a little galena. The width of the zone of crushed graphitic slate carrying these minerals varies from a few inches up to 3 feet 6 inches.

The main crosscut did not meet with any ore after traversing the second lode.

The lower-level workings are 60 feet above the button-grass plain, and 50 feet below the upper workings. The adit level is driven for a total distance of 285 feet, and intersects both lodes.

The first was cut at a distance of 212 feet from the mouth of the adit, and there are 15 feet of country between it and the second lode.

The first lode was driven on northwards for 15 feet. The lode-formation appears to be about 4 feet in width, and similar to that on the upper level, but no galena was visible. The drive was abandoned here, and the lode driven on southwards for 73 feet. The formation is well defined all the way. It is about 4 feet wide, and has clean walls. Very little metal is now visible, but a few splashes of coarse-grained galena occur near the south end on the back of the drive. None was showing in the face.

A drive was started on the eastern lode and carried 6 feet before being abandoned. The lode is well marked, and is in graphitic slate. The ore is accompanied by veins of quartz and siderite, and consists of galena, resin, or ruby blende, fahl-ore, and copper pyrites. The fahl-ore would account for the high assay values which have been recorded of the ore in this mine.

No work was being done on the section at the time of my visit, and the old workings were very much discoloured. The amount of ore in the mine could not be determined, nor the proportion of fahl-ore to the galena. The only spot where any appreciable amount of metallic minerals was visible was at the point where work has been done on the eastern lode on the lower level. There I saw a vein of an inch and a half of the fahl-ore at the sole of the face.

Some rich returns are said to have been obtained from the ore taken from the winze on the upper level. In all, about 120 feet of backs would be obtainable from the lower level to the highest point of the outcrop.

(4)—The Murchison Extended Mine (late North Murchison).

The company holds one section (No. 1075-M), which is registered in the name of E. T. Midwood.

There is a fair amount of surface prospecting work done on this section, but no payable lode has yet been located.

Near the centre of the western boundary-line there has been some trenching along a creek which runs westwards, and a little galena has been disclosed. A main adit has been driven east on a bearing of 91° for a distance of 143 feet.

At 120 feet a lode was met with. This is a brecciated zone of black slate, in which much siderite is visible, and a little galena and fahl-ore. It seems highly probable that this ore-body is on the line of the Central Farrell fractures, but whether a second lode corresponding to that in the Central Farrell property exists I could not determine from the work which has been done.

A considerable amount of trenching has been done on the southern boundary of the section. Some carbonated black slate has been located which carries some pyrites and traces of galena.

Further east of this place trenches have been carried up the hill in steps to a height of 430 feet above the button-grass. The top few feet show a silicification of the country rock, and in the quartz veins a little chlorite and pyrites, but no galena. The occurrence seems similar to that in the South Murchison eastern tunnel. I could see no galena nor any siderite associated with the quartz. The occurrence does not seem to me likely to prove of commercial value. The bearing of this quartz zone is about 175°.

(5)—The Mackintosh Copper and Gold Mining Company, No Liability.

The company holds two 80-acre sections, viz., Nos. 3221-93M and 3223-93M.

The workings on these sections have been carried out in both lead and copper-bearing lodes, which are situated along a line on the western portion of the two sections.

The most southerly workings are in the extreme south-west corner of the southern section, and within 150 feet of the most northerly workings of the North Mt. Farrell Mine. The ore-body is clearly a continuation of the North Mt. Farrell lodes, and it seems continuous right through this southern Mackintosh section and part of the northern.

The company has let several tributes, and the most southerly workings are being carried on by J. Geddes and party.

An adit is driven eastwards from the western boundary-line of the section on a bearing of 91°. The country traversed is all slate, and before meeting the main lode three minor lodes were cut and driven on for a short distance. All of these appear to be merely branches of the main lode, and their strike is N.W. and S.E. From the second branch-lode a rise has been put in to the surface. No work was being done on any of these occurrences at the time of my visit.

The main lode was driven upon southwards for 200 feet on a bearing of 9°. A rise has been put to the surface and a winze sunk on the ore. There are said to be from 1 to 6 inches of first-class ore here, and with it a few feet of seconds.

The dip is to the west, and the footwall is of quartz, and barren.

The width of the lode varies from 4 to 9 feet. Stoping is being carried on at a point 25 feet from the south boundary. The formation is a brecciated zone of quartz and galena, and fragments of slate scattered through pug. Some first-class ore is found on the foot and hanging-wall side. The better ore is said to be on the hanging-wall. These veins of firsts are usually in short overlapping lenses.

The present stopes are 30 feet above the level, and there are another 100 feet of backs between the workings and the surface. The ore is partly bagged in the stopes, and the best seconds are hand-jigged.

Some second-class ore is left in the stopes for filling, and the remainder is stacked on the tip with the seconds from the jigs.

The following table compiled from the sale-notes of the tributors shows the grade of ore, and its value:—

Date	Net Weight of Ore.			Assay Value.		Total Value (per ton.)			Metal Quotations.			
				Lead.	Silver. (oz.)				Lead. (per ton.)			Silver. (per oz.)
	tons.	cwt.	qrs	per cent	per ton	£	s.	d.	£	s.	d.	d.
June 11, 1907 ..	10	1	1	53·0	54·3	20	7	.2	20	15	0	32·00
July 23, 1907 ..	11	6	0	58·2	68·7	21	19	8	22	0	0	32·06
Aug. 19, 1907 ..	11	11	3	58·5	73·4	21	12	7	19	15	0	32·94
Sept. 20, 1907..	15	9	2	60·5	78·8	22	13	6	19	17	6	32·44

In this southern section of the Mackintosh property there are two other places where the creeks have exposed ore, and it is probable that they are on the same lode as that worked by J. Geddes and party.

In these, no work was being done at the time of my visit. Some good second-class ore was visible in the workings, but the lode is not suitable for a small tribute party, although it could doubtless be profitably worked on a larger scale. The lode-stuff in both of these workings is similar to the bulk of the good second-class ore in the North Mt. Farrell Mine.

In the south-western corner of the northern Mackintosh section two lodes have been located by trenching in a creek. A tunnel has been driven from a point a little further west. The bearing is 113°, and the country is clay schist for the first 52 feet. After traversing 81 feet of slate which lies east of the clay schist, this tunnel intersected the first lode. Here good ore is said to have been met with, and a few stopes have been carried almost to the surface, some 85 feet above the level. The first-class ore was sold and the seconds stacked on the tip. The stopes are 40 feet long, and a rise from over the adit was taken right to the surface.

The drive on the ore-body has a bearing N. 10° E. It has been extended southwards for 20 feet, but northwards for 90 feet. The greater portion of this level is full of water dammed up by a heap of mullock, and consequently inaccessible. The lode-channel seems to be well marked, though the lode varies. The footwall is well defined, and on it the first-class ore is obtained. The hanging-wall is indefinite, and a shot put into the apparent country may at any time reveal ore.

At winze has been put down at a point a few feet north of the main crosscut to a depth of 26 feet.

The ore-body here dips more steeply. It is 8 feet in width, carrying about 6 inches of clean firsts on the footwall side and a band of some inches of pug, which contains brecciated steel-grained galena. This latter is hand-jigged.

During my visit some work was done by a tribute party on the ore in this winze, but the water could not be kept under and the party were compelled to abandon the tribute. Nothing could be done with the second-class ore, although it was of splendid grade. Of the hand-picked firsts and jigs some 3 tons of ore were sent away. The average value of this ore is said to have been £16 per ton.

Fahl-ore is mentioned as having been seen in small amount in the ore taken from this lode.

The main crosscut has been driven another 100 feet eastwards beyond the first lode. At 42 feet from the latter a second lode has been cut carrying second-class ore. This has been driven on for a short distance north and south. The lode here appears to be making towards the first lode, with which it would junction at a point further south. A shaft was started in this ore-body at the surface, and is said to be down some 36 feet. Some good second-class ore is tipped round the collar of the shaft.

The Mackintosh property, therefore, seems to carry a length of lode and lead ore of such grade that mining operations on a large scale would be highly profitable. It does not possess the topography that would make the mining on a large scale possible without the sinking of a shaft; yet the bulk of second-class ore and the readiness with which it could be concentrated are in favour of this treatment on an extensive scale. The ore is physically well adapted to concentration, and closely resembles the North Mt. Farrell second-class ore. The present inactivity on this property is deplorable.

At a point further north in the northern section of the Mackintosh lease, and 250 feet from the western boundary, two lodes have been exposed in the bed of a creek.

The country-rock is a pale clay schist, which has been silicified, and which carries also veins of quartz. There is a little carbonate of iron with the quartz, and the metallic minerals present are iron and copper pyrites. The ore is dense and hard, and the copper pyrites is found disseminated in fairly coarse blebs throughout a zone about 8 feet wide. The strike appears to be a few degrees west of north, but very little work has been done, and it is difficult to ascertain the strike and dip.

A shaft has been sunk at a distance of 25 feet from the creek on its northern bank to a depth of 35 feet. It was full of water when I visited the property. The country-rock is the same as that exposed in the creek, viz., clay schist.

The slate is 50 feet to the east of this shaft, and although a number of trenches have been cut in the creek bed on the east of the copper lode no trace of mineral has been found.

On the western side of the lode above mentioned, and distant about a chain, there is a second copper-bearing zone, of a similar character. It is some 3 feet wide, and carries both iron and copper pyrites.

This is the most southerly point at which copper is visible along this line, *i.e.*, in the absence of a much larger proportion of galena.

It does not appear from the work so far done at this point that the ore will give profitable returns as a copper proposition. The occurrence is, however, worthy of being further prospected.

(6)—The Farrell Blocks.

The company known as "The Farrell Blocks" holds two sections, which are registered in the name of E. Goldsmith, and are numbered 2397-M, 79 acres, and 2820-M, 80 acres.

On the western of these two sections (No. 2820) no work has been done. There does not seem much prospect of the Mackintosh lead lode passing into this ground at a reasonable depth. The dip is certainly to the westward, but the winze put down on the western Mackintosh lode shows that the tendency of the lode is to become more nearly vertical than it was between the adit level and the surface; and the lode is distant about 350 feet from the western boundary of the Mackintosh section.

The northern section, No. 2397, occupies a better position with regard to the lode system.

On the boundary-line between this section and the northern Mackintosh section there is a small quartz blow which may be connected with the outcrop cut by the creek a short distance northward; yet the whole area here is highly contorted, and the creek beds show quartz veinlets, which run in all directions, and many of these carry no trace of metal.

In the south-west corner of the section a lode-formation has been cut in a small creek. It is a zone of highly-contorted clay schist, which has been impregnated with silica, and which carries copper and iron pyrites. A little galena is visible in the lode.

On the northern bank of the creek, some 30 feet away, a shaft has been put down 30 feet. No metal was encountered in sinking. The rock penetrated was the clay schist very much contorted, and carrying a little carbonate of lime. The shaft is now full of water. Some 65 feet of backs could be obtained here by driving an adit from the west, but such work is not at present justified. A crosscut from the bottom of the shaft would also prove the lode. However, until the lode is proved to be continuous by other trenches at the surface, the exploitation at a depth should be held over.

Trenches have been cut in the bed of the creek which traverses the middle of the section for a distance of about 7 chains. The country rock exposed is for the most part slate, which is very much contorted. It is sometimes graphitic, and contains a little siderite and veins of quartz. The latter are flat veins dipping mostly to the east, or follow the contortions in the slate. No metallic mineral other than iron pyrites was visible in the main part of the trenches. However, in the southern end of the workings, near the junction of the slate and clay schist, some good galena was obtained. It cut out in the bottom of the trench, however.

The work done at this point has clearly been influenced by the idea that the galena can only be expected to be found within the slate boundaries. The trenching has here been carried out to the east of the proved line of fracturing of the area, and I should recommend that in future prospecting the trenches be continued for a short distance to the west of their present extent. It is possible to obtain 60 feet of backs at the point where the galena was met with in the trenching by 150 feet of driving from a point a little lower down the creek. Still, the trenches might be extended westwards with much less expenditure.

(7)—The Sections on the North-western Flank of Mt. Farrell.

On Section No. 3010, which is registered in the name of D. Powell, some trenching has been carried on on both banks of a large creek which runs through the section, but without result. The section lies to the east of any lodes yet discovered.

On Section 2905, which adjoins the northern section of the Mackintosh property, a trench has been cut in the creek bed, but abandoned in river wash, which consists of fragments of conglomerate from the mountain.

In the south-eastern corner of Section 2909, on the eastern side of the Mackintosh River, some trenches have been cut in the bed of a small creek. The river bank is very steep at this point. The upper trenches expose a highly contorted graphitic slate, with irregularly distributed veins of quartz, siderite, and galena. Some of these veins dip west and others flatly to the south.

On the water's edge a few shots have been put into the bank, and show the same clay schist which is found in contact with the slate all along this line; and in the rock are a few scattered splashes of galena. No further work has been done on the section.

Passing northwards along the eastern bank of the Mackintosh River the next two sections are registered in the name of G. E. Butler, and are numbered 2796-M, 80 acres, and 2892-M, 40 acres.

On the 80-acre section some work has been done in the past near the northern boundary. At the time of my visit nothing was being done.

The fault-plane referred to above traverses this section, and a creek is situated on the line of the fault. Some trenching had been done in the slate near the track, but the sides had fallen in, and nothing was visible of the bottom. A tunnel has been started into the mountain and driven 30 feet in a direction bearing E. 16° S. The tunnel was begun in a coarse quartz grit, and was abandoned when the massive conglomerate of the mountain was encountered in the face. There are some quartz veins in the grit carrying iron pyrites, and in one place, near the entrance, some galena.

However, there does not seem to me much inducement to continue driving, in spite of the presence of a small amount of galena; for what metal was discovered was enclosed within a member of the slate series, and it has not yet been proved that any of the lode-fissures are continuous into the massive conglomerate. This section was formerly known as the "Metropolitan."

At the extreme north end of the mountain, on Section 2873-M, registered in the name of C. R. Lynch, some work has been done to try and locate an ore-body said to be visible in the river at low-water. This latter was not to be seen during my visit. A short tunnel has been driven in the river bank with a bearing of S. 12° W. The work has revealed slate with quartz and iron carbonate veinlets, but no galena could be detected. The tunnel runs with the cleavage of the slate, and a crosscut has been put in towards the east for 14 feet. The slate here, too, carries quartz and siderite stringers.

A trench above the track on the Mt. Farrell side of this tunnel shows only slate.

On the eastern boundary of the section, near the cage crossing to the Tullibardine area, a short trench has been cut in a crushed grit carrying arsenical pyrites. The weathering of this mineral has produced some limonite at the surface; but no sign of a defined ore-channel was visible when I last saw the work.

The position of this section appears to be a little to the east of the line of fracturing of this area.

(8)—The Tullibardine Company.

The company holds three 80-acre sections, all of which are registered in the name of J. McPhee, viz., Nos. 2058, 2592, and 2593.

The greater portion of these sections is covered by unconsolidated river wash, through which the main creeks have cut their way and exposed the underlying rocks.

The felspar porphyry forms a series of steep hills on the western boundary of the property, and the rock underlying the river alluvial is slate or pale clay schist. The strike of the belt of clay schist is, as far as could be determined, considerably east of north. Whether it is the northward continuation of the belt of similar rock which traverses the Mackintosh and Farrell Blocks sections, I could not on this visit definitely decide. However, I think it will prove to be portion of what was originally one continuous formation dislocated by the fault which traverses Section 2796. The fault-plane will, I think, be found to be the spot at which the strike changes. If so, the fracture system which has controlled the position of the ore found on the Tullibardine is probably portion of the same fracture system as that which traverses the Mackintosh area and the Farrell Blocks, and which has been traced to the river bank in Section 2909. In other words, the lode channel, as well as the country rock, has probably been dislocated by the fault which cuts across the country on Section 2796.

In the Tullibardine area the slate occurs on the west as well as on the east of the clay schist. This was the case on the North Mt. Farrell lease (3262), but at the northern locality there is a much greater thickness of slate on the western side.

The main workings are situated in the south-eastern corner of the central Section, No. 2058, on the banks of the large creek which traverses the section. The creek takes a sharp bend from an easterly to a southerly course at this point, and a face has been broken down from the southern bank just at the turn. This cut is 25 feet in length, and exposes the country to a depth of from 5 to 12 feet below the surface-soil. The clay schist is very waxy in appearance, and carries numerous intersecting quartz veins, which carry copper pyrites and some secondary copper ores. The quartz veins vary from half an inch up to a foot in width, but they make and pinch within very short distances. The country rock contains greenish patches, the green colour being due, not to copper, but to a green sericitic mica.

In a complex lode-formation of this character the strike and dip are difficult to estimate. One very strong vein, which has been followed down in a winze, strikes N. 25° E., and dips east at 80°; but other veins dip towards the west.

The copper pyrites is very clean and free from iron pyrites, and is in places quite coarse and massive; and, resulting from its alteration, malachite and bornite are common in the lode-formation.

A winze has been put down on the eastern end of this face for 7 feet. The same types of country and mineral vein persist. In addition, the schist is thoroughly impregnated with very finely divided native copper where it is enclosed between a cupriferous quartz vein and a plane of separation along which surface waters have been circulating. The schist is at this place deeply stained with limonite.

A little further up the creek to the westward a couple of small cuts have been made in the bank, and show a little copper pyrites. One of these veins shows a fair amount of ankerite* with the quartz, and serves to show the connection between the copper ores and the lead ores. At this place, 15 feet west of the main face, the clay schist has a belt of slate intercalated with it. The slate dips to the westward.

In all, the veins which show copper extend to a distance of 100 feet west of the main face exposed.

Across the creek from the main cut there are two trenches which show quartz veins or silicified schist carrying copper ore. These serve to indicate that the copper bearing zone is at least 150 feet in width.

Where the creek turns to run southwards there is a strong quartz vein carrying coarse copper pyrites. On this, Pearce, who first held the property as a reward claim, had sunk a shaft 20 feet, but the creek at the time of my visit made it impossible to investigate this work. Pearce had apparently turned the creek to the west, but the later work had thrown it over again, so that the water could not be baled out of the shaft.

Alongside this old shaft a tunnel has been driven eastwards on a bearing of 126° in slate, which here junctions with the clay schist. The cleavage-planes of the slate at the entrance of the tunnel dip at 60° to the east, but in the face they dip at 80° to the west. The slate, considered as a whole, will be found, I think, to dip to the west, as does the small band intercalated in the clay schist.

At 75 feet the tunnel cuts through a band of silica 2 or 3 inches wide, and striking N. 5° W.

Further in, 8 feet from the face, the country becomes fractured in all directions, and the fractures are filled with siderite. In the face, further veins of quartz appear striking from 30° to 40° east of north. These quartz veins carry copper pyrites and some odd splashes of galena. The tunnel was here abandoned.

Another tunnel was started, 100 feet south of the first, and across the creek. It was driven west on a bearing of 299° for 35 feet, the intention apparently being to prove the veins of cupriferous quartz exposed in the main cut on the creek bank. The only copper veins met with were some small ones in the approach. The country intersected by the tunnel is clay schist, much crushed and fractured. Some bands of the schist are a little darker than others, and resemble more closely an ordinary slate. Vertically above this tunnel a couple of trenches have

* Ankerite is a carbonate of lime, iron, and magnesia.

been cut in the creek bank, and show a few quartz veins carrying copper pyrites.

The tunnel should certainly be continued for another 100 feet to prove whether the veins of copper-bearing quartz exposed by the main face are continuous. So far only the width of the formation has been indicated by prospecting operations.

The creek turns again to the east a little way further south, and some trenching should be done here to prove whether the lodes cut by the eastern tunnel are of any horizontal extent.

In the south-western corner of the northern section, a trench one chain long has been cut, and a hole put down some 6 feet in the centre of it. The country rock is the clay schist in which green patches of sericite occur, and which is thoroughly impregnated with ankerite. A little quartz is present in veins and small lenses, but no copper accompanies it at this spot.

Near the centre of the southern section, No. 2592, there is a short trench upon a quartz outcrop. The surface cover is considerable, and only a few irregular masses of quartz are visible. There is a small amount of ankerite and both copper and iron pyrites included in the quartz. I noticed also some fragments of included slate, like those in the quartz reef on the Mt. Farrell leases. The outcrop is poorer than that in the north-eastern corner of the section, but seems worth prospecting further.

A few chains to the south-east a trench, 40 feet in length, has been cut. It shows the usual alluvial cover resting upon a dark-coloured wavy slate. There is some quartz in the slate, and on the sides of the trench I saw some slate with veins of siderite and a little iron pyrites. This may come from the end of the trench now filled in by the fallen alluvial from the sides.

On the eastern bank of the creek, south of this latter place, a trench 8 feet long exposes a lode which differs from the copper formation in a striking way. The country rock is the same clay schist, with green sericitic mica on the divisional planes, and carrying a quantity of carbonates, but no silica. The metallic minerals are galena and blende.

The strike measured over the short length exposed is between 10° and 12° east of north. The dip is to the westward. No copper ore at all has been seen at this place.

The ore strikingly resembles that which comes from the vughs in the quartz reefs of the Mt. Farrell Mine.

There is a vein, about 10 inches wide, of ore which carries the metallic minerals (galena and blende) in bands up to an inch in width, and also scattered through the gangue.

A trench, 6 feet deep, was cut at a distance of 60 feet to the southward to test this lode. The sides had partly fallen in and were not visible. On the banks were some pieces of greenish schist carrying veins of quartz and carbonates, with iron and copper pyrites, but no galena.

There is little else done on this area. In the bend of the river, just south of the boundary-line of Section 2593, a trench has been cut in the clay schist, but no ore is visible.

The copper ore of the central section is in itself of very promising appearance; but the quantity available cannot be estimated even roughly until some further prospecting work is done, with a view to proving the length of the lode-formation. The amount of ore carrying native copper cannot be expected to be considerable.

(9)—The White Hawk District.

(a)—*The White Hawk Mine.*

The White Hawk property includes the sections numbered 2330-M, 42 acres; 2331-M, 80 acres; and 2332-M, 47 acres. All of these are registered in the name of R. P. Symmons. The 80-acre section contains the workings.

At the centre of central block (No. 2331) is the lode, which was first located by Tom Farrell, and the section was his reward claim. His original workings have been almost completely obliterated by recent prospecting operations. The ore outcrops at the foot of a steep hill of limestone.

A short drive has been put in on a bearing N. 30° W. on the lode. A body of gossan carrying some galena and cerussite (lead carbonate) was met, and a winze put down to a depth of 5 feet on the lode a few feet from the entrance.

At this point the lode seemed to dip east at about 40°, and to strike about 30° west of north. However, very little information could be gathered from the amount of work done. The shape of the ore-body was not clear. On the northern wall of the winze there was a good seam of galena and blende, but metal was absent from the southern wall. The ore gave me the impression of following the joint-planes of the limestone, but no length of lode can be said to have been proved.

Work has been abandoned at this particular spot, and a crosscut has been driven westwards for 141 feet on a bearing of 265°, in the hope of cutting another ore-body.

The first discovered outcrop of ore is situated at the approach to this tunnel. No other metallic mineral than iron pyrites was visible to the west of the lode at the entrance. Galena is said to have been seen while work was proceeding, but I did not find any in the workings.

The drive cut across some cavities in the limestone, which are still visible in the back, and down which the surface drainage brings a quantity of mud.

On the steep hill side which forms the western bank of the White Hawk Creek south of the centre of the section, there are two places where a small amount of galena, associated with zinc-blende, is visible. One is near the top of the hill, and carries some coarse-grained galena with semi-oxidised blende. The strike and dip could not be ascertained. The other occurrence is some 10 feet above the creek level, and shows galena following the joint-planes, and dipping east.

The metal appearing here is, in my opinion, not connected with any other lode yet located in this area.

Near the south boundary-line of this central section a mass of gossan was discovered, which, on being broken into, was found to carry veins of galena. The dip and strike could not be determined accurately, and the possibility of the veins now visible being of a secondary nature is so strong that such observations could hardly be of any value.

A tunnel was started from the creek bank, which is here precipitous, to cut the lode at a depth of 85 feet below the outcrop. The tunnel is on the same level as the other tunnel in the centre of the section, but here the creek is about 25 feet lower. The bearing of the tunnel is 256°, and it has been driven westwards. The limestone traversed dips at 40° to the west. Joint-planes crossing the bedding-planes at the entrance to this tunnel are apt to give a false impression of the structure; but the joints become less pronounced as the surface-rock is left. The limestone shows numerous seams of calcite running with the bedding-planes, and opening out here and there into lenses from a quarter of an inch to half an inch wide, and from half to three-quarters of an inch long.

The tunnel at 40 feet from the entrance met with a body of semi-oxidised ore. There was some crystalline calcite and a mass of gossan carrying galena and cerussite. On the sole of the drive this ore looked very well. A winze had been started during my visit to the district, and was down 9 feet on ore. A chamber was cut on the southern side of the crosscut, and the winze was following the ore, which at this place is dipping eastwards. The dip varies, becoming much flatter in the bottom of the winze. On both hanging-wall and footwall there is pug carrying fragments of limestone. The ore consists of gossan, carrying blende and galena in bunches through it, and at the bottom of the winze at the time of my visit there were 2 inches of clean galena in the gossanous material, which was dipping east at 35°. The amount of ore was increasing as the workings were carried down, and there appeared to be signs of the lode increasing in width on the southern side of the winze.

The adit was continued past this spot, and when I visited the mine the work of driving westwards was proceeding, at a distance of 123 feet from the entrance.

This tunnel at 80 feet passed through a slide-plane, dipping with the country, and carrying fragments of limestone set in a paste of soft, wet, yellow clay. Some cavities of solution were passed through, similar to those met with in the northern tunnel. Where the drive intersected one of these, at 103 feet from the adit entrance, a mass of gossanous material was met with, which carried galena. This fragment of ore may have been derived from the upper portion of the body of ore cut at 40 feet, and may have rolled down the open cavity to its present position.

Beyond this point the last 20 feet of the tunnel are in very dense limestone, in which the bedding-planes are not decipherable, but which is traversed by a number of very irregular joints. Veins of calcite were present, and in them a little iron pyrites.

The work done at this end of the section has given very inconclusive results. There are two bodies of ore—the surface gossan, some 85 feet above the tunnel; and the ore-body on which the winze is sunk. But the connection between the two, if any exists, has not been proved. The tunnel was being driven in country which, at the time of my visit, showed no indication of the presence of ore. It would therefore seem advisable to follow the surface gossan down, to try and determine the strike and dip. Until more is known about this surface ore it appears to be inadvisable to prospect for it by means of a tunnel.

On the northern boundary of the section in the creek bed a trench has been cut for a few feet. The massive limestone here contains some crystalline calcite, but I could see no trace of any lead ore.

The following assay returns will show that the metallic contents vary considerably. This is no doubt owing to the fact that the lodes are subject to the leaching action of surface waters.

Description of Ore.	Lead.	Silver (per ton).	Zinc.
	per cent.	ozs. dwts. grs.	per cent.
Mixed sulphides	41·8	12 5 0	20·5
Gossan	39·2	15 16 5	—
Galena (from gossan)	66·7	11 3 5	—
Galena (from gossan)	49·5	9 13 6	—
Galena (from winze)	39·1	8 15 0	—
Galena	77·2	53 1 16	—
Galena	50·51	27 17 8	—
Galena	60·6	6 7 9	—

(*b*)—*Other Sections on the White Hawk Creek.*

On the Section 3367-M, 72 acres, charted in the names of R. P. Symmons and C. R. Lynch, a gossanous cap on the limestone has been found. Some trenching has been done on this outcrop, starting from the small creek that runs southwards to join the main creek near at hand. The trenching shows a number of veinlets of calcite, carrying galena, blende, and copper pyrites. These dip to the west into the limestone, and with the bedding-planes. From the amount of work that had been done, these veinlets gave me the impression of being "droppers" from a lode crossing the bedding-planes. A trench across the formation in an east-and-west direction would afford valuable information.

There is no further work done on this or the other sections charted in the same names.

(10)—The South Murchison Silver and Lead Mining Company, No Liability.

The company holds one section, No. 704-M, of 73 acres, upon which a considerable amount of prospecting has already been done, but hitherto without any successful issue. The object of the work done is to pick up the southward continuation of the Murchison lode. It has been already pointed out that the lode-channel after passing through the porphyroid in the Murchison low-level workings turns and follows a direction only a few degrees west of south. If this strike continues unchanged, the lode-channel should traverse the South Murchison ground, provided that it is continuous for that distance. The surface cover of vegetation is extremely thick at this place, and the prospecting work has been considerably hampered by its presence.

A lode is said to have been discovered in the river bank just east of the crossing. This formation is said to have carried galena in a gangue of quartz and siderite. At the time of my visit the river was at first too high to see this lode, and later, when the water had subsided, it was deeply covered with silt.

Two lines of trenches are cut at a point near the south boundary-line of the Murchison section, but no definite lodes have so far been located. Some siderite is visible in dark graphitic slate, and with it a little quartz and iron pyrites. This spot is a little to the east of the upper tunnel, and is the strongest evidence I saw on the section of the proximity of a lode likely to contain lead.

The tunnel just mentioned was driven westwards on a bearing of 280°. The country penetrated is a dark-coloured slate, slightly contorted. The tunnel has been carried for a total distance of 107 feet. At 70 feet a drive north was put in some 27 feet, and a further crosscut was driven north-west for 27 feet. The face of this crosscut showed massive quartz, with a little calcite and pyrites. The quartz contains some chlorite. No galena was found in these workings, and they have been abandoned. The company, at the time of my visit, was exploiting the more easterly portion of the section by a low-level tunnel. This starts from the river bank at a point 17 chains N.N.E. of the corner peg on the river bank.

The tunnel is driven west on a bearing of 270°, and had been extended some 160 feet when I visited the property. There is a dark slate at the approach, and then for 150 feet the adit is in a pale-coloured clay schist, not different from the slate except in colour. A few veins of quartz were intersected, carrying some chlorite and associated with calcite. Some of the veins showed a few splashes of blende and galena.

At 150 feet the tunnel passed into a belt of porphyroid, which continues up to the face of the drive.

The company expected to cut the lode by this tunnel with 100 feet of driving, but events have shown their estimate to be much too small. The width of the felsitic rock has not yet been proved at this point, and the surface vegetation is too dense to settle the matter till some further trenching is done. The lode for which the company is driving is said to be in slate where it was picked up on the river bank. Yet this does not necessarily mean that the lode will continue in slate. The felsitic rock may carry the lode if the fracture persists and crosses over into it from the slate. The upper-level tunnel would appear to be situated just to the westward of the belt of rock said to contain the lode. Had it been 100 feet further to the east much more information might have been obtained. The configuration of the country is less favourable at this point. Still, a site for the lower-level tunel might well have been obtained further west than the one selected.

(11)—The other Sections North of the Murchison River.

On the remaining sections charted on the map accompanying this report practically nothing has been done.

A few cuts have been made along the river bank on Section 2945, registered in the names of R. Green and A. King. Galena is showing in two places in a lode-formation which consists of slate cemented together with carbonate of iron and quartz. This latter occurrence of ore may have some connection with the western lode, which has been located across the river on Thomas' Blocks.

(12)—The Thomas' Blocks Silver Mining Company, No Liability.

This property consists of three sections, viz., 2808-M, 80 acres (lessee, C. W. Thomas); 2850-M, 80 acres (lessee, C. Thomas); and 2918-M, 20 acres (lessee, G. O. Smith).

The main portion of the leases is situated on typical schistose porphyroid, but the slate occupies a large area of the northern section (2808).

Work on the lodes found on these properties has only been in progress for a few months, and thus far nothing is known of the behaviour of the lodes in depth.

There are certainly two lodes on the property, of which the eastern one is the principal.

This main lode, at its outcrop near the northern boundary of Section 2808 in the bend of a creek, showed about 14 inches of banded ore, in which were 4 inches of clean steel-grained galena on the hanging-wall side. The metallic minerals occurring with the galena at the surface were blende, copper pyrites, and iron pyrites. The gangue minerals were quartz, ankerite, and fluorspar.

It was decided to exploit the lode at this spot, and with that object a shaft was sunk at the site of the outcrop first located. This shaft was only just started at the time of my visit, and some difficulty was experienced in keeping it clear of water. There were a few inches of very good ore, consisting of galena and copper pyrites, in the bottom of the shaft. The amount of copper pyrites was not large, but all the ore I examined carried blebs of it.

A point has been chosen about 250 feet further down the creek from which to drive for the lode. Near this approach there was a small vein of a quartzose character, which showed a little galena and blende. In cutting a magazine at this point, the ore was not found to make into body of any size. It is probably an off-shoot from the principal lode.

The first few feet of the tunnel are driven in a southward direction, and it then turns away with a south-west erly bearing to intersect the lode near the shaft sunk from the surface. The tunnel was begun in slate, which gave way within a few feet to a wavy porphyroid. Galena was visible here and there on parting-planes in this rock, which clearly shows the results of alteration by vein-forming solutions. The main lode-channel had not been reached at the time of my visit. When the lode is cut at this point much more information should be afforded. The ore at the surface seemed very free from oxidation on the whole, but a sample from greater depth is needed for comparison.

I have been shown since leaving the field some of the ore from the shaft, which contained a considerable proportion of fahl-ore. The assays made of samples taken from this place gave these returns:—

Silver (per ton). ozs. dwts.		Lead (per cent).
102 18	...	65·4
215 0	...	69·5
201 0	...	—

The discovery of the fahl-ore here seems an excellent sign, and if any quantity of this mineral is commonly associated with the galena of the lode, an ore with a silver content much above the average will result. The increase in the silver content with recent deeper development is notable, for earlier assays of material taken from the outcrop are said to have shown only from 27 to 50 ozs. of silver to the ton.

What would appear to be, in all probability, portions of the same lode as this main one just described outcrop at several points on the slopes which rise gradually from the the river towards Mt. Murchison.

One of these outcrops is situated within the southern section (2850), and close to the south-eastern corner of Section 2808. Very little of the lode was visible at the time of my visit, and the character of the ore seemed a little different from that at the principal workings. It was dense and quartzose, but carrying two bands of galena, making in all about 6 inches of second-class ore. Trenches at intermediate points are necessary to prove definitely whether these southern outcrops are on one and the same line of lode. The trenches would also serve to locate the better shoots of ore for exploitation.

In the south-western corner of the northern section the "western lode" has been exploited by a trench. The lode runs N. 25° W., and is in the same country rock—porphyroid. A trench some 50 feet in length and 8 feet deep has been cut. The metal occurs on a good wall as a narrow seam 1 to 2 inches in width. It is free from non-metallic gangue minerals, but both iron pyrites and blende accompany the galena.

No height of backs can be obtained at this point by tunnelling, and it will be probably found more advantageous to carry a trench on the line of the lode as at present, and to sink on any good shoot of metal that may be met with.

In the north-west corner of the south section there is some gossanous material on the surface which may be derived from this western lode.

(13)—The Tullah Silver and Lead Mining Company, No Liability.

The company is engaged in exploiting a lode which has been discovered on Section 2925-M, 80 acres, registered in the name of E. Pennefather.

The lode has been exposed by some 30 feet of trenching in the creek which traverses the southern portion of the section. At the surface it appears to be of a composite character, consisting of numerous short lenses and bands of galena, blende, and iron pyrites, in a zone of altered felspar porphyry. The width at the surface is about 15 feet, and the strike, as far as could be ascertained, N. 8° W. There is some good milling ore visible in the trenches, but the lode would need some hand-picking, since the ore follows only certain irregular lines.

A tunnel has been driven, at a depth of 80 feet below this outcrop, in an easterly direction, the bearing being 76°. The country rock driven through is for the most part massive uncrushed felspar porphyry. At 15 feet from the entrance a former river-channel was intersected. The river wash which filled this channel, of which the width in the tunnel is 20 feet, contains boulders of granite, felsite, diabase, and some rounded fragments of lode-material similar to that found in the lode itself.

After passing through this old river bed, a reddish or greenish felspar porphyry was traversed by the adit till a point 210 feet from the entrance was reached. Then the lode-formation was encountered. The tunnel was continued for a total distance of 234 feet from the mouth.

The lode-formation is, in all, 23 feet in width, and dips to the westward at from 80° to 85°. It is a complex lode system, comprising numerous zones separated by divisional planes roughly parallel to the outer walls. The gangue is for the most part a greenish sericitic alteration product of the felspar porphyry. Some silica is present, especially on the footwall side. Much of this silica is of earlier date than the impregnation by the lead-bearing solutions.

The footwall country is a chloritized felsite, which is free from galena, but ribbed with vertical veinlets of quartz. Part of it, too, is hardened by an intimate infiltration of silica, till the rock becomes practically a jasper or chert. This phenomenon is merely a phase of the formation of the siliceous veinlets so common throughout the district, and with which no other metallic mineral than iron pyrites is associated.

The felspar porphyry, once fractured and cemented together with the silica veinlets, has been refractured, and the metallic contents have been introducd.

The metallic minerals present are galena, blende, and copper pyrites; and with them there is present a little siderite. This latter gangue mineral, so characteristic of the field generally, is present in appreciable amounts only where the larger pockets of ore are found. The zone of country which has been altered by the vein-forming solutions is notable for the development of sericitic mica rather than the carbonate minerals.

The galena and other metallic ores are found in bunches and pockets, and along all the cross-heads in this compound lode-formation. The zone which carries the most ore is the central portion of the lode. This is also the softest, for the development of sericite and carbonates is most marked there. Some of the galena is in an extremely fine state of division, and the lode is so minutely impregnated with it in this central zone that any broken fragment of ore shows the fine-grained metal throughout.

With a view to proving the lode, there was started during my visit to the field a northward drive, which had been carried for some 28 feet along the footwall. The lode here was hard and poor. Since my return from Mt. Farrell the drive has been carried another 100 feet northwards, but the driving has been continued a little to the west in the central and softer portion of the lode-formation. The results are reported to be much more encouraging, and some ore carrying a fair proportion of fahl-ore has been obtained.

It will probably be wisest for the company to follow the lode on the present level and sink on the better shoots of metal met with, rather than to drive a low-level adit, which would need to be a very long one, in order to obtain any considerable height of backs. A survey made by the company shows that, with 925 feet of driving, some 320 feet of backs are obtainable.

The following are the results of assays made from ore from this mine since 6th January, 1908:—

Silver (per ton). ozs.	dwts.	grs.		Lead (per cent.).
13	4	14	...	77·1
32	0	6	...	77·6
47	17	3	...	73·0
305	16	0	...	77·6
222	10	0	...	74·7
429	18	16	...	74·5

The latter three samples contained fahl-ore. The variation in the silver content in the others is perhaps due to the proximity to the surface. Much water was encountered during the driving, when the lode-formation was met, and the circulation of surface waters may cause a partial leaching of the silver contents.

(14)—M. Donoghue's Sections, Nos. 2863 and 2864.

These two sections are of 80 acres each, and are on the line of what is probably the major fracture in this area.

The main lode outcrop, now being prospected on Thomas' Blocks, is the most northerly outcrop on this line of lode. As already stated, some further intermediate trenches are required before these different outcrops can be regarded with certainty as being on one continuous lode. Still, the probability that they are on the one lode is very great. The line of the lode seems on the map to bend away a little towards the east; but it is to be remembered that the country is rising here towards the heights of Mt. Murchison, and the dip of the lode at Thomas' Blocks has been shown to be to the westward.

Just outside the south-eastern corner of Section 2850, of the Thomas' Blocks lease, there is an outcrop of the lode. The country rock is still the schistose type of the porphyry. Galena is visible at the surface, and some iron pyrites in a siliceous lode.

Still further south there is an outcrop in the creek, on which some work has been done, and in which a very promising lode has been disclosed. It is a complex formation, from 14 to 18 inches in width, consisting of second-class ore with narrow veins half an inch wide of clean galena on the walls. With the galena are its associates, characteristic of the lodes on the field, viz., blende and both copper and iron pyrites.

The country rock is here no longer schistose, but massive quartz-felspar-porphyry. The hanging-wall is but little altered, and is pink; but the footwall is greenish, and carries streaks of metal in the sericitized zone. This occurrence is 720 feet, by aneroid measurement, above the river.

Still further south, and a chain inside the boundary of Section 2864, is an outcrop showing disseminated galena, blende, and iron pyrites over a lode 18 inches wide in the quartz-porphyry. This spot is 875 feet above the river.

Further up the hill still, and 960 feet above the river, there is in the creek a greenish lode some 8 inches wide, carrying pyrites and galena.

The south-western portion of the southern section contains two occurrences of ore, which have had a little trenching done on them. The western occurrence shows iron pyrites, blende, and galena, in a green lode-matter resulting from the alteration of the felspar-porphyry, which is here schistose.

South-east of this occurrence is a somewhat similar one. The trench shows a greenish quartzose lode, of which the bearing is about N. 35° W. The lode carries galena, blende, and pyrites. The country is the massive type of felspar porphyry.

The lodes on this section are well worth further prospecting, especially the eastern one, which I think to be probably the southward continuation of the "main lode" on Thomas' Blocks. The prospecting now being carried out on the latter property will no doubt afford valuable information, which will be of benefit to the future prospecting of this lode. The surface configuration will enable the lode to be worked at several levels by means of short adits.

(15)—The Sections in the Sterling River Valley.

To the west of the Thomas' Blocks and Donoghue's sections are a line of sections situated on the low ground leading down to the Sterling River. These sections—numbered 2861-M, 20 acres; 2837-M, 80 acres; and 2862-M, 68 acres—stand in the names of J. H. Finlay and M. Donoghue.

The western portion of the area consists mainly of slate, but in which there are some parallel narrow bands of porphyroid. The outcrops are few, and I could not determine whether the porphyroid was intrusive or whether thin sheets of lava were interbedded with the slates.

There is a long quartz reef traceable right through these sections from end to end, which has a trend slightly to the east of north.

The only work done on these sections has been carried out on this quartz body.

The outcrop of quartz has been cut through by a trench at a point just south of the boundary-line, between Sections 2837 and 2862. The quartz is some 15 feet across at this point, and has a westerly dip. There is a little iron pyrites present in the quartz, and with it some copper pyrites. On the hanging-wall side of the reef in the slate there is a vein of galena half an inch in width; and on the footwall side there is a gossanous admixture of quartz limonite and iron carbonate carrying a little galena.

An assay of the ore from this spot is said to have shown the presence of 11 ozs. of silver to the ton.

A few chains to the northward the quartz shows only iron pyrites, and no trace of lead ore.

Following the outcrop northward it disappears under the button-grass, but again reappears in the same line. Some trenches have been cut across it in Section 2861, and just outside the northern boundary of this section, but only iron pyrites was found in the quartz.

This quartz reef seems, therefore, barren, as far as galena contents go, and to resemble in many ways the quartz reef in the Mt. Farrell sections. The one spot at which the galena has been found appears to me a place where a later fracturing has in part coincided with the original fracture, enabling the galena to be introduced alongside the quartz.

(16)—Other Sections South of the Murchison River.

On the north side of the Tullah property, and between it and the river, lie two sections—No. 2830-M, 80 acres, registered in the name of C. A. J. Collins; and No. 2911-M, 79 acres, in the name of C. Thomas.

The former of these, No. 2830, carries only one trench in the centre of the section. The rock exposed is porphyroid, impregnated with galena, blende, and iron pyrites. Too little work has been done to form any estimate of the value of the lode.

On Section 2911 there is a little work done on the north-western corner, high on the slopes of Little Farrell. In the crushed conglomerate, 500 feet above the river, a small body of quartz has been disclosed, which carries some very coarse clean copper pyrites. The bulk of ore proved is so far very small, but it is so rich in copper pyrites that further work at the spot might well be carried on.

A little higher up the hill there is some massive haematite, which merges gradually into the crushed conglomerate, which it has in part quite replaced. I did not see any sign of any copper ores in association with the iron oxide.

On Section 2921-M, 37 acres, in the name of E. Goldsmith, no work at all has been done, and no lode discovered.

To the east of Donoghue's sections lies an 80-acre section, No. 2940, standing in the name of H. J. Kelly. The country rock is massive quartz porphyry on the western side, and this merges into a medium-grained granite on the east.

A trench has been cut in the granitic rock, and exposes a green, altered zone, which carries some iron pyrites.

The same zone has been cut by a trench a little further north, outside the section, and some veins of quartz, carrying iron pyrites, are exposed, I saw no indication of galena in this area.

(17)—The Sections on the Northern Slopes of Mt. Murchison.

(a)—*The Two 40-acre Sections,* 2865 *and* 2866.

These two sections are registered in the names of R. P. Symmons and J. J. Rice.

On the southern section, 2865, on the track running through the section, a small excavation has been made in the outcrop of a lead lode. The country rock is granitic but the galena occurs in a remarkable gangue of quartz, barytes, calcite, and actinolite. Reference has been made to this lode type in an earlier portion of this report.* Some coarse cubical galena was visible at the top of the cut, but the lode seems to pinch towards the bottom of the excavation, and the galena is largely replaced by iron pyrites. These workings are 1000 feet above the Murchison River.

On the adjoining section, 2866, a shot has been put in the rock over the track in the northern portion of the section. A chloritized lode-stuff is exposed, carrying a few splashes of copper pyrites. This ore resembles the copper ore visible at several points on the Osborne Blocks and other sections situated along the Murchison River.

The bulk of ore does not seem to be great, and the copper content too low at this place for the deposit to be of value, unless future operations produce a marked improvement.

(b)—*The Two 80-acre Sections,* 3070 *and* 3071.

These two sections, known as the "Sterling" sections, are registered in the name of W. Woolven. They are situated on the northern slopes of Mt. Murchison, and in altitude from 1300 feet above the river on the northern boundary, to 1440 feet on the eastern boundary of the southern section. The country rock is on the eastern side massive, uncrushed felspar porphyry, and on the western the typical crushed porphyroid.

Near the centre of the northern section there is an outcrop of massive hematite at the surface, and a tunnel has been driven some 30 feet below to cut the lode. The tunnel runs for 40 feet on a bearing of 124°, and cuts the body of hematite, but does not penetrate it. On the exposed face I saw a little copper carbonate and copper sulphate. Galena is said to have been seen while the tunnel was being driven, but I could not find any trace

* See p. 49.

of it remaining. It is said that the black gossanous material on the border of the mass contains native copper. No specimen which I examined carried the mineral. The country rock is porphyroid.

All the ironstone seen was apparently well above the water-level, and the workings are consequently too shallow to give an idea of the proportion of copper ore associated with the hematite. The configuration of the country is rather unfavourable for the driving of a lower-level tunnel. It would be better in future prospecting to sink on the lode.

On the southern section the porphyroid carries a few stains of copper carbonate, but outcrops of the rock are few, and no further signs of the presence of a lode were detected.

(c)—*The Barytes Lode.*

Situated between Section 2865 and the Murchison River, and at a height of from 600 to 700 feet above the river, there is a strong vein of barytes.

This is exposed at the surface for a length of 5 chains. Its width is at least 4 feet at the southern end of the outcrop, but no work has been done elsewhere, and I cannot say if this is the average width.

The barytes is crystalline, and white or transparent at first sight. Careful examination, however, shows that it is flecked throughout with minute specks of galena.

Several prospectors enquired of me whether the barytes cap might not be a sign of a massive galena lode in depth. They seemed to have the impression that there were known cases of the variation of lode contents of the type mentioned. If any such cases exist they are unknown to me.

It is true that in the case of barytic lead-veins* the progress of weathering may after a long interval of time produce a gossan relatively rich in barytes. This is because of the insolubility of barytes. But in the present case the vein is a solid one, consisting almost entirely of massive barytes, and not a honeycombed gossan; and there is no justification for the belief that the mineral character will alter materially.

If the occurrence is to prove of commercial value it will be as a source of the mineral barytes itself. Barytes is used mainly in the manufacture of paint as a substitute for white lead or zinc oxide, and to a less degree for

* Described on p. 49 of this report.

weighting paper and for the preparation of the oxide of barium.

For such purposes it is necessary to, first of all, free the barytes from its associated impurities. In this case no great difficulty would be encountered; for, apart from the small galena content, I did not observe any other mineral present, and the purity of the colour indicates its freedom from iron.

The price fluctuates slightly, but the average value for the crude product, delivered at a grinding-mill, may be reckoned at between 16 and 20 shillings per short ton.

When finished for the market, the mineral is worth as much as £4 per ton.

Until better facilities for the transport are available, I doubt if the value of the mineral is sufficient to justify the exploitation of the lode.

(18)—The Eastern Sections on the Murchison River.

(a)—*The Sections known as "The Osborne Copper Blocks."*

The track which follows the northern bank of the Murchison River towards the south-east traverses a number of sections, of which only two are at present taken up. These are Nos. 2144-M, 80 acres; and 2145-M, 80 acres—both of which stand in the name of C. Madden. The greater portion of both these sections consists at the surface of chloritized quartz felsite, but the conglomerate encroaches upon the borders of each section.

On the northern side of the river, near the centre of Section 2144, there is a massive outcrop of hematite. The schistose green quartz felsite has been, by silicification, converted into a grey quartzite in the immediate neighbourhood of the hematite.

A few distinct quartz veins are to be seen, and these carry both iron and copper pyrites; and besides these actual veins, the green quartz-felsite is irregularly impregnated with iron and copper pyrites and a little galena. Very little prospecting has been done on this outcrop, which certainly merits further attention. Two approaches of a few yards each have been cut from the west and north-west, as if to cut the hematite body; but in neither case has the work been carried far enough to afford much information.

Below this point, on the track, the quartz felsite again shows an impregnation with copper pyrites.

This section seems well worthy of more work being carried out upon it. Very little has ever been attempted, and the vegetation is so thick that prospecting cannot be carried out without trenching.

In the adjoining section (2145) at the southern corner of the portion which lies on the northern side of the Murchison River, and right on the water's edge, there is a further outcrop of metal. A zone of the quartz felsite about 30 feet in width is impregnated with copper pyrites and bornite. The occurrence has had very little done on it, and the surface only has been exposed here and there. As far as I could see, there are no definite walls to the deposit. Some joint-planes are visible, but these seem of later date than the impregnation with metal, for the ore does not follow the divisional planes at all.

This formation should certainly be vigorously prospected.

A very similar occurrence of quartz felsite which has been impregnated with copper pyrites is situated nearly a mile south of this spot, on Section 4440, where the track traverses the centre of the section. Here, too, only the surface has been broken from the outcrop.

On the southern side of the river, and in Section 2145, some further workings are situated. Some copper and iron pyrites are visible in the quartz felsite, and a short tunnel has been driven westwards at a point 75 feet above the river. The tunnel only runs in some 15 feet; and a short drive, 10 feet in length, runs southwards from the end.

About 20 feet higher up the hill the quartz felsite is replaced by actinolite rock. A trench shows a few colours of iron pyrites and hematite along joint-planes, and in thin seams in the rock. The prospects at this point do not seem very encouraging.

(*b*)—*Foy's Lode.*

During my visit to the field a discovery was made by R. Foy of a lode crossing the Murchison River in the north-western corner of Section No. 24-M.

There are two distinct veins on the eastern side of the river, separated by a distance of 5 feet. The eastern one carries some good coarse galena associated with blende, iron pyrites, and copper pyrites in a gangue, which is mainly silica. A few fragments of bleached and kaolinized country rock are included in the lode. This vein is about 8 inches wide where it was first picked up, at a height of 25 feet above the river, and widens to a foot or more at the water's edge.

The eastern wall (footwall) is the green quartz-felsite which has been sericitized. The hanging-wall is impregnated with very finely divided galena and thin veinlets of quartz and pyrites. The dip is towards the west, at about 75°; and the strike, measured across the river to the outcrop on the other side, is N. 21° W.

The western vein is smaller—4 inches wide—and dips to the west at angles which vary a good deal over the small length of lode visible. It carries a little less metal and more quartz. Blende and copper pyrites are present with the galena. Across the river at the water's edge both veins could be seen; but they are here hard and quartzose. The two veins unite about 12 feet from the water, and at the junction a pocket of good galena occurs. A little blende, copper pyrites, and fahl-ore accompany the galena at this point.

Traced beyond the intersection the ore becomes once more hard and dense, and narrows down to a width of 6 inches.

The pinching of the lode may be only a local feature, but the prospectors will probably find it more profitable to exploit, first of all, the main vein on the eastern bank of the river. As a preliminary to future operations, I should advise trenching on the eastern bank.

The lode being known to persist on the western bank, it should be eventually followed there; and the exploitation at this point will be easy, since the bank rises almost precipitously from the river.

The brecciated character of the lode-stuff indicates the fact that the lode is the result of the filling of a well-defined fissure, rather than an impregnation of the country rock.

(c)—*Kittson's Workings.*

Following the track southwards from Foy's lode a small outcrop of hematite is met at a point just outside the western boundary-line of Section 24-M. The country rock is quartz felsite, but no copper is found here in association with the iron.

The track follows the river bank, and no striking difference is noticeable between the country rock here and that further north until a belt of crushed conglomerate is met with, similar to that which forms the western slopes of Little Farrell, in Section 2911.

Beyond this the igneous rocks occur again, and in them the old workings of H. E. Kittson are situated. The section, No. 2829-M, 80 acres, is now registered in the name of L. Jolly.

The workings are in the northern portion of the section, and on the south side of the river close to the cage.

Close to the landing-place of the cage, and only just above the river level, an excavation has been made in the steep bank, which shows a band of quartz porphyry impregnated with iron pyrites, copper pyrites, native bismuth, and a complex mineral termed lillianite. Some oxidised copper ores are also present. Some very rich silver ores are said to have been derived from this locality; but in what form the silver existed I cannot say. The veins seemed to run in all directions, and all the mineral exposed was much weathered and discoloured by limonite.

About 150 feet to the south-east, and 80 feet above the river, another zone is opened up, some 20 feet wide, and through it a number of small veins run. The veins are vertical, but their strike is very variable. These veins carry a little iron and copper pyrites, together with some specular iron ore.

Below this outcrop, and 30 feet above the river, a tunnel was started in granite, but abandoned when 15 feet of driving had been done.

The mouth of the tunnel shows a greenish altered zone in the granite, which appears to dip northwards. If the work is persevered with, this tunnel should prove the lode-formation in depth. The surface workings are too much affected by weathering to give much information at the present time. I could find no sign on the surface of a main fissure, nor could I trace any connection between the ore exposed in the two sets of workings.

No work at all was being done at the time of my visit to the locality, and there were no signs of any recent attempt to prove the property.

(19)—The Sections on the Pieman River.

The track to Rosebery from Mt. Farrell follows the Pieman River round the base of Mt. Black, and from the Murchison River on the western side of the Mt. Farrell township to the railway bridge over the Pieman the country rock traversed is wholly the felspar porphyry.

The river alluvial overlaps the base of the higher ground, and the present river has cut its way down through this gravel.

The felspar porphyry is very similar in appearance to the corresponding rocks further east. It is on the whole schistose, but the degree of schistosity varies between wide limits.

The region is traversed by a number of minor, and one major, fractures, at a distance of about 2½ miles from the junction of the Mackintosh and Murchison Rivers.

Only one section on the area is at present taken up, viz., No. 2382, 40 acres, which is registered in the names of G. A. Gabbedy and W. M. Black. It is on this property that the mine known as the Langdon is situated.

The lode was first discovered at the point where Innes' track crosses it by a prospecting party, who worked northwards from Rosebery along the felspar porphyry belt. It exhibits a marked peculiarity of structure, in that the strike is due east-and-west. The dip is northward.

A tunnel has been driven southwards from a point 30 feet below the outcrop. The bearing is 147°, and at 30 feet it passed through the lode.

It is said to have been driven another 30 feet on the same bearing, but the portion of the drive past the lode was blocked by waste. The tunnel was carried past the lode, for the reason that the values had so materially decreased in depth that it was thought the lode was still ahead.

I am informed that the upper portion of the workings produced some very good galena, of which about 40 tons was taken to the smelters. At the time of my visit all this material had been stoped out right to the surface. A few specimens lying on the tip showed good coarse galena with resinous-looking blende.

There is a drive on the lode from the adit for 30 feet in an easterly direction. The back of the drive shows that the ore-body has pinched to a width of only a few inches, and, in fact, can hardly be traced at the intersection of the drive and tunnel. About 10 feet from the end of the drive there are 6 inches of ore, consisting of coarse galena mingled with resin blende. But on the whole the galena seems to have given place to resin and ruby blende.

The contraction of the ore-body and the impoverishment in the lead content have no doubt led to the abandonment of active work, and the mine has been idle for 12 months.

It is regrettable that while work was in progress no winze was put down on the lode to prospect it in depth. The pinching of the lode may be only a local feature, and after such a promising outcrop it is a pity not to carry the work down beyond the very shallow-level tunnel.

There have been several trenches cut on the western continuation of the lode outcrop, but they show only zinc-blende with traces of galena in veins through a mineralized zone. These trenches extend to the western boundary of the section, and have not indicated sufficient values to justify further prospecting at a depth.

The country rock is a felspar porphyry, which is slightly altered near the lodes, probably by the development of sericite. Numerous veinlets of silica are to be seen in the country rock near the lode, and these veinlets seem to have a tendency to run in an east-and-west direction. The country rock is also indurated here and there by an intimate impregnation by silica, till it resembles a chert.

Higher up the hillside, some 250 feet along the track, there is a little work done on a gossanous capping. A few shots have been put in, and a complex lode-formation is disclosed. It is 6 or 7 feet in width, and carries a number of small veins up to 3 inches in width of zinc-blende, and very occasional splashes of galena. The blende has by weathering acquired a coating of limonite, but the undecomposed material is dull yellow, and has been mistaken for carbonate of iron.

Too little of the lode was exposed to determine the dip. The strike seemed to be a little north of east. The country rock is similar to that of the Langdon Mine.

There has been some trenching on the adjoining section, 2524, now vacant.

In one of the trenches below the track on the eastern boundary a small vein, some 4 to 6 inches in width, is exposed. It strikes N. 55° W., and dips to the north-east at from 80° to 85°. The lode contents are blende and a little galena in a band of silicified felspar porphyry.

A trench running a little east of north has been put down to cut the continuation of this lode, but without success.

There is also some trenching on the line of the Langdon lode, and in one trench a lode a foot wide, carrying some veins of tarnished blende and a little galena, is visible. A winze, full of water at the time of my visit, had been put down in the bottom of the trench, so I could not see the lode at that point.

The veins that have been located in this section seem to carry blende rather than galena, and work in the area has been altogether abandoned.

VII.—CONCLUSION.

Summing up, the writer may express the opinion that there is a well-assured future before the central area of the Mt. Farrell mining field.

The centre of future operations will, as far as can yet be foretold, be located round the North Mt. Farrell and Mackintosh leases. These appear to possess, in a greater measure than any others, the attributes which justify the outlay of capital for the development of the mines and the treatment of the ore.

One of these properties—the Mackintosh—is at present practically untouched. Yet the ore proved at the surface gives every indication of permanency in depth, and the length of the lode compares favourably with that of the lodes on any other lease in the field.

The ore-bodies on the two above mentioned properties contain a bulk of second-grade ore, which will, with efficient milling plants, ensure profitable returns for several years at least.

And there are several other properties to the southward which can show a fair amount of milling ore. No one of these, taken by itself, can yet be said to have justified the erection of a concentrating mill. Still, were a customs mill located in the district, there are several mines, now inactive, which would probably contribute second-class ore. The returns from this second-class ore would at all events assist financially towards the development of the properties; and during the mining of the second-class ore the contributing mines might well improve, or show an ever-increasing bulk of the milling ore.

The tendency has been thus far for the management of those mines which are in the earlier stages of development to expect highly payable lodes of first-class ore, rather than lodes of which the greater proportion, at least, is second-class ore. This being so, the work of development has in some cases been abandoned at once where first-class metal is not encountered. The lessons taught by the development of the North Mt. Farrell Mine should be remembered; for not only does the ore-body vary very considerably from point to point, but in one case the main lode (No. 3 lode) was passed through without being recognised.

The attitude assumed with regard to the presence of first-class ore has resulted in undue prominence being given to the assay returns from picked specimens of ore. Few, if any, assays of samples properly taken are obtainable; and the value of assays of specimens is, of course, purely qualitative. The presence of fahl-ore with the galena, will, in the majority of cases, ensure a high return of silver. Yet, in the mines which have been opened up to any extent, the proportion of fahl-ore to galena is small.

The recent developments at the southern end of the field seem to point to its presence in larger proportions there, but this cannot be regarded as certain until the lodes are opened up more extensively.

The southern end of the field is undoubtedly expanding, and much will depend upon the work of the next few months on the Tullah Mine and Thomas' Blocks. Every successful development on these properties will stimulate further prospecting in this direction.

The northern end of the field has been seriously hampered by the difficulties of transport, and the lodes which have been located are almost entirely undeveloped, notwithstanding the fact that they were the first discovered in the district.

There is one strip of country which has thus far quite escaped the attention of prospectors—that between the Tullibardine lease and the Farrell Blocks, and lying on the western side of the Mackintosh River. It has been indicated in this report that it is probable that the Tullibardine lode lies on the main fracture-line of the central and northern part of the field, the strike-line of which has been bent a little to the eastward by the disturbance which produced the fault that traverses Section No. 2796.

The area on the Murchison River, eastward of the gorge cut through Mt. Farrell, is well worthy of more systematic prospecting. The recent discovery of a lead lode in that district should assist in stimulating prospecting activity.

This report embodies the field work which was carried out during the months of September, October, and November of 1907.

In conclusion, I wish to express my appreciation of the assistance afforded to me during my examination of the field and the preparation of this report by all those who are, in different capacities, interested in the field. The number of these to whom I am indebted is so large that I trust I may be permitted to make this general acknowledgment of thanks.

L. K. WARD,
Assistant Government Geologist.

Launceston, 15th February, 1908.

KEY TO PLATE II.

The Mineral Sections now taken up.

Number of Section.	Acres.	Lessee.
		WHITE HAWK DISTRICT.
2330-M	42	R. P. Symmons. (The White Hawk.)
2331-M	80	
2332-M	47	
3367-M	72	R. P. Symmons and C. R. Lynch.
3368-M	40	
3369-M	37	
		THE AREA NORTH OF MT. FARRELL.
2592-M	80	J. McPhee. (The Tullibardine.)
2593-M	80	
2058-M	80	
		THE AREA ON THE WESTERN SLOPES OF MT. FARRELL.
2873-M	80	C. R. Lynch.
2892-M	40	G. E. Butler.
2796-M	80	G. E. Butler. (Formerly Metropolitan.)
2909-M	80	W. Innes.
2905-M	80	J. Geddes.
2397-M	79	E. Goldsmith. (Farrell Blocks.)
2820-M	80	A. E. Goldsmith. (Farrell Blocks.)
2983-M	80	A. E. Goldsmith.
3010-M	80	D. Powell.
3223-93M	80	Macintosh Copper & Gold Mining Co., N.L
3221-93M	80	
4116-93M	68	North Mt. Farrell Mining Co., N.L.
3262-93M	76	
1867-93M	80	
2351-M	75	
2722-M	40	
1074-M	20	
292-W	10	
82-W	4	
2409-93M	80	Mt. Farrell Mining Co., N.L.
2410-93M	80	
2656-M	10	
2815-M	80	M. L. Maconnochie.
1980-M	80	(Formerly Central Farrell.) Murchison River Mining Association, N.L.
3263-93M	60	
1286-M	5	
1075-M	79	E. T. Midwood (Murchison Extended). (Formerly North Murchison.)
2777-M	80	H. J. Kelly.

Number of Section.	Acres.	Lessee.
2891-M	40	M. J. Thornton.
2981-M	75	C. H. F. Shearn.
704-M	73	South Murchison Silver-Lead Mining Co., N.L.
2945-M	40	R. Green and A. King.
2946-M	40	

THE SECTIONS SOUTH OF THE MURCHISON RIVER.

2921-M	37	E. Goldsmith.
2830-M	80	C. A. J. Collins.
2911-M	79	C. Thomas.
2808-M	80	C. W. Thomas. (Thomas' Blocks.)
2850-M	80	C. Thomas.
2918-M	20	G. O. Smith.
2925-M	80	E. Pennefather. (Tullah Silver-Lead Mining Co., N.L.)
2863-M	80	M. Donoghue.
2864-M	80	
2861-M	20	J. H. Finlay and M. Donoghue.
2837-M	80	
2862-M	68	
2940-M	80	H. J. Kelly.
3071-M	80	W. Woolven. (Formerly Sterling.)
3070-M	80	
2865-M	40	R. P. Symmons and J. J. Rice.
2866-M	40	

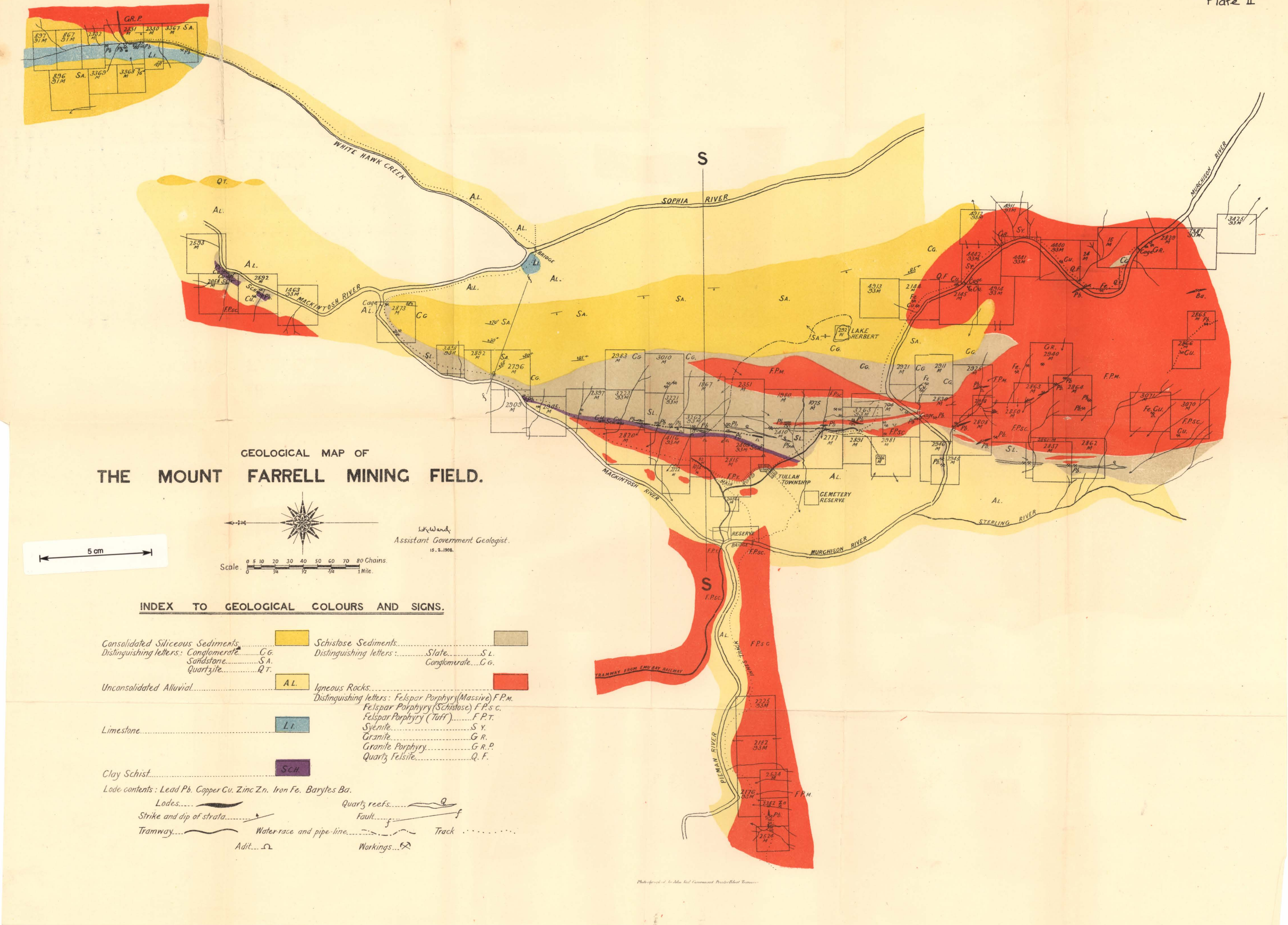
EASTERN SECTIONS ON THE MURCHISON RIVER.

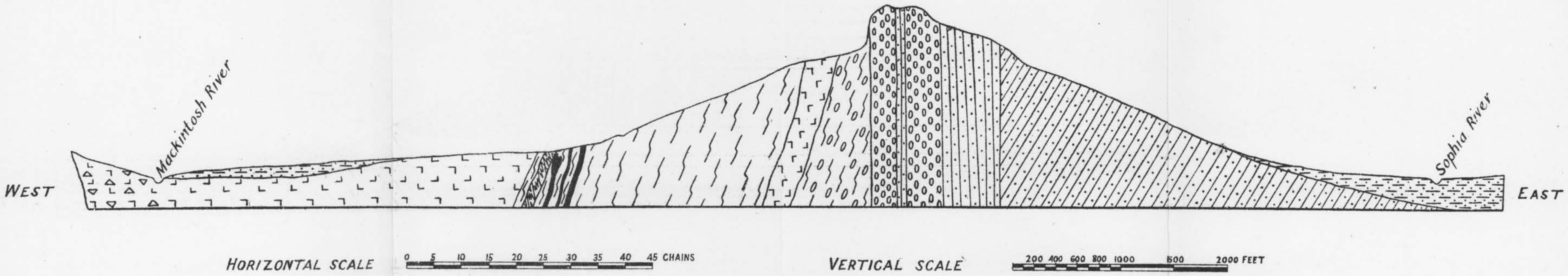
2144-M	80	C. Madden.
2145-M	80	
2829-M	80	L. Jolly.

SECTIONS ON THE PIEMAN RIVER.

2382-M	40	W. M. Black and G. A. Gabbedy. (Formerly Langdon.)

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.

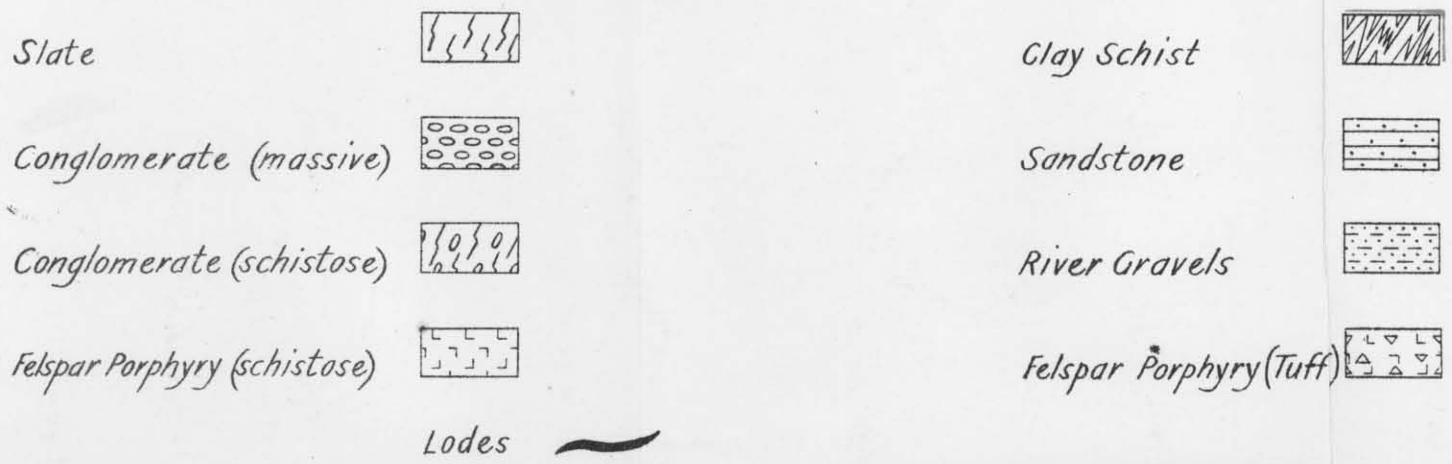

GEOLOGICAL MAP OF
THE MOUNT FARRELL MINING FIELD.
W.H. Ward
Assistant Government Geologist.
15.2.1908.
Scale. 0 5 10 20 30 40 50 60 70 80 Chains.
0 1/4 1/2 3/4 1 Mile.
INDEX TO GEOLOGICAL COLOURS AND SIGNS.
Consolidated Siliceous Sediments
Distinguishing letters: Conglomerate CG. Sandstone SA. Quartzite QT.
Unconsolidated Alluvial AL.
Limestone LI.
Clay Schist SCH.
Schistose Sediments
Distinguishing letters: Slate SL. Conglomerate CG.
Igneous Rocks
Distinguishing letters: Felspar Porphyry (Massive) F.P.M.
Felspar Porphyry (Schistose) F.P.SC.
Felspar Porphyry (Tuff) F.P.T.
Syenite SY.
Granite GR.
Granite Porphyry GR.P.
Quartz Felsite Q.F.
Lode contents: Lead Pb. Copper Cu. Zinc Zn. Iron Fe. Barytes Ba.
Lodes
Quartz reefs
Strike and dip of strata
Fault
Tramway
Water-race and pipe-line
Track
Adit
Workings
WHITE HAWK CREEK
SOPHIA RIVER
MACKINTOSH RIVER
MURCHISON RIVER
STERLING RIVER
PIEMAN RIVER
LAKE HERBERT
TULLAH TOWNSHIP
CEMETERY RESERVE
RESERVE
BRIDGE
TRAMWAY FROM EMU BAY RAILWAY
INNES TRACK
S
S
5 cm



SECTION ACROSS MOUNT FARRELL

ON LINE S. S.

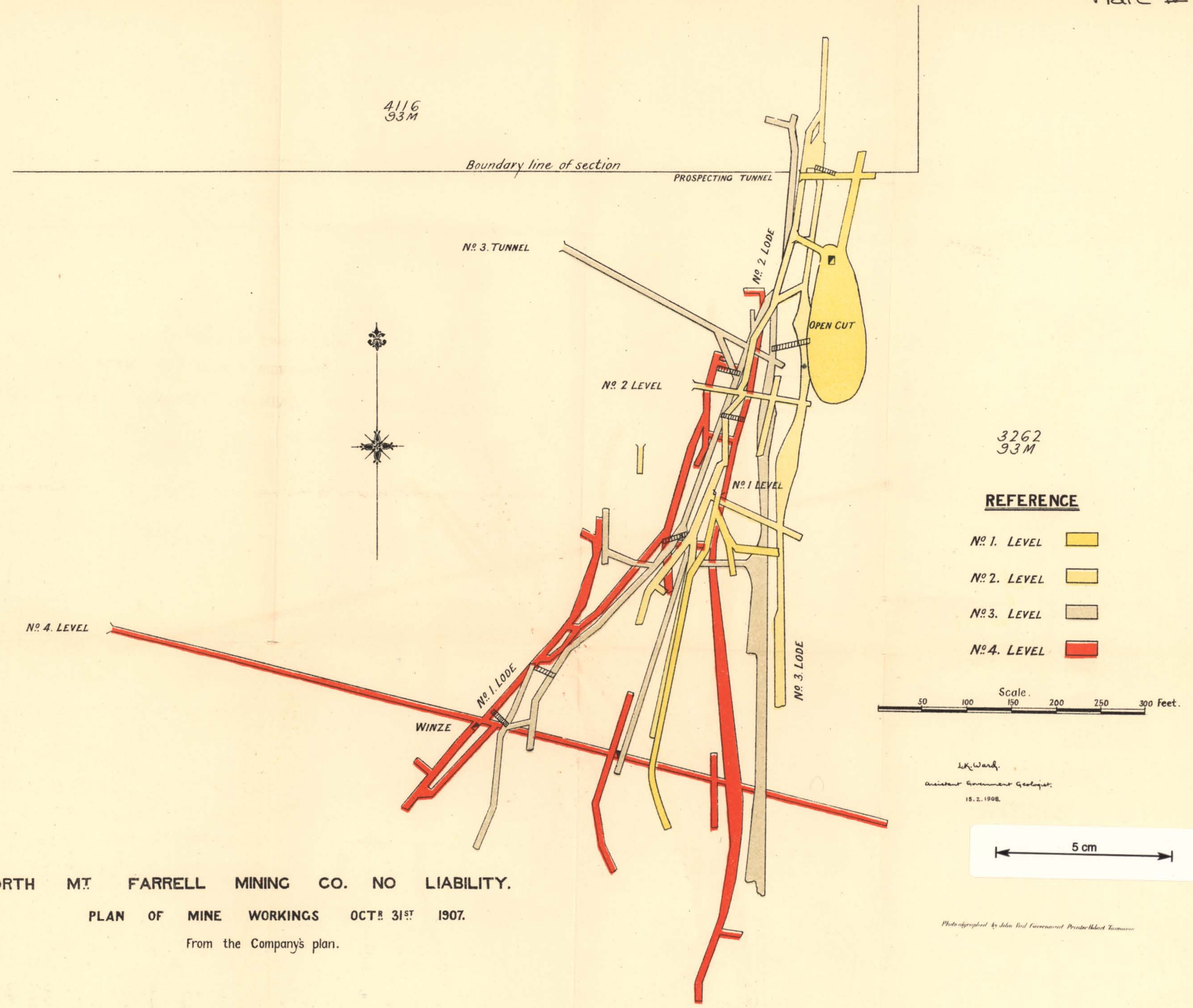
LEGEND



L.K. Ward.
Assistant Government Geologist.
15.2.1908.

Photo-lithographed by John Vail Government Printer Hobart Tasmania

Plate IV



NORTH MT. FARRELL MINING CO. NO LIABILITY.

PLAN OF MINE WORKINGS OCTR. 31ST 1907.

From the Company's plan.

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