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THE GEOLOGY AND ORE DEPOSITS OF THE ROSEBERY DISTRICT

by

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I INTRODUCTION

(1) General.

The systematic geological and topographical mapping of an area of approximately 12½ square miles in the vicinity of the Rosebery Township, and the examination of the ore bodies within that area, was primarily, the outcome of a report by Dr. Woolnough, Geological Adviser to the Commonwealth, acting on behalf of the Development & Migration Commission. Dr. Woolnough recommended the systematic geological mapping of certain areas of Lower Palaeozoic rocks; these rocks are the repositories of the principal ore bodies in Tasmania, and it was considered that the elucidation of their structure and an examination of the contained ore bodies would add considerably to the knowledge concerning the occurrence, mode of deposition and extent of the principal metalliferous deposits in Tasmania. Furthermore, it was thought that the work carried out would form an admirable basis on which future prospecting operations, both geophysical and otherwise, could be carried out.

The unit adopted for each topographic and geological map to be produced under the above scheme was the quarter sheet, i.e. a sheet bounded by 5 minutes of longitude and 5 minutes of latitude. The systematic work recommended by Dr. Woolnough involved the production of a number of such sheets and their subsequent joining together. The existing mineral charts were found unsuitable for this purpose, and, furthermore, no topographic maps were available; hence, to enable the sheets to be joined, and to form a framework for the topographical and geological work, it was decided to institute a system of third order minor triangulation and theodolite surveys. In addition a certain amount of levelling was carried out in each area and the existing levels were correlated.

(2) Nature & Scope of the Present Work.

The minor triangulation, theodolite surveys and levelling work for this area were carried out by G. Campbell-Smith A.S.

The creeks, ridges and main tracks were then traversed by chain and compass; heights were obtained by aneroid readings and were checked on known precise levels where possible. During the course of the chain and compass work the geological formations were mapped in detail. In addition, all mine workings and ore bodies within the area were carefully examined, and the relationships between the ore deposits and the geological features were determined. Sampling operations were undertaken in some cases. In addition to the detailed mapping of the area under discussion, several brief reconnaissance trips were made into the surrounding districts with the object of obtaining as broad a knowledge as possible of the general geological features. The chemical analyses and assays were done in the Government Laboratory, Launceston. The petrological work involved was carried out by the writer. Field work extended over two periods, the first being from the 12th May - 19th September, 1930, and the second from the 23rd January - 22nd May, 1931, a total period of eight months.

(3) Acknowledgments.

It is the writer's pleasure to acknowledge his indebtedness for assistance rendered by the Superintendent of the Electrolytic Zinc Company's Rosebery Mine, Mr. N.E. Giblin, and members of the mine staff. Especial thanks are due to Mr. G. Barker (Under-ground Manager), to Mr. I.D. Cameron (late Asst. Mining Engineer) and to Mr. H.K. Shirreffs (Plant Superintendent). Mr. Barker's knowledge of the district, and of the Rosebery Mine in particular, was of inestimable value. During the course of underground operations at the Rosebery Mine, the writer was accompanied by Mr. I.D. Cameron whose capable assistance and detailed knowledge of the mine workings and the ore bodies proved of great value. To him credit must be given for the preparation of a plan of the Rosebery Mine showing all the actual occurrences of ore; without this plan it would have been impossible to illustrate clearly the existing relationships between the ore bodies and the geological features. To Mr. Shirrefs I am indebted for information regarding the composition of the ore.

Messrs. T. Onslow and F. Jones acted as field assistants during the course of the survey. Their sterling work under arduous and difficult conditions helped materially in expediting the completion of the survey.

Thanks are also due to the Chief Government Chemist and Staff for the preparation of numerous rock analyses and assays.

The writer also wishes to express his appreciation of the courtesy and hospitality extended by numerous residents during his stay in the district.

II. PREVIOUS LITERATURE.

(I) List of Publications.

(The following list includes all the references to geology and mining within the district).

1. A. Montgomery M.A., Report on "The Progress of the Mineral Fields in the neighbourhood of Zeehan viz.:- Mackintosh River, Mt. Black, Mt. Read, Mt. Dundas, Mt. Zeehan, Stanley River, Mt. Heemskirk, 15th May, 1895.

2. A. Montgomery M.A., "Report on The Zeehan-Dundas Mineral Fields in February, 1896".

3. W.H. Twelvetrees F.G.S. and W.F. Petterd C.M.Z.S. "On the Occurrence of Limurite in Tasmania". Proceedings of the Royal Society of Tasmania, 1897. Supplementary Notes Proc. Roy. Society Tas. 1898-99.

4. J. Harcourt Smith B.A. "Report on The Mineral fields in the neighbourhood of Mt. Black, Ringville, Mt. Read and Lake Dora". 11th June 1898.

5. W.H. Twelvetrees F.G.S. and W.F. Petterd C.M.Z.S. "On the Felsites and Associated Rocks of Mt. Read and vicinity". Proceedings Royal Society of Tasmania 1898-1899.

6. W.H. Twelvetrees F.G.S. "Outline of the Geology of Tasmania" Proceedings Royal Society of Tasmania 1901.

7. G.A. Waller, "Report on The Ore Deposits (other than those of Tin) of North Dundas". 30th April 1902.

8. G.A. Waller. "Report on The Primrose Mine Rosebery"., November 2nd, 1903.

9. L.K. Ward, B.A., B.E., "The X River Tin Field" Bulletin 12 G.S.T., 1911.

10. Loftus Hills M. Sc. "Zinc-Lead Sulphide Deposits of the Read-Rosebery District, Mt. Read Group", Bulletin 19, 1914.

11. Loftus Hills M. Sc. "Preliminary Report on The Zinc-Lead Sulphide Deposits of the Rosebery District", 1915.

12. Loftus Hills, M. Sc. "Zinc-Lead Sulphide Deposits of the Read-Rosebery District, Rosebery Group," Bulletin 23, 1915.

13. Loftus Hills M. Sc. "Zinc-Lead Sulphide Deposits of the Read-Rosebery District, Metallurgy and General Review". Bulletin 31, 1919.

14. Loftus Hills M.B.E. M. Sc., "The Progress of Geological Research in Tasmania since 1902" Proceedings Royal Society of Tasmania 1921.

(2) Summary of Previous Work.

The first official report on the Rosebery District was made by A. Montgomery (1) in 1895. He described the occurrence of zinc, lead, copper, gold and silver ores on sections held by the Rosebery and South Rosebery Companies, and the occurrence of pyritic schist on Scott's section. These sections are more familiarly known as the Tasmanian Copper, Primrose and North Tasmanian Copper. A brief description was given of the occurrence of pyritic ore, in the Stitt River to the west of the present railway bridge, on sections then held by the Mt. Black Prospecting Association. Mention was also made of the bismuth-pyrite-tourmaline lodes to the south of the present Rosebery Mine workings, and of the occurrence of fluorite and wolfram in them. Montgomery described the country rock of the lodes as argillitic schist, and referred to the occurrence of black slates and porphyry on the hanging wall of the lode on the Rosebery Mine. All the lodes were regarded as being conformable with the enclosing schists. The westerly dipping lodes to the west of the Stitt River Bridge, and the easterly dipping lodes at the foot of Mt. Black were thought to occur in opposite limbs of an anticlinal fold. Montgomery's second Report (2) deals mainly with individual mines.

In a paper "On the occurrence of Limurite in Tasmania", read before the Royal Society of Tasmania in 1897, Twelvetrees and Petterd (3) described the axinite-chalcopyrite deposits of Colebrook Hill. This paper was followed by two supplementary notes in the "Proceedings of the Royal Society of Tasmania for 1898-99". The main mass of the axinite &c. was described as an intrusive limurite rock.

In 1898 the district was visited by J. Harcourt Smith (4) (then Government Geologist), who reported in some detail on all of the mines then active. He described the country rock of the main zinc-lead ore body of the Tasmanian Copper Mine &c., as argillaceous schist, and expressed the opinion that the laminations of the schists corresponded with original bedding planes. The lodes were described as bedded veins, i.e. certain beds in the schists were dissolved and replaced by metallic sulphides introduced in aqueous solutions. Other ore bodies of the district he regarded as true fissure lodes. The country rock of the Koonya Mine was described as argillaceous schist. The cupriferous deposits of the Colebrook Mine he regarded as being due to segregations of metallic sulphides, derived from a basic igneous rock, which were injected into the enclosing slates. The axinite and datolite of these deposits were considered to be subsequent pneumatolytic action.

A paper by W.H. Twelvetrees and W.F. Petterd (5), published in the "Proceedings of the Royal Society of Tasmania 1898-99", was the first attempt to elucidate the problem presented by the complex schists and associated acid igneous rocks of Mt. Read and Rosebery. The paper deals in greater detail with the rocks in the vicinity of Mt. Read than with those near Rosebery, but the rocks of both areas were evidently looked upon as parts of a single series, and the general conclusions referred to both areas. The schists were described as argillitic, phyllitic, siliceous, quartzitic and talcose. The talc schists were thought to have had a different origin from the argillitic and quartzitic ones. The important features of the work of Twelvetrees and Petterd is that, within the zone of schistose rocks of the Read-Rosebery District, they clearly recognised sheared and unaltered felsitic rocks. Both the felsitic rocks associated with the schists, and the more massive felsitic and porphyritic rocks lying further to the east, were thought to be of similar origin, i.e. component parts of an extensive series of acid effusives, and no attempt was made to distinguish between them. They were described as "the upturned edges of sheets of lava - contemporaneous with the argillaceous sediments now converted into schists". To these felsitic and porphyritic rocks the name keratophyre was given. The microscopic examination of the rocks was evidently confined mainly to specimens taken from the main mass of porphyry lying to the east of the ore bodies. The analysis of quartz-keratophyre given in the paper, from the North Hercules Section Mt. Read, was evidently made from a specimen of the massive porphyry or keratophyre which covers the greater part of that section. The felsitic rocks interbedded with the schists were treated in less detail. A specimen from a band of felsite 40' wide, taken from the Tasmanian Copper Company's Mine, was examined by Professor Rosenbusch, who described it as follows:- "Nothing is left of the original groundmass, it has been converted into sericite quartz and albite etc". The ore bodies were described as replacements of the argillaceous schists and the felsitic rocks associated with the schists were regarded as barren. The Mount Black ore body was described as a fissure lode.

In the "proceedings of the Royal Society of Tasmania 1900-01", W.H. Twelvetrees (6) published a paper dealing with the general geology of Tasmania. In it, he described the massive porphyries of Mt. Read, Mt. Black, Mt. Murchison etc., as being intrusive. He had, therefore, altered his earlier opinion and no longer regarded them as effusives.

In 1902, G.A. Waller (7) (then Assistant Government Geologist) reported on the Tasmanian Copper, North Tasmanian Copper, Primrose, Mt. Black, Great South Rosebery, Chamberlain, Salisbury, and Colebrook Mines. He described the rocks of the "schist" belt as light coloured argillaceous schists with bands of dark slate, quartzites, and siliceous schists, and stated that, within the schists, bands of felsite were common. He described the occurrence of the massive porphyry, or keratophyre, in the vicinity of the Mt. Black Mine, and stressed the fact, that when the porphyry was schistose it was difficult to distinguish it from some of the schists proper. The term "felsite" was evidently used by Waller as a field term to embrace both the felsitic bands in the schists and the main mass of the porphyry; he did not appear to separate the two occurrences, and referred to the felsitic bands in the schists as "bands of keratophyre". It is certain that Waller regarded these felsitic bands and the main mass of the porphyry as intrusive, and in this he was supported by Twelvetrees and Petterd, who had altered their views since the publication of their paper. The ore bodies in the schists he regarded as replacements, and seemed to think that there was possibly a cupriferous zone underlying the zinc-lead sulphide ore bodies. The ore bodies in the massive porphyry were described as fissure veins. With the exception of the Mt. Black Lode it was thought that ore bodies occurring within the massive porphyry would not be of any size or value. The report on the Colebrook is accompanied by an excellent topographical plan showing the distribution and extent of the mine workings; the ore body was described as a metasomatic replacement of bands of impure limestone occurring in slates.

The Primrose Mine was again examined by Waller (8) in 1903. The report deals mainly with mining problems and no fresh geological work was done.

In 1911, L.K. Ward (9) examined the X River Tinfield. He described the rocks of the Colebrook Ridge as a series of interbedded slates and tuffs.

In 1914, Loftus Hills (10,11,12 & 13) (then Assistant Government Geologist) undertook a detailed study of the

Zinc-Lead Sulphide Deposits of the Read-Rosebery District. The results of his work are embodied in three bulletins published by the Geological Survey. In 1914, he completed work on the Mt. Read Area (10). The study of the Rosebery area (11) was completed in 1915. His third bulletin on the district (12) was published in 1919; it deals mainly with the metallurgy of the ores and describes zinc-lead sulphide deposits in other parts of the world.

In connection with his work on the zinc-lead sulphide ore bodies, Hills undertook a study of the general geology of each district as a basis for the investigation of the genesis of the ore bodies. In order to understand his interpretation of the geological features of the Rosebery district it will be necessary to refer briefly to his Bulletin dealing with Mt. Read (10).

The rocks of the Mt. Read district were divided by Hills into three series:- (a) the Dundas Slates and Breccias, (b) the Read-Rosebery Schists and (c) the Felsites, Keratophyres and Chloritic schists. As previous work had been done on the Dundas Slates and Breccias they were referred to briefly. The Read-Rosebery Schists were described as chloritic, argillaceous, calcareous and quartzitic, they were regarded as altered sedimentary rocks. The exact position of the chloritic schists was not clearly defined; they appear to have been mapped partly with the massive porphyries, and partly with the schists proper; in the text, the felsites, porphyries, etc., and the schists have been treated together, but it would appear that those schistose chloritic rocks which are characterised by predominant quartz and subsidiary chlorite have been regarded as altered sedimentary rocks.

The argillaceous, calcareous and quartzitic schists were considered to be the most important beds economically; the calcareous beds were said to grade into a rock which is practically a pure limestone. Hills described the felsites, keratophires, porphyries, etc., as lava flows and in support of this view the earlier work of Twelvetrees and Petterd (5) was quoted, but their later view that the rocks were intrusive and Waller's supporting opinion were disregarded.

The three series were described as being conformable, the Dundas Slates and Breccias being the oldest, and the Felsites, Porphyries, Keratophyres, etc., - the youngest. The series were described as having been thrown in two main series of folds called Alpha and Beta respectively. The zinc-lead sulphide ore bodies were regarded as replacements of a calcareous horizon in the schists, and the pyritic copper deposits were regarded as metasomatic replacements of beds of black schist. Hills considered that the Alpha and Beta folds had a considerable bearing on the distribution of the ore bodies. His ideas are best conveyed by the following quotation from his bulletin (Ref. 10 p. 52) "The ore bodies are folded, the folds conforming with those which are structural features of the Read-Rosebery schists. Both the Alpha and Beta series of folds affect the ore bodies".

The bulletin is accompanied by a geological sketch map of the district, plans of the mine workings and sections illustrating the Alpha and Beta folds.

The bulletin on the Mt. Read district, published in 1914, was followed in 1915 by that dealing with the Rosebery district. The general geological conceptions evolved by Hills in his study of the Mt. Read area, and his ideas relating to the distribution of the ore bodies, were confirmed by him when studying the Rosebery area. Some minor points of difference were emphasised; the position of the calcareous ore bearing horizon in the Read-Rosebery schists was said to have changed from the middle to the top of the series and was said to have changed from the middle to the top of the series and was described as being somewhat thinner. The mapping of the axes of the Alpha folds, delineated in the Mt. Read bulletin, was continued northwards into the Rosebery area; in addition, some further Alpha axes were mapped in the eastern portion of the Rosebery area. The Alpha folds were said to be affected by certain Beta folds.

The Dundas Slates and Breccias, the Read-Rosebery schists and the Felsites, Keratophyres, Porphyries were regarded by Hills as being Pre-Silurian.

In a paper published by the Royal Society of Tasmania in 1921 (14), Hills refers the Dundas Slates and Breccias, The Read-Rosebery schists etc., to the Cambro-Ordovician.

In 1927, the Primrose, Tasmanian Copper, North Tasmanian Copper and Dalmeny Leases, now held by the Electrolytic Zinc Company, were reported on by C.G. Gibson, acting on behalf of that Company. He was unable to find any trace of the Alpha or Beta folds described by Hills nor did he agree with the view that the ore bodies were replacements of highly calcareous beds. Gibson's work was of necessity confined to the areas adjoining the mines, nevertheless the results of his investigations mark an important step in the progress of geological thought on the district. While adopting Hills conceptions with regard to the general geology of the district, he mapped several bands of sheared porphyry within the so called Read-Rosebery schists, and remarked on the impossibility of distinguishing between the highly sheared porphyries and what he called the "schists proper". Gibson regarded the lodes as replacements of beds of argillaceous schists occurring in quartz schists. The report has not been published but was kindly made available by the management.

III HISTORY.

The early history of the Rosebery District commencing with the discovery, by A.J. Allom in December 1890, of the pyrite tourmaline lode at the old Mt. Black Proprietary, and the subsequent development of the field up to 1919, have been treated in detail by Hills+, and need not be recapitulated here.

A few years prior to 1919, the main activities of the district were centred around the Tasmanian Copper, Primrose and North Tasmanian Copper Mines. Of these, the Tasmanian Copper and Primrose Mines were held by the Mt. Read and Rosebery Mines Ltd., a subsidiary company of the Mt. Lyell Mining and Railway Coy., and under the general direction of the Mt. Lyell Company's officials extensive diamond drill boring, underground development and experimental work on the treatment of the ore were carried out. Pending the erection of a treatment plant, the Tasmanian Copper and Primrose Mines were shut down in September, 1919, but in August 1920 both mines, and the Hercules Mine, Mt. Read District, were purchased from the Mt. Read and Rosebery Mines Limited by the Electrolytic Zinc Company of Australia Ltd.

During the first few years of its tenure, the Electrolytic Zinc Company confined its chief activities to the perfection of a treatment process, the only ore mined being that required for experimental purposes. In 1920-21 a little work was done on behalf of the company by Minerals Separation (De Bavay) Ltd. In 1921, test work, on the separation of the constituents of the zinc-lead ore by oil flotation, was commenced at Zeehan using the SO_2 process. This process produces a galena-pyrite concentrate; the zinc is depressed and is afterwards recovered by using copper sulphate and a little oil. Owing to the failure of effecting a separation of the pyrite and galena this process was abandoned in 1923. Test work by Freeman and Read, at Broken Hill in 1923, showed that if the flotation medium were alkaline (Na_2CO_3) preferential floats of the zinc and lead could be made, and on this basis, called the soda process, the Zeehan Experimental Mill (capacity, 120 tons a day) was started in 1924. This process ran from 1924 to 1927, cyanide (KCN) being used to depress the zinc and pyrite in the lead float, and copper sulphate to depress the pyrite in the zinc float. During this period many difficulties were encountered, but as a result of introducing relatively high circulating loads of pulp in the mill, in conjunction with the use of cyanide as a depressant for pyrite in the lead float, the process was eventually perfected and in 1928 the construction of a mill at Rosebery (capacity 500 tons a day), to treat ore from the mines at Rosebery and Mt. Read, was commenced.

15+ Loftus Hills "The Zinc-Lead Sulphide Deposits of the Read-Rosebery District Part II (Bulletin 23) pp. 94-98 and Part III (Bulletin 31) p. 4 et. seq.

Power for mill and plant requirements was obtained from the Mt. Lyell Company's plant at Lake Margaret. In 1924 the Hydro-Electric Department, acting on behalf of the Electrolytic Zinc Company, arranged to purchase the surplus power from the Mt. Lyell Company and constructed a transmission line from Lake Margaret to Zeehan. This was extended through Williamsford to Rosebery in 1927.

The North Tasmanian Copper Mine was transferred to the Intercolonial Metal Coy. (a reconstruction of the Tasmanian Metals Extraction Coy.) in June 1920 but as no work was done on the property it was forfeited to J.H.S. Munro in December 1922, and was eventually sold to the Electrolytic Zinc Company, who thus gained control of the three principal mines in the district.

A considerable amount of diamond drill boring was carried out at Rosebery during 1926-27, the object being to test the northern, southern and downward extentions of the Rosebery ore body; a good deal of this work was done on the North Tasmanian Copper Mine.

With the exception of the diamond drilling comparatively little work was done on the mining properties prior to 1928, but, with the solution of the metallurgical difficulties and the decision to erect a treatment plant, extensive underground development work was undertaken, and preparations were made for the extraction of a minimum of 300 tons of ore a day from the Rosebery Mines; the remaining 200 tons, to satisfy plant requirements, was to be obtained from the Hercules and Mt. Read Mines, the latter having been purchased by the company in 1926. In order to facilitate transport an aerial ropeway was constructed between Williamsford and Rosebery. The main development work at Rosebery consisted in extending, in a northerly direction, the already existing drives on the Tasmanian Copper Mine.

Owing to the fall in the price of metals, all work on the mines ceased in October 1930, the only work now in progress being the completion of the mill on which about twenty men are employed.

Other work in the district, not mentioned in previous publications, includes the completion of development work on the Koonya Mine by the Colebrook Prospecting Association in 1916, and prospecting, development and diamond drill boring on the Rosebery Lodes Mine extending from 1916 to 1920. In each case no ore body of a payable nature was disclosed.

IV GEOGRAPHY & PHYSIOGRAPHY.

(1). LOCATION and EXTENT.

The area described in this bulletin is situated on the West Coast of Tasmania; it lies in the north-western portion of the County of Montagu and embraces a small portion of the County of Russell. The township of Rosebery is situated near the centre of the mapped area and is the main centre of the district.

The extent of the area is approximately 12½ square miles; it forms a rectangle whose northern and eastern sides extend 3½ miles west and three miles south, respectively, from the trig. station at the summit of Mt. Black.

(2). TRANSPORT and COMMUNICATIONS.

Railways.

Rosebery is connected by means of the Emu Bay Railway with Burnie, the principal port of North Western Tasmania, and is distant some seventy miles from it; a spur line from Primrose Siding connects the Electrolytic Zinc Company's Mine with the Emu Bay Railway Company's main line. From Rosebery the Emu Bay Railway goes on to Zeehan which, in turn, is connected by the Government line with Strahan, the only port on the West Coast; the distance between Rosebery and Zeehan is 18 miles and between Zeehan and Strahan 29 miles.

Roads.

A well graded road connects Rosebery with Williamsford, a township some five miles to the south, and the main centre of the Mt. Read District. A six foot road is at present being constructed from Rosebery to Tullah, the centre of the Mt. Farrell District.

Tracks.

By means of several fairly well graded tracks communication has been established between Rosebery and other mining and prospecting centres in the vicinity.

From the end of the Sterling Valley Road a track crosses the low saddle joining Mt. Murchison to Mt. Black, and connects with the wooden tramway from the Sterling Valley Mine to Tullah. Innes' Track, which formerly connected Rosebery with Tullah, is now overgrown and difficult to follow. The Wilson River Track leaves the Emu Bay Railway near the 71 Mile Peg, and, after crossing the Pieman River, proceeds in a north westerly direction to the Huskisson River, and thence goes on to the osmiridium diggings on the Wilson River. A track connecting Rosebery with the deserted site of Ringville leaves the Williamsford-Rosebery Road near the cemetry. The track between Williamsford and Queenstown may be reached from Rosebery by following Dunkley's Tram, but this route could not be recommended to anyone not familiar with the district.

(3). TOPOGRAPHY

The district generally is one of high relief and the nature of the topography essentially juvenile. The present land forms are probably modifications of the topographic features existent during the Pleistocene Glacial Age.

(a) Mountains & Hills.

Mt. Black (3,037'), Bald Hill (2047') and Colebrook Hill (1767) are the three most prominent topographical features of the district.

Mt. Black in the extreme north eastern corner of the mapped area is the most densely wooded mountain in Tasmania. Several long spurs radiate from it; one of which extends in a westerly direction across the northern boundary of the area and terminates near the railway line in the vicinity of the 69 Mile Peg; Karlson's Knob (1360) is a prominent hill on this spur. Another fairly well defined spur extends in a south westerly direction from the top of the mountain to the township. One of the most prominent features of Mt. Black is a long flat ridge which extends in a general southerly direction and is connected by a low saddle with the foothills of Mt. Murchison, some of which penetrate the south eastern corner of the area, this ridge lies to the east of and is parallel to, the eastern boundary of the sheet.

Bald Hill, an elongated razor backed ridge, is really the termination of a long northern spur of Mt. Read. Except on its western slopes, where it is covered with a growth of Eucalypts, Bauera and Horizontal, the surface is covered with button grass.

Colebrook Hill is situated in the south western corner of the area. From it a long flat ridge runs south towards Williamsford; another ridge trends in a north westerly direction from the top of the hill for about half a mile, after which it turns north and terminates on the railway line near the 73 Mile Peg.

Westcott Hill, a fairly prominent hill immediately west of Natone Creek, is connected to Colebrook Hill by a comparatively low saddle.

On the west side of the Pieman River, two low hills, Onslow Hill and Patterson Hill, rise above the comparatively flat country in that vicinity.

(b) Drainage.

(i). Surface Drainage:- The rivers and creeks all flow in steep sided valleys or in deep gorges and are marked by numerous rapids and waterfalls. The Pieman River, which enters from the north and flows out to the west, takes the whole of the drainage of the area.

The Stitt River, a tributary of the Pieman, rises on the north-western slopes of Mt. Murchison. In its course to the Pieman it takes the whole of the drainage from the eastern slopes of Bald Hill, and by means of Mountain Creek, Rosebery Creek and Saddle Creek effects the drainage of the western slopes of Mt. Black and of some of the foothills of Mt. Murchison. Barker Creek, which enters the Stitt immediately below the railway bridge, drains portion of the western slopes of Bald Hill.

Chamberlain and Salisbury Creeks drain the greater portion of the western slopes of Bald Hill; they junction below the railway station and enter the Pieman a few chains north of the cage crossing.

Rising immediately north of the low divide, which separates it from Ring River drainage system, Natone Creek flows in a general northerly direction and enters the Pieman River about ten chains below the cage crossing. By means of numerous tributaries and heads it drains the eastern slopes of Colebrook Hill and portion of the western slopes of Bald Hill. Some of its eastern branches rise on the northern slopes of Mt. Hamilton.

Josephine Creek drains the northern slopes of Colebrook Hill and the western slopes of Westcott Hill; it enters the Pieman River below the 72½ Mile Peg on the Emu Bay Railway.

Bobadil Creek drains the northern portion of the area; it enters the Pieman River below the 68½ Mile Peg.

On the west side of the Pieman River, Watson's Creek rises in a button grass plain to the east of Onslow Hill and enters the Pieman River about 25 chains below the cage crossing; McKimmie Creek drains the country between Onslow Hill and Patterson Hill.

(ii). Sub-Surface Drainage:- In those portions of the district covered by unconsolidated fluviatile and glacial deposits much of the rain percolates through the porus sands, gravels and glacial wash until it reaches bedrock, and hence some of the drainage becomes sub surface. This is particularly noticeable on the west side of the Pieman River gorge where the base of the Tertiary sands and gravels is frequently marked by springs and seepages. Furthermore, the absence of sizeable creeks on the west side of the Pieman is in direct contrast with their abundance in other portions of the area where the extent of these unconsolidated rocks is considerably less.

Many small creeks rising on the western slopes of Bald Hill lose half their volume on entering the glacial deposits of the Natone Valley; one or two of the smaller ones disappear entirely. The greater part of the water lost in this way travels along the surface of the underlying bedrock until, eventually, it issues forth as a seepage or spring.

(c) The Button Grass Plains.

These are stretches of open, treeless country covered with low tufts of button grass (Mesomelaena sphaerocephala). In this area there are two such plains, one on the west side of the Pieman River, and one in the vicinity of the Dalmeny Section in the Stitt Valley; these are probably the remnants of former flood plains or river terraces. A small, flat, button grass swamp occurs near the railway station; this may have been due to the silting up of an old valley during glacial times.

A characteristic of the button grass plains is the peaty nature of the soil. Primarily, the button grass appears to thrive in very siliceous, and hence poor, soils where there is an abundance of water. The decaying roots build up a peaty soil two or three feet thick which retains the water even in relatively dry seasons. This soil is very acid and appears to be unsuitable for the growth of other vegetation.

(4). Evolution of the Present Lands Forms

A study of the topographical and geological features of Western Tasmania has led several investigators to a belief in the existence of at least two great cycles of erosion in that region.

The first of these dates back to pre Permo-Carboniferous times. The nature and extent of the land forms developed during this cycle are not fully understood, but portions of this ancient peneplain are now found at elevations of 3000', e.g. at Mt. Dundas, and it is possible that many of the mountains of the West Coast Range are remnants of this dissected peneplain.

The second great cycle is post-Mesozoic and pre-glacial, and, although the knowledge concerning it is more extensive, there are certain anomalous features which it would be advisable to consider. In north-western Tasmania there exists a great basalt covered peneplain which now lies at an elevation of 2,100 feet to 2,200 feet above sea level. The work of Gregory (16) Ward (17 & 18) Twelvetrees (17) and Nye (19) has also established the existence of an old coastal peneplain which extends from the Arthur River in the north to Low Rocky Point in the south; the present level of this peneplain between the Arthur and Pieman Rivers is 800' - 900'; near Rosebery, Renison Bell and Zeehan it is approximately 700'. Near Low Rocky Point, a possible extension of this old plain descends to within 200 feet of sea level. In addition to this southerly slope the peneplain has a gentle slope to the west. The Henty peneplain described by Gregory, Ward and Twelvetrees forms portion of the Coastal Peneplain. The relationships between these two peneplains, the one at an elevation of 2,100' to 2,200' and the other ranging from 700' to 900', are not clearly understood, but both are considered to be pre-glacial and post-Mesozoic. The principal movements of the land masses in this region since Mesozoic times have all been negative or upward, and it is possible that the North-Western Peneplain and the Coastal Peneplain may represent successive stages during the uplift. An alternative suggestion is that the North-Western Peneplain owes it position to block faulting, but for this there is, so far, no evidence. Ward (20- suggested that the Norfolk Range (2000' - 2600'), which rises above the Coastal Peneplain, was formed as a result of the unequal erosion of a plateau region of much greater antiquity than the Coastal Peneplain, but this plateau, had it persisted, would have stood far above the level of the North-Western Peneplain and, therefore, cannot be correlated with it.

This broad outline of the topographic history of Western Tasmania may now be applied to the area with which we are dealing.

Mt. Black, Bald Hill and the top of Colebrook Hill probably represent residuals of the pre Permo-Carboniferous Peneplain.

The flat ridge (1600') extending south from Colebrook Hill may be a southern but slightly lower portion of the North Western Peneplain; however, as there is some doubt as to whether the North Western Peneplain extended so far south, it may be portion of the dissected pre-Permo-Carboniferous Peneplain.

To the west and north of Rosebery, the dissected Coastal Peneplain, which in this district we may refer to as the Pieman Peneplain, appears to extend to the foot of the Parsons Hood and Mt. Ramsay. The view from Colebrook Hill suggests that the peneplain extended to the foot of Mt. Black and Bald Hill. Within the area there is little evidence to prove that such was really the case but the flattened nature of some of the hills, e.g. south of the 71½ Mile Peg and Rosebery Hill, is suggestive evidence of its former existence.

Since the close of the cycle which culminated in the formation of the Coastal Peneplain (in this district the Pieman Peneplain), there has been a persistent upward or negative movement of the land masses, and the present rivers have deeply dissected the former surface of the peneplain. During the uplift there has been at least one period of "still stand" during which the Pieman reached a temporary base level and formed the terraces which now stand at an elevation of 450 feet. Further uplift has rejuvenated the river and enabled it to carve the deep gorge in which it now flows. The mean level of the Pieman River in this district is approximately 250 feet, hence the uplift must have been 200 feet plus the depth to which the Pieman now has to erode to reach base level.

(16) Gregory, J.W. Proc. Royal Soc. Vic. Vol XVI, Part I, p. 177 et seq.
(17) Ward, L.K. and Twelvetrees, W.H. "The Ore Bodies of the Zeehan Fields". Bulletin 8, pp 9-14 1910.
(18) Ward, L.K. "The Mt. Balfour Mining Field". Bulletin 8 10, pp 8-10, 1911.
(19) Nye, P.B. Unpublished report on the country in the vicinity of Low Rocky Point.
(2) Ward, L.K. See above (18) pp 7-8.

The period of "still stand" resulting in the formation of the Younger Pieman Terraces was followed by extensive glaciation. The occurrence of glacial moraines and of numerous erratics of West Coast Range conglomerate illustrates that the elevations of the ice sheet ranged from 500 feet to 1900 feet. As the glacial morainic deposits overlie the Younger Pieman Terraces, it is apparent that the glacial activity is later than the period of "still stand". As to the exact nature of the land forms developed by the glaciation in this area there is little evidence. It seems probable that the valley of Natone Creek now occupies the old course of the Ring River, which, dammed back by a glacial moraine, was obliged to find an outlet to the south. The striated surfaces south of the No. 4 level adit in the Rosebery Mine indicate that some of the land had been eroded to its present level.

With the melting of the ice cap, there has been uplift and hence renewed activity among the river systems. The Stitt River, Mountain Creek, Rosebery Creek, Saddle Creek &c. are probably post-glacial streams. In the Stitt Valley, the flat country near the Dalmeny Lease (R.L. 500) suggests that it may have been formed contemporaneously with the Younger Pieman Terraces, and certain shallow gravels through which the river has cut lend support to this view. However, had the Stitt been a pre-glacial stream its valley would have been filled with moranic deposits and of this there is no evidence. In the Stitt Valley and in the river itself, particularly in the higher reaches, there are numerous large and small erratics of the West Coast Range conglomerate. Being particularly resistant to the forces of erosion, these boulders have probably survived the weathering of the rocks, on which they were deposited by the ice and have gravitated to their present positions.

The post glacial streams flow in steep V shaped valleys and their courses are marked by numerous waterfalls and rapids. The Stitt River, below the Williamsford Road flows in a deep gorge. The rejuvenation of the Pieman River consequent on the uplift has enabled it to carve a deep gorge in it's old flood plain, and the softer nature of the rocks has enabled it to erode at a much greater rate than its tributaries, the entrances of which are often marked by waterfalls and rapids.

(4a) Brief Summary of the Topographic History of the West Coast.

The topographic history of the West Coast region as illustrated by a study of this and other areas may be summarised tentatively, as follows:-

The close of the first great cycle of erosion resulting in the formation of the pre Permo-Carboniferous Peneplain was followed by sinking of the land masses and extensive sedimentation during Permo-Carboniferous times. The absence of Triassic rocks on the West Coast indicates that the close of the Permo-Carboniferous period in that region was marked by uplift. This was followed by further negative or upward movements of the land masses during the igneous activity of the Upper Mesozoic.

Several successive stages have marked the progress of erosion since Mesozoic times. The first of these was the formation of the North-Western Peneplain, on the surface of which fresh water sediments were deposited during the Tertiary lacustrine period (21).

Uplift (or block faulting?) of 1,200 to 1,400 feet followed by a period of quiesence resulted in the formation of the Coastal Peneplain. In the south, the dissection of the North-Western Peneplain has been almost completed, but, in the north, the old surface has been protected by flows of basalt e.g. at Waratah (22).
**

The formation of the Coastal Peneplain was followed by a further uplift of 250 feet and another period of quiesence, which synchronised with the formation of the Younger Pieman Terraces.

These constant upward movements aided by changes in climatic conditions were probably partly responsible for the Pleistocene glaciation. Further climatic changes caused the melting of the ice cap and subsequent uplift has resulted in renewed activity among the present river systems. The extent of the post-glacial elevation was 200 feet plus the depth to which the present streams must erode in order to reach base level.

(5) Relation of Topography to Prospecting & Mining

The configuration of the ground is such that the principal ore bodies have been exploited by adit levels to some depth below their surface outcrops, hence drainage and haulage costs are low. As a general rule those lodes or portions of lodes above the 500 to 600 foot contours have been exploited in this way. Below these levels shaft sinking is necessary, except in cases where outcrops occur in the beds of steep sided rivers and creeks.

The Rosebery Mine has been developed from 1229' above sea level to 540' above level by means of adits, but below the present bottom level (RL 540') a shaft will be necessary.

** (21) P.B. Nye "The Silver Lead Deposits of the Waratah District". Bulletin 33. p. 61. 1923.
(22) Do abone (21).

Table I

ANNUAL and MONTHLY DISTRIBUTION OF RAINFALL - ROSEBERY.

Rainfall in points 100 = 1".

Year	Jan	Feb	Mch.	Apl.	May	June	Jly.	Aug.	Sep.	Oct.	Nov.	Dec.	Year.
1913	552	303	581	271	670	512	912	1132	1070	591	1597	696	8887
1914	610	173	513	1455	660	673	1044	718	604	106	346	355	7057
1915	426	229	726	732	878	960	744	972	1171	1294	1645	209	9986
1916	504	123	347	1364	742	394	361	1130	645	812	658	913	7993
1917	409	522	715	753	913	861	1919	763	991	861	639	269	9615
1918	433	398	319	358	782	920	1173	384	417	1017	435	879	7515
1919	497	303	622	362	494	1497	1029	692	720	520	318	476	7530
1920	94	359	755	589	737	863	879	956	749	540	860	426	7807
1921	345	225	392	765	582	984	1111	1410	828	491	826	264	8223
1922	445	273	902	806	893	583	278	558	578	912	684	736	7648
1923	1351	296	711	28	2086	772	1046	890	1167	784	802	585	10518
1924	843	520	629	1013	568	865	812	897	1042	855	848	344	9236
1925	433	753	208	611	146	442	654	852	984	1022	294	661	7060
1926	339	660	251	685	759	466	956	939	692	894	1003	469	8113
1927	387	407	315	354	1021	625	850	947	480	460	368	335	6549
1928	382	363	288	593	832	425	1022	1043	1513	1331	906	544	9242
1929	680	101	657	733	395	1252	1066	736	744	686	641	838	8529
1930	693	210	236	642	459	260	1061	717	1125	583	855	531	7372
1931	693	471	560	1088	894								
Average for 18 yrs.	524	345	498	673	757	742	940	874	862	764	763	529	8271

The rivers and creeks offer the best facilities for prospecting, the work being carried out with greater facility during the summer months. The heavily timbered mountains and hillsides give few exposures.

(6) Climate and Meteorology.

The climate of the district is extremely wet, the average annual rainfall in the Rosebery township being 82.7 inches.

The attached table, supplied by the courtesy of J.C. Foley, Commonwealth Division Meteorologist, Hobart, shows the monthly and annual distribution of the rainfall over a period of 18 years.

It will be observed that the rainfall is spread over the whole year. December, January, February and March are the driest months, and July, August and September the wettest. During the frosts of May and June the weather, though cold, is sometimes comparatively fair. The rivers and creeks respond quickly to periods of heavy precipitation, the Pieman River rising as much as twenty feet in the course of a few days. Falls of snow are frequent from July to October and the melting of the snow helps to regulate the supply of water to the creeks and rivers. Snow is more common on the neighbouring mountains, e.g. Mt. Murchison and Mt. Read, than it is on Mt. Black; it rarely falls in the township.

The rainfall data shown above cannot be taken as representative of the district as a whole, the precipitation in the surrounding hills being considerably greater than it is in the Rosebery township.

There is not sufficient water available in the district for any extensive power schemes, although the Stitt River may possibly be able to provide sufficient for a small one. A water race conducts the water from Rosebery Creek to a small reservoir above the mill site, and this, supplemented by pumping from the Stitt River, provides sufficient water for the requirements of the Rosebery Mill. Tanks are relied on for domestic supplies.

7. Vegetation and Timber.

The high annual rainfall is reflected in the dense forest growths which cover the greater portion of the area. The slopes of Mt. Black, the foothills of Mt. Murchison and much of the south-west corner are covered by Myrtle forests. The western slopes of Bald Hill, the country between the station reserve and the Stitt River and the north western portion of the area are covered principally by eucalypt forests, though Patterson Hill and some of the country to the south is mainly Myrtle country.

The most common trees in the Myrtle forests are the Myrtle (Fagus cunninghami), Leatherwood (Eucryphia billardieri), Celery-top Pine (Phyllocladus rhomboidales, and Sassafras (Atherosperina maschatum); Blackwood (Acacia melanoxylon) is less common. The undergrowth in the Myrtle forests is prolific and contains amongst others, the following common forms:- Horizontal Scrub (Anodopetalum biglandulosum), Laurel (Anopterus glandulosus), Stinkwood, and manferns or Tree ferns. (Dicksonia). In some of the low lying Myrtle forests e.g. in the south west portion of the area Manuka (Leptospermum scoporium) and Tea-Tree are fairly abundant.

The Eucalypst forests contain Stringy Bark (Eucalyptus obliqua), Peppermint, and various other Eucalypts. Large Stringy bark trees occur among the Myrtles on Patterson's Hill. The undergrowth of the Eucalypt forests is mainly Bauera and Tea-Tree.

The country between the Wilson River Track and the Pieman River is covered by a dense growth of Tea-Tree and Bauera, but patches of Eucalypts are common.

Belts of King William Pine (Arthrotaxis cupressoidas) occur near the summit of Mt. Black, and a considerable belt of Celery-top Pine occurs on Onslow Hill.

The chief timbers used in mining are the Myrtle, various Eucalypts and Leatherwood. Celery-top Pine, on account of its lasting qualities, is the most valuable timber but most of the accessible trees have now been cut out. King William Pine is also valuable and has been worked extensively in the past, but the belts on Mt. Black are now practically exhausted.

V. GEOLOGY.

(1) Summary.

The western half of the mapped area is composed principally of Lower Palaeozoic sediments which strike in a general north and south direction and dip to the west at a steep angle. These rocks are divisible into two conformable series. Of these the Pre Dundas or Rosebery Series is the oldest and is probably of Cambro-Ordovician age; the rocks of this series are divisible into the following groups or stages, viz;- the Lower Slates and Quartzites, the Fuchsitic Breccia-Conglomerate, the Purple Slates and the Upper Slates and Quartzites. Overlying the Upper Slates and Quartzites are the slates and fine grained breccias of the Dundas Series; these are probably of Lower Ordovician age.

The rocks occurring in the eastern half of the area are principally quartz and felspar porphyries, which are definitely intrusive into the Lower Palaeozoic sediments and are probably of Devonian age. Along certain belts these rocks have been highly sheared and altered, and they contain a few isolated blocks of sedimentary rock which have probably been derived from the intruded sediments.

A small outcrop of gabbro and a dyke of serpentine occur in the south western portion of the area. These are also of Devonian age.

Deposits of river gravels of Upper Tertiary age and Pleistocene glacial deposits overlie the older rocks.

River gravels are being formed in the beds of some of the present streams.

(2) The Sedimentary Rocks.

(a) Table showing the sequence of the Sedimentary Rocks.

System	Series	Correlation	Lithological Character
Cambro-Ordovician	Rosebery or Pre Dundas	-	Slates, quartzites & breccia-conglomerate.
Ordovician	Dundas	Dundas Series	Purple and light coloured slates & breccias.
Unconformity			
Upper Tertiary	-	-	Conglomerates, gravels, sands and clays.
Unconformity			
Pleistocene			Boulder clays, sands & moranial deposits.
Unconformity			
Recent			Conglomerates and gravels.

(b) Rosebery or Pre-Dundas Series.

(i) Lower Slates & Quartzites.

The oldest rocks of the Rosebery series consist of a broad belt of slates and quartzites, the lowest members of which are composed principally of slates, and the upper of quartzites.

Slates.

These consist of thin bedded grey, green, black and purple slates with occasional beds of arenaceous rock.

The exposures of these rocks are somewhat limited. They outcrop in the bed of the Stitt River, from a point a few chains west of the north-west corner of lease 10087 to within twelve chains of the entrance of the Stitt River into the Pieman, and have been exposed in the railway cuttings at Primrose Siding; in the latter locality they are overlain by fluvio-glacial deposits. On the branch line from Primrose Siding to the Rosebery Mine, purple, grey and black slates are exposed in a small cutting, and these may represent an eastern extension of the slate horizon. South of the Stitt River, the slates are represented by one small outcrop of greenish slate in Chamberlain Creek. Further south the slates die out, apparently they are displaced by the intrusive quartz felsites.

The general strike of the slates varies from true north and south to N. 10° E, and the dip is generally to the west at 70° - 80°. In the Stitt river, they are somewhat folded and contorted, and, although the strike remains fairly constant, the dips are variable and may be east, west or vertical. These variations are doubtless due to the proximity of the intrusive quartz porphyries and felsites.

In view of the paucity of exposures, it is difficult to form an estimate of the thickness of these rocks. The full width of the exposures in the Stitt River is, approximately, 1,300 feet, and, if we disregard the folding and assume an average dip of 75 degrees, their thickness in this section would be 1,200'. However, the outcrops on the branch line to the Rosebery Mine are about half a mile still further to the east, and this would suggest a much greater value for their original thickness.

Quartzites.

These consist essentially of fine and coarse grained, dark grey and white micaceous quartzites, with occasional beds of black and grey slates. The fine grained micaceous quartzites predominate, the slates occurring in thin seams or as bands ten feet or more in thickness.

The quartzites form an almost continuous strip passing through the area from south to north. At the southern end, they are exposed in the excavations at towers 35, 36, and 37, on the Williamsford-Rosebery Aerial Haulage, and outcrop in some of the adjacent creeks and on the hillsides. Further north, they outcrop in Natone Creek for some distance above the railway line, and on the hillsides to the east. Good exposures may also be seen in the road and railway cuttings between Natone Creek and the 71 Mile Peg. From the vicinity of the 71 Mile Peg northwards, there is little difficulty in tracing this horizon; outcrops are numerous in that portion of Chamberlain Creek below the railway line, and the quartzites form ragged and precipitous cliffs along the steep banks of the Pieman River; a noteworthy outcrop occurs a few chains below the entrance of the Stitt where the cliffs rise some 200 feet above river level. Many excellent sections are exposed by the deep cuttings on the Emu Bay Line north of the 69 Mile peg.

The strike of the quartzites is very close to true north and south, with slight variations to the east or west from place to place; the dips are westerly at 60° to 80°. A purely local change in dip occurs immediately east of the road and railway crossings over Natone Creek, where the dip is easterly at 75° to 85°, but the rocks resume their normal westerly dip a few chains to the south. There is no folding in the quartzites and this change is difficult to explain, but a possible explanation presented itself while examining the rocks in Chamberlain Creek; in that locality the drag on a small, flat, west-dipping fault plane had caused a local reversal of dip in the strata above the fault; the southerly extension of this fault may have caused a similar effect in the localities cited.

The thickness of the quartzite horizon is approximately 1,200'.

In the northern portion of the area, the section across the slates and quartzites afforded by Bobadil Creek indicates that, while quartzites still predominate in the upper portion of this horizon, there is no predominance of slates in the lower, and, between the railway line and the porphyry contact, the proportion of slates to quartzites is roughly equal.

On their eastern margin, the lower slates and quartzites are in contact with intrusive quartz porphyries which cut them at an acute angle; the result is a gradual diminution in their width from north to south. The slates are cut off a little to the south of Chamberlain Creek, and the quartzites finally die out near the Jupiter Mine, some thirty five chains beyond the south boundary of the area. The exposed western margin of the quartzites is also in contact with a small intrusive dyke of quartz porphyry. However, as both strike and dip of these rocks co-incides with that of the breccia-conglomerate which lies above them, they doubtless form portion of the same series.

(ii) The Fuchsitic Breccia-Conglomerate & Associated Rocks.

The rocks of this group form the most definite mapping horizon in the district. They consist of a bed of fuchsitic breccia-conglomerate, with interbedded slates and fine grained, greenish argillaceous quartzites.

The fuchsitic breccia-conglomerate is a coarse grained rock composed of angular and rounded pieces of black and white chert, quartzite, micaceous quartzite, and black and grey slate. The cementing material may be siliceous, or may consist of material similar to that constituting the argillaceous quartzite. The rock is sheared and is freely impregnated with bright green fuchsite, which occurs in massive form disposed parallel to the direction of shearing. A little pyrite occurs either as small seams in the rock, or as minute particles disseminated through it. This rock is undoubtedly of sedimentary origin and occurs interbedded with the other members of the series.

Greenish slates, with subordinate bands of black, grey or brown slates and fine grained argillaceous quartzites constitute the remainder of this group. The slates are of the usual fine grained type and call for no detailed description. The argillaceous quartzite is a fine grained, greenish rock resembling a normal siliceous quartzite. It sometimes contains small angular fragments of chert and slate, and, generally, a good deal of mica. Some types are pyroclastic in appearance, but the amount of igneous material revealed by microscopic examination is relatively subordinate.

Under the microscope, the argillaceous quartzite is seen to consist mainly of angular and sub-angular fragments of quartz, with flakes of muscovite, set in a fine grained argillaceous ground mass, the amount of which is slightly in excess of that of the quartz. In addition, there may be present small fragments of felspar, chlorite, calcite, pyrite and magnetite and an occasional spherulite. A good deal of limonite also occurs, and, in places, forms a border around what appears to be decomposed augite or hornblende. Chlorite is fairly abundant in some sections and imparts to the rock a pale green colour. The nature of the ground mass could not be resolved even under the high power.

The breccia conglomerate and its associates extend in a northerly direction from the south boundary of the mapped area to the Pieman River, northwards of which they disappear under Tertiary and Pleistocene deposits. The most southerly outcrop is on the Williamsford Road at a point about twenty six chains south of the cemetery turn off; here the road cuttings have exposed the eastern edge of the fuchsite breccia-conglomerate, and it is seen to be in contact with the western band of quartz porphyry. Further north, these rocks are exposed in Natone Creek from the Old Zeehan Track to the concrete dam. To the north of the dam, their outcrop forms a large waterfall in Natone Creek, and, still further north, they outcrop on the north-western slopes of Westcott Hill. Good exposures of the fuchsite breccia-conglomerate may be seen in the road and railway cuttings at a point about fifteen chains west of Natone Creek; it also outcrops in Natone Creek below the railway line and on the banks of the Pieman River immediately west of the mouth of Natone Creek.

Rocks similar to the slaty members of this group, and purple slates similar to those described below, outcrop in Slip Creek and in the railway cuttings near the 68 Mile Peg. These, may possibly represent the northern continuation of this group. In this locality, however, there are no rocks analogous to the breccia-conglomerate or the argillaceous quartzite, and, furthermore, there is no sign of the quartz porphyries which, at the southern end of the area, occur on the eastern side of the breccia conglomerate. Hence this correlation must remain doubtful, though it is possible that the breccia-conglomerate, the argillaceous quartzite and the western band of quartz porphyries may all die out as they go north.

The general strike of these rocks is true north and south, but it may vary 10° to the east or west from place to place. The dips are usually westerly at 75° to 80° but some flatter dips were observed, the lowest being 65° W. At the south end of the mapped area, the contact, between the breccia-conglomerate and the western band of quartz porphyry, is dipping to the east at 75°; whether this is just a local reversal of dip, or whether the dip of the whole of the Cambro-Ordovician sediments changes as it goes south, has not yet been determined; further discussion on this point will be found in another section of this report.

The thickness of the breccia-conglomerate and associated slates is in the vicinity of three to four hundred feet.

With regard to their relationships with the rocks above and below, the mapping and field relationships indicate conformability, but, as the breccia conglomerate and its associates are separated from the Lower Slates and Quartzites by a band of quartz porphyries, it may be as well to trace the relationships of the various rock types from the Lower Slates and Quartzites to the Purple Slates.

The succession from east to west is;-
Lower Quartzites.

0-40' Argillaceous quartzites similar to those described above.

300'-600' of Quartz porphyry.

Breccia Conglomerate &c. 100' Fuchsitic)
Breccia Conglomerate. 200'-300' Slates &)
Argillaceous Quartzites with thin bands of)
breccia conglomerate.)

Purple Slates.

This general succession may be traced from east to west in several places, e.g. along the Emu Bay line near Natone Creek, from the cage crossing at the Pieman River, and across the Natone valley south of the railway line. It may be mentioned, however, that the Purple Slates are exposed only on the western flanks of Westcott Hill.

The eastern contact of the quartz porphyry is exposed only at one place, i.e. on the Williamsford Road at a point ten chains south of the cemetery; here, the quartz porphyry abuts against slatey members of the Lower Slates and Quartzites; the contact is sharp and appears to be intrusive. Further south along the road, the western margin of the quartz porphyry can be seen in contact with the fuchsitic breccia-conglomerate, but the contact is by no means sharp, and, generally, is marked by shearing. The porphyries contain numerous rounded and angular cherty inclusions which appear to have been derived from the breccia-conglomerate. This quartz porphyry band is possibly a dyke intrusive along the contact of the Lower Quartzites and the breccia-conglomerate.

Occurrence of Fuchsite in the Breccia Conglomerate:- Fuchsite is so evenly and widely distributed through the breccia-conglomerate that, at first glance, it appears to be an inherent constituent of the rock, but the nature of the mineral precludes the possibility of this. Its occurrence is confined almost wholly to the breccia-conglomerate; it does not occur in slatey members of this group, and only a few small pieces have been observed in the adjacent quartz porphyries. The mineral occurs as pieces about the size of a three-penny piece up to large pieces a quarter of an inch thick and two inches in diameter.

The fuchsite is pale green to bright green in colour, has a soft, soapy feel and a hardness of 2 to 3. It is quite easy to obtain a sample of the mineral by flaking it from the rock with a penknife; a sample obtained this way was analysed with the following result:-

Analysis of Fuchsite.

Constituents.	%
SiO_2	51.00
Fe_2O_3	0.86
FeO	1.29
Al_2O_3	32.80
TiO_2	0.18
CaO	-
MgO	0.32
Cr_2O_3	1.33
K_2O	7.55
Ignition Loss	4.90
	100.23

The analysis indicates that the mineral is a chrome bearing mica and hence agrees generally with the composition of fuchsite.

Under the microscope, the mineral is similar to sericite in its general physical properties. In ordinary light, it has a pale green tinge, and, between crossed nicols, gives third order polarisation colours which range from blue-grey to yellow to red.

The occurrence of the fuchsite in the breccia-conglomerate is interesting in as much as it is generally regarded as a secondary mineral, formed by the action of potassium bearing solutions on rocks containing chromium and aluminous silicates. Chromium is usually associated with basic igneous rocks, and, with one exception, the igneous rocks of this district are all acid and contain no chromium; furthermore, an analysis of the porphyries adjacent to the breccia-conglomerate showed no chromium, and, it is unlikely that chromium should be distributed regularly through such a rock as the breccia conglomerate. It seems probable that the fuchsite was formed in the rock as a result of pneumatolytic action, that is to say, vein forming solutions containing chromium and potash impregnated the breccia-conglomerate, and, acting on the aluminous silicates present in the matrix, gave rise to the formation of fuchsite. In this case it seems probable that the origin of the chromium was pneumatolytic, i.e. it was derived from the same source as the potash and was not a residual constituent of the rock. The selective depositon of the mineral was doubtless due to the fact that the breccia-conglomerate contained abundant pore spaces through which the solutions could percolate.

(iii) The Purple Slates.

The purple slates form a fairly definite horizon separating the upper members of the Breccia-conglomerate &c. from the Upper Quartzites. The rocks are all thinly bedded purple slates; they are sometimes greenish on weathered surfaces, and, ultimately, weather to a reddish brown soil. They outcrop on the old Zeehan Track and may be traced northwards along the eastern slopes of Westcott Hill to within twenty chains of the railway line, whence they disappear under alluvium and fluvio-glacial deposits.

These rocks strike north and south and, apparently, are conformable with those above and below. The maximum thickness is approximately 300'.

(iv) Upper Quartzite & Slates.

Another wide belt of interbedded quartzites and slates occurs above the purple slates. The quartzites of this horizon are fine grained and, as a general rule, are far less micaceous than those of the lower horizon. The slates are grey or black in colour, finely laminated and fissile, and contain a good deal of pyrite and occasional seams of calcite. Many of the slates are sheared, the shearing co-inciding with the bedding planes along which mica is freely developed.

These rocks occupy a broad zone, roughly 30 chains wide, which extends from the south boundary of the mapped area to the Pieman River. They outcrop along the old Zeehan Track and in the various heads of Natone Creek to the south of it. To the north, extensive outcrops occur on Westcott Hill and in the various creeks flowing north from it. Good exposures may be seen in the road and railway cuttings adjacent to the 72 mile peg on the Emu Bay Line, and along the banks of the Pieman River. A small outcrop of quartzite on Onslow Hill probably represents the northern extension of this horizon.

Among the various exposures the proportion of quartzites to slates is roughly equal, but, as a general rule, slates appear to be slightly in excess in the northern exposed portions, while further to the south, e.g. on Westcott Hill, the predominant rock type is quartzite.

The general strike of the Upper Quartzites and Slates is approximately true north and south; it may vary a little to the east or west from place to place, but the variation rarely exceeds 10° and never exceeds 15°. The dips are usually westerly at 75° - 85°; sometimes they are flatter; sometimes vertical. In some places the slates are folded and contorted, e.g. at the mill excavations on Munro's Section, on the old Colebrook Tram a little to the west of the mill and to a lesser extent in the railway cuttings near the 72 Mile Peg. There is also slight evidence of folding and faulting among the quartzites and this, in places, causes local reversals of dip. However, such evidence as exists indicates that the folding and faulting are not extensive and does not affect the general structural features.

The total thickness of this horizon is approximately 2000 feet.

The Upper Slates and Quartzites appear to be conformable with the purple slates and, as far as could be determined, are overlain conformably by the slates and breccias of the Dundas Series.

(v) Age of the Rosebery or Pre Dundas Series.

This series is entirely non fossiliferous, but, from the fact that the rocks underlie the Dundas slates and breccias, which are of Lower Ordovician Age, the series has been referred to the Cambro-Ordovician.

The Breccia-Conglomerate horizon may mark the passage from Cambrian to Ordovician, but, as the thickness of the conglomerate itself is not very great, it probably represents a minor break in the conditions of sedimentation.

In an effort to fix the probable age of the series, the writer visited the supposedly Cambrian beds occurring in the railway cuttings on the Emu Bay Line between 49.9 miles and 50¼ miles. From this locality Professor David obtained the remains of a fossil, Hurdia Davidi, which has been described by F. Chapman (23) as probably of Middle Cambrian Age. The rocks in the cuttings from which the fossil was obtained are thin bedded, fissile, black slates, and are very similar to some of the slate members of the Lower Slates and Quartzites. However, thin bedded, black slates are common in Silurian rocks and in both the Dundas and Pre Dundas Series, and any correlation based on such lithological evidence is practically valueless. No fossils were found by the writer.

A general examination of the cuttings adjacent to the 50 Mile Peg revealed the presence of thick beds of West Coast Range Conglomerate (Silurian). At 50¼ Miles these conglomerates appear to rest conformably on the black slates, but there is abundant evidence of faulting in the vicinity and the apparent conformability of the conglomerates may be due to the possible co-incidence of fault planes and bedding planes.

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(23) F. Chapmen, L.S. "On a supposed Phyllocarid from the Older Palaeozoic of Tasmania." Proceedings of the Royal Society of Tasmania. 1925 pp 79-80.

(c) Dundas Series.

Slates & Breccias.

Rocks of this series occurring in the Rosebery District are similar to the slates and breccias of the Dundas Series as developed elsewhere in the State, and contain a variety of lithological types consisting mainly of slates, cherts and breccias. The slates are generally massive, and may be purple, grey, green or black. The cherts are of a dense black variety, and are doubtless silicified forms of the slates. Both the slates and the cherts are interbedded with the breccias which are sedimentary rocks composed largely of igneous material. Many of the slatey members are simply exceedingly fine grained forms of the breccias. Although rapid alterations across the strike are common, it is often difficult to detect any trace of the original bedding planes and the structural features of the rocks are obscure.

Among the weathered rocks, the identification of the various rock types is a matter of some difficulty. In the early stages the breccias weather in spheroidal fashion after the manner of a basalt and are thus readily recognised, but the ultimate product is a reddish brown soil containing numerous slate particles. This reddish brown soil is characteristic of the series as a whole and appears to be produced irrespective of the predominance of the slates or the breccias.

The breccias are generally similar to those of the Waratah district where they have been studied in detail by Nye (24), who sub-divided them into micaceous and felspathic types in accordance with the predominance of the one or the other constituent. Similar rocks occurring in the Smithton district have been studied by the writer, although in that locality the distinction between the micaceous and felspathic breccias was not always apparent, and the most common type appeared to be a transition phase between the two. Although the breccias of this district are almost identical with those from the districts mentioned above, there are certain points of contrast between all three occurrences. Thus, while both micaceous and felspathic types do occur in this district, there is little distinction between them and one grades readily into the other. The most common type appears to correspond generally with the fine grained breccias as developed at Smithton, though some types contain much more chlorite.

The typical breccia of this district is best developed on Colebrook Hill. It is a fine grained, bluish grey rock closely resembling a basalt, the resemblance being accentuated in places by the spheroidal weathering. In hand specimen, quartz and chlorite are the only recognisable minerals. Under the microscope, the rock is seen to consist of fragments of augite, chlorite, felspar and quartz, and occasional flakes of biotite, set in a fine ground mass of similar material containing abundant oxides of iron. Augite occurs as irregular grains and is partly replaced by chlorite; some of the augite is titaniferous and shows the characteristic violet pleochroism. Chlorite is present as flakes and grains; in the former case it probably represents altered biotite and in the latter it has probably replaced augite; it frequently shows anomalous interference colours. Felspar occurs as angular fragments, and consists of both orthoclase and plagioclase, the latter showing the usual lamellar twinning. The quartz fragments are angular, and are of the usual glassy water clear variety. Biotite is not abundant and occurs as minute flakes. The oxides of iron are ilmenite, magnetite, and hematite. Some of the ilmenite has undergone alteration to leucoxene.

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(24) P.B. Nye. Bulletin 33. "The Silver Lead Deposits of the Waratah District". L24 1923

A similar type of breccia occurs in a cutting on the Emu Bay Line opposite Barnes Farm, but it is somewhat finer grained than the breccia described above and differs a little in its microscopic characters. The essential constituents are angular fragments of quartz and felspar, with flakes of biotite and chlorite, and occasional grains of augite. In addition, a few flakes of muscovite and some small grains of tourmaline are present. Most of the felspars are untwinned, and, generally, there is less felspar in this rock than is usual with the more common types. Ilmenite, magnetite and hematite are all fairly abundant; some of the ilmenite grains are large and show partial decomposition to leucoxene along the cleavage and twinning planes.

Another type of breccia outcrops on a waterfall in Jasephine Creek, at a point about four chains from the Pieman River. This rock is greenish-grey in colour and, in hand specimen, appears to contain muscovite. Although the mineralogical constituents are similar to those of the Colebrook Hill type, the relative proportions of the minerals are different. Generally, it contains much more chlorite and less augite. In addition, a little calcite is present, sometimes replacing felspar.

No chemical analyses of these rocks are available, but analyses of similar rocks from Waratah (25) and Smithton (26) show that their composition approaches very closely to that of a basic igneous rock. The minerals of the breccias are remarkably fresh and are such as one would expect to find in a basic rock, but the angular nature of the minerals, the microscopic structure of the rock, and its close association with the slates prove that it is of sedimentary origin.

These rocks occupy a strip some forty to fifty chains wide which runs parallel to the western boundary of the area. They have their greatest development on Colebrook Hill and in the creeks adjacent to it, and also outcrop in the railway cuttings west of Munro's Creek and along the banks of the Pieman River. They persist northwards under the Recent and Pleistocene deposits on the western side of the Pieman, and reappear on the Wilson River Track and on Pattersons Hill. The small area of this series included in the mapping forms a very minor portion of the whole. They have been traced westwards beyond the mapped area for a distance of one and a half miles, and extend far to the south and south-west.

No idea of the total thickness of the slates and breccias could be obtained, but, from their extensive areal distribution, it must be expressed in tens of thousands of feet. To the south of this area, they have been traced over a distance of some seven miles across their general direction of strike but the evidence of folding & their obscure structural features renders any estimate of the thickness somewhat hazardous.

To the south of this area there is abundant evidence of folding within the Dundas Series but there is little, if any, in this district. Only three strikes could be obtained and these ranged from N and S to N 10 degrees W, the dips are westerly at 65 degrees to 80 degrees.

The series as exposed at Rosebery appears to rest conformably on the Upper Quartzites, and, to the west of the mapped area, they are in faulted relationship with the limestones and fossiliferous slates and sandstones of Silurian Age which outcrop, on the Wilson River Track, near the Huskisson River.

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(25) Nye P.B. Silver Lead Deposits of the Waratah District p. 26.
(26) Unpublished report on the Geology of the Smithton District.

Following the Wilson River track beyond the western boundary of the mapped area, the writer traced the Dundas slates and breccias for a distance of approximately one and a quarter miles. At a distance of one and three quarter miles from the boundary, on a hill within fifteen chains of the Huskisson River, a fairly extensive outcrop of fossiliferous slates and sandstones was discovered. The fossils obtained have not yet been classified but the collection contains many forms identical with those found in the Silurian System. Among them are the following. Tentaculites, Rhynconella, Orthis, Trilobites, Discoidal impressions, Strophomena, Corals, Orthoceras and Camarotoechia.

These Silurian rocks occur as a downfaulted block in the Dundas Series. The exact nature of the relationship is best illustrated by reference to A.M. Reid's map of the Wilson River district (27). Reid shows the Dundas Series (Ordovician) extending westwards beyond a large serpentine dyke which occupies the fault along the western margin of the Silurian rocks. The eastern fault probably passes about a mile and a half to the west of the western boundary of the Rosebery area.

With regard to the age of the Dundas Series, a recent re-examination by R.A. Keble (28) of graptolites (previously examined by Dr. T.S. Hall (29) from the N. . Dundas Railway, indicates that the series be placed either at the summit of the Lower Ordovician, or at the base of the Upper Ordovician. The principal forms suggested by Keble are:-

Dichograptid.
Tetragraptus (?)
Leptograptus (?)
Syndyograptus (?)

The locality from which the fossils had been obtained, viz. on the N.E. Dundas Railway, 12.35 miles from Zeehan, was visited by the writer, and, although no fossils were found, an examination of the associated rocks proved helpful. The graptolites had evidently been obtained from a wide zone of thin bedded, black, pyritous slates, on either side of which are slates and breccias, similar to, but somewhat coarser in grain than, those described above. By following the railway line east, from the 12 Mile Peg to its terminus at Williamsford, an excellent section across the general strike of the Dundas Series was observed. At the 12 Mile Peg the series is represented by black slates which continue almost to the 13 Mile Peg, where greenish and grey slates are also present. East of the 13 Mile Peg are coarse breccias and slates which, approaching Williamsford, merge into fine grained slates and breccias identical to and continuous with those at Rosebery. The distance along the railway line is approximately six miles, but the direct line of the section would be only two and a half miles. The structural features as shown by this section are somewhat complex and no general direction of dip could be decided upon, but, if we assume that the eastern side of the Dundas series corresponds with its base, as is indicated at Rosebery, it will be apparent that the fossil horizon occurs towards the middle of the series and hence the slates and breccias at Rosebery are probably of Lower Ordovician Age.

Keble's examination of Hall's specimens confirms the latters view that the Dundas series were Ordovician in age, and, at the same time, allays the doubts expressed by Loftus Hills (30) as to the reliability of Hall's determinations.

(27) A.M. Reid Bulletin 31. Osmiridium in Tasmania, Plate IX
(28) R.A. Keble "Tasmanian Graptolite Record" Proc. Royal Soc. of Tasmania 1928.
(29) Hall T.S. Evidence of Graptolites in Tasmania, Proc. Royal Society of Tasmania, 1902,pp K17.
(30) Hills Loftus. The Progress of Geological Research in Tasmania since 1902. Proc. Royal Society of Tasmania, 1921, p. 119.

On general lithological grounds, the slates and breccias of the Dundas series have been correlated previously with the Heathcotian series of Victoria, which are of Upper Cambrian age (31 & 32). With the advent of the fresh evidence afforded by Keble this broad correlation can no longer be regarded as tenable.

(31). Hills Loftus. The Jukes Darwin Mining Field Bulletin 16 pp6162 1914.

(32). Nye P.B. The Silver-Lead Deposits of the Waratah District Bulletin 33, pp 29-30, 1923.

(d) Tertiary.

The Older River Gravels &c.

The deposits of unconsolidated conglomerates, gravels, sands and clays which form the dissected terraces of the Pieman River appear to be overlain by Pleistocene glacial deposits, and therefore, have been referred to the Tertiary. The conglomerates are composed of rounded waterworn boulders of West Coast Range conglomerate, porphyry, chert, quartzite, slate and Dundas breccia; many of these, particularly the harder pebbles, attain a diameter of two feet or more. The gravels are composed of pebbles similar to those forming the conglomerates. Small amounts of gold and occasionally, tin are found in these coarse beds. The sands and clays are loosely coherent and very often the latter contain fossil leaf impression identical with forms growing at the present day.

These deposits occur at elevations ranging from a probable minimum of two hundred and fifty feet, to a maximum of four hundred and fifty feet, the aggregate thickness being, therefore, two hundred feet. The observed maximum thickness in any single section along the river banks was, approximately, one hundred feet.

Various sections indicate that the deposition of these beds was accompanied by a constant changing of conditions. Thus, about twenty chains above the cage crossing, thick conglomerate beds are overlain by sands, while on the western bank of the River just below the cage, the basalt conglomerates and sands are overlain by a bed of conglomerate about forty feet thick. Other sections show alternating beds of conglomerates, gravels and sand.

Beds identical with those described above are exposed in many of the railway cuttings along the Emu Bay line between the 65 and 73 Mile Pegs. In all probability, many of these were formed contemporaneously with the older river gravels and, where possible, have been mapped with them. Likewise the gravels occurring near the Stitt River, on the track from the township to the Recreation Reserve, were probably formed in pre-glacial times. The former beds, i.e. those occurring along the railway line, occur at various elevations ranging from four hundred feet to six hundred feet. Similar gravels extend up the valley to the east of Natone Creek.

The formation of the older river gravels probably took place during the cycle of denudation which culminated in the formation of the Coastal Peneplain. The various exposurers in this and adjoining areas indicate that during that time large gravel deposits were being formed over considerable areas. The total former thickness of these beds, i.e.before the post-glacial uplift, is somewhat uncertain, for, although the vertical range of their occurrence is large, they appear to have been deposited on a rather irregular as well as a sloping surface.

(e) Pleistocene Glacial Deposits.

These consist of typical moranial deposits and boulder clays, with occasional thin bands of sand. In addition, innumerable large erratics of West Coast Range conglomerate are scattered over a very large portion of the district.

The largest of the moranial deposits skirts the western edge of the Williamsford Road, from the old Tasmanian Metals Extraction Company's workings southwards, and then extends up the valley of Natone Creek. Its occurrence indicates the existence of a former glacier which flowed over the western slopes of Mt. Read and then northwards down the Natone Valley. Near the old T.M.E. Company's plant, these deposits attain a thickness of, approximately, two hundred and fifty feet. They consist principally of large boulders of West Coast Range Conglomerate, but also contain a few boulders of porphyry. Many of the conglomerate boulders are as much as fifteen feet in diameter.

A fairly extensive deposit of unassorted glacial wash occurs along the eastern side of the Rosebery Mine workings, and extends for a short distance up the slopes of Mount Black. The maximum thickness of this deposit, as shown by shafts put down for the purpose of diamond drill boring, is about sixty feet. The maximum diameter of the boulders in this deposit rarely exceeds five feet and the average size varies from three to six inches. They consist principally of porphyry and West Coast Range conglomerates, but occasional boulders of granite and diabase are also present. Many of the smaller pebbles are facetted and striated. South of the No. 4 level adit, on the western side of the wash, is a well striated surface with a marked easterly dip; this probably represents the western edge of a former glacial valley. The occurrence of boulders of granite and diabase in this deposit is of considerable interest as it gives some idea of the extent of the glaciation and of the distance travelled by the glaciers. The nearest granite is on Granite Tor some ten miles east of Rosebery, and the nearest diabase in that direction occurs on Barn Bluff about ten miles still further to the east. With regard to the latter, it is possible of course that in pre-glacial times some of the country around Rosebery was covered by diabase, as this rock forms a capping on Mt. Dundas - a prominent mountain about ten miles to the south-west. That some of the material in this wash is of purely local derivation is shown by the occurrence of occasional boulders of zinc-lead sulphide ore.

In that portion of the Stitt River above the Dalmeny Lease, the floor of the valley is largely filled with erratics of West Coast Range conglomerate. In the writer's opinion, these boulders do not constitute evidence of the former existence of a glacier which occupied the valley of the Stitt as, on the whole, the lower portions of that river are particularly free from the typical moranial deposits. It seems probable that the pre-glacial land surface in that locality extended far above the present one, and that the ice flowed over the western side of Bald Hill Ridge. The conglomerate boulders have probably survived the weathering of the underlying rocks and have gravitated to their present positions. The boulder clays and sands occur principally in the Natone valley, but there are no really good exposures in this area. However, some excellent deposits of this type occur on the Williamsford Road near the low saddle which forms the divide between Natone Creek and Ring River. These consist principally of thin bedded, unconsolidated clays containing boulders of West Coast Range conglomerate, porphyry, chert, &c. In the Natone Valley and at Williamsford some of the clays overlie pre-glacial river gravels.

(f) Recent Deposits

The Younger River Gravels. These consist mainly of gravels and conglomerates forming in the beds of the present rivers and creeks. Generally, they are similar in composition to the gravels and conglomerates of the older series, and many of them are probably formed as a result of the resorting of the older glacial and alluvial deposits.

A fairly extensive bed of these gravels occurs along the banks of the Stitt River between the Dalmeny section and lease 10548. They consist of rounded pebbles of porphyry, quartzite and conglomerate, which vary in size from three inches to a foot. The average thickness of this bed is about four feet, but at the Delmeny shaft it is approximately ten feet thick.

A bed of gravels about three feet thick occurs in Saddle Creek. This, however, is composed almost entirely of pebbles of porphyry. Gravels are also forming along certain of the flatter portions of Mountain Creek and in other smaller creeks within the area.

Other deposits of gravels and conglomerates occurring in this and adjoining areas appear to overlie glacial boulder beds and are, therefore, of post-Pleistocene or Recent Age. Some of these contain beds of sand and clays, and are identical with the older deposits occurring along the banks of the Pieman River. Thus, with any single occurrence of these beds, it is often impossible to say whether they are of pre-glacial or post-glacial age, unless, of course, one can observe the actual nature of their relationships with beds of undoubted glacial origin.

(3) The Igneous Rocks
(Devonian)

The igneous rocks of the district are divisible into the following groups:-

(a) Quartz Porphyries & Felsites

(b) Felspar Porphyries

(i) Massive Felspar Porphyries

Orthoclase Porphyries
Albite Porphyries
Porphyrite

(ii) Sheared Felspar Porphyries, Chloritic Schists and quartz sericite schists.

(c) Gabbro and Serpentine

(a) Quartz Porphyries and Felsites. The rock most typical of this group is a pale greenish or whitish rock containing phenocrysts of quartz alone. In the field it may pass by insensible gradations into a quartz-felspar porphyry, or into a homogeneous felsitic rock in which there are no visible phenocrysts. Most of these rocks are sheared, the shearing being most pronounced in the quartz porphyries and felsites, and somewhat less noticeable in the quartz-felspar porphyries. In zones of intense shearing the former rocks are often traversed by a network of quartz veins. The typical quartz porphyry is a fine grained, dense, schistose rock of a pale greenish or whitish colour. In hand specimens, its most characteristic feature is the abundance of the quartz phenocrysts, which are particularly prominent on weathered surfaces. Under the microscope, the phenocrysts are sometimes seen to be idiomorphic crystals, but more often they are rounded and corroded, and contain inclusions of the ground mass or, in rare instances, inclusions of glass. In the highly schistose types the phenocrysts show strain shadows.

The ground mass may be cryptocrystalline or microcrystalline, generally the former. When microcystalline it appears to consist mainly of quartz. In the highly schistose rocks it consists of a fine grained aggregate of quartz and sericite which curves around the phenocrysts; sometimes there is a considerable development of secondary quartz. In some sections the ground mass contains thin streaks of chlorite and epidote.

Most of the felsites associated with the quartz porphyries are hard, dense, flint like rocks which vary in colour from greyish green to pale green to white. Microscopic examination of these rocks occassonally reveals the presence of one or more small quartz phenocrysts.

In hand specimens, the quartz-felspar porphyries do not differ greatly from the quartz porphyry described above, and, in the field, it is possible to pass from one rock to the other without being aware of the change. The main distinction between the two rocks is the presence, in the quartz-felspar porphyry, of visible phenocrysts of felspar in addition to those of quartz. Furthermore, the quartz-felspar porphyries are sometimes a slightly deeper green in colour, due to increased development of chlorite, and, generally, are more massive.

Microscopically, the quartz-felspar porphyries show phenocrysts of quartz, orthoclase and albite set in a microcrystalline groundmass. The quartz phenocrysts are similar to those already described and are more abundant than those of felspar. Orthoclase and albite occur as idiomorphic or hypiciomorphic crystals; generally, orthoclase is the more abundant, but the two minerals are often closely associated and may occur as continguous crystals. Some of the phenocrysts are possibly anorthoclase. Chlorite is a fairly common constituent, but is never very abundant. A little calcite appears in some sections, generally as a replacement after felspar. Magnetite is present as an accessory constituent.

A variant of the normal rock types of this group is a granite porphyry which outcrops in the Stitt River, close to the N.W. corner of lease 10087. In the field, this rock appears to grade into the quartz-felspar porphyries which form extensive outcrops higher up the river. In hand specimen, it is a fine to medium grained, greyish white rock of holocrystalline appearance. Under the microscope it is seen to consist mainly of crystals of quartz, orthoclase and albite. There is a subordinate amount of ground mass, composed chiefly of quartz and felspar, with a good deal of muscovite. The quartz crystals are large and irregular, and are frequently broken; those of orthoclase and albite are irregular, and only show partial crystal outlines; much of the albite has been replaced by calcite. Large flakes of muscovite are fairly common, and there are also occasional large, irregular areas of calcite. Apatite occurs as small needle like crystals in the felspars. Magnetite and pyrite are also present in small quantity.

The chemical composition of the typical quartz porphyries is illustrated by the following analyses.

Table 2
Analyses of Quartz Porphyry.

	R.176 Regd.No.1650/30.	R1. Redg. No. 1646/30.
SiO_2	81.12	73.76
Fe_2O_3	0.29	4.08
FeO	0.77	0.97
TiO_2	0.072	0.05
Al_2O_3	13.27	14.80
CaO	Tr.	0.10
MgO	0.36	0.58
P_2O_5	0.042	0.01
S	0.006	Tr.
Na_2O	0.83	0.33
K_2O	3.15	4.83
CO_2 & Loss	1.80	2.30
	101.710	101.81

R.176 Quartz Porphyry, Williamsford Road near the south boundary of the area.
R.1 Quartz Porphyry, Quarry near Staff Tennis Court.

Compared with the unaltered orthoclase porphyries, these rocks are much higher in silica and are lower in soda, lime, magnesia, and alumina. The quartz-felspar porphyries associated with the quartz porphyries and felsites have not been analysed, but they would probably contain less silica and more soda than is shown in the above analyses.

The main belt of quartz porphyries and felsites forms a narrow band which passes through the area from south to north, and separates the Cambro-Ordovician sediments from the massive and sheared felspar porphyries. The felsites are best developed on the western slopes of Bald Hill, near the south boundary of the area, and, in that locality, there are also certain areas of highly weathered siliceous rocks of doubtful origin which have been mapped with the felsites. Further outcrops of felsite occur on the Williamsford Road near the old Salisbury Mine. The principle outcrops of quartz porphyry occur on the low ridge immediately west of, and parallel to, Barker Street, and the fresh rock has been exposed in a small quarry near the tennis court. To the north, the deep railway cuttings north of the Stitt River bridge afford excellent exposures of quartz porphyries and quartz-felspar porphyries. Quartz porphyries also outcrop on Reservoir Hill, and are exposed in the deep railway cutting immediately west of the ore bins, on the branch line from Primrose Siding. The most northerly outcrop of this group occurs in Bobadil Creek.

Another belt of quartz porphyry appears to occur as a narrow dyke intrusive along the contact of the Lower Slates and Quartzites with the breccia-conglomerate. In places, this dyke contains abundant quartz phenocrysts, but, in others, it is highly felsitic and phenocrysts may be rare or absent.

In addition to the occurrences cited above, two small dykes of quartz-felspar porphyry are exposed in cuttings on the branch line from Primrose Siding. These differ from the quartz-felspar porphyries described above in as much as the proportion of phenocrysts to base is considerably greater, and, in some respects they resemble the granite porphyry. Both dykes are intrusive into purple and black slates which possibly represent an eastern extension of the slates exposed at Primrose Siding.

In certain localities, the quartz porphyries enclose isolated bands of slate. A good section across one of these bands is afforded by the deep railway cuttings to the west of the ore bins. The slate band appears to have been intruded by the porphyry in a roughly lit-par-lit fashion, and both rocks are so intensely sheared and contorted that at first sight their true relationships are masked, and they appear to to be alternating bands of sheared sediments. Despite the intense shearing and contortion, the quartz porphyry still retains its characteristic colour and appearance and the quartz phenocrysts still persist. A thin section of the porphyry showed that the phenocrysts were similar to those described above, and they alone are positive evidence of the character and identity of the rock. Moreover the slates are often baked and toughened along the contacts and have sometimes retained their marginal toughening throughout the shearing. Again, short dyke like tongues of porphyry may be seen intruding the slates Figure 1.

Intrusive Nature of the Quartz Porphyries & Felsites:-

From the regular nature of the western tongue of quartz porphyry, it was at first thought that the quartz porphyries and felsites may have been lava flows interbedded with the sedimentary rocks of the Rosebery Series. However, the fact that the main belt of quartz porphyries cuts acutely across the lower members of the Rosebery Series indicates that they are intrusive, and hence the western tongue of quartz porphyry has been interpreted as a dyke intrusive along the contact of the Lower Quartzites and the Breccia-Conglomerate. Further support of the intrusive nature of the quartz porphyries &c. is afforded by the probable embayment of purple slates into the quartz porphyries which occurs to the east of Primrose Siding. The two dykes exposed in cuttings along the branch line may be off shoots from the main mass of quartz porphyry, though, on the other hand, these may be quite independent dykes.

(b) Felspar Porphyries

A broad belt of intrusive felspar porphyries occupies the eastern half of the mapped area, and extends north, south and east of it. The parent magma of these rocks has been widely differentiated, and the fresh unaltered rocks present a multiplicity of types. In addition, certain areas have undergone a considerable degree of metamorphism which has obliterated all trace of their original structure. The nett result of the primary differentiation and the superimposed metamorphism is that in the field aspects of the rocks differ in various portions of the same mass, and it is difficult to realise that one is looking at rocks of the same primary origin. In the mapping, these rocks have been subdivided into two main groups, one group comprising the massive types and the other the schistose. It will be realised that in such a subdivision there will be a good deal of overlapping, but, as the schistose types are of considerable economic importance, it is necessary to indicate their areal distribution and lithological characteristics. Among the massive rocks, the variation is so great that it is impossible to map the various types separately, but their general characteristics are indicated below, and the distribution of the principal types is shown on the accompanying geological map.

(i). Massive Types.

Orthoclase Porphyries. These constitute the major portion of the felspar porphyries. Generally they are fine to medium grained, massive, jointed, porphyritic rocks varying in colour from dark green to greenish-white to white; some types are pink, while others are quite black and have the appearance of a chert.

The phenocrysts may be of quartz and felspar or of felspar alone, and there is considerable variation in the proportion of the phenocrysts to base. In a small quarry on the Williamsford Road, near the turn off along Dunkley's Tram, the felspar phenocrysts are aggregated into nests, and are set so close together in the rock as to give it a coarse granitic appearance. In other types, phenocrysts of both quartz and felspar are abundant, and the rock resembles a granitic porphyry. On the other hand the phenocrysts may be so sparsely scattered through the rock that is resembles a felsite. Despite these variations, the majority of the orthoclase porphyries are of the usual fairly common types with respect to the proportion of phenocrysts to base.

Another variable constituent is chlorite. In the more common types there is usually sufficient to impart a green colour to the rocks, but in certain greenish white felsitic facies, and in other types containing abundant quartz phenocrysts, it is comparatively rare, or, it may be completely absent. In the pink types, chlorite occurs in irregular streaks and gives the rock a dappled appearance. Certain more basic facies of the orthoclase porphyries contain considerable amounts of chlorite.

In some localities these rocks are traversed by narrow veins of quartz and tourmaline.

Microscopic Characters. Under the microscope, these rocks are seen to consist of phenocrysts of orthoclase, albite and quartz, set in a fine grained ground mass. In the majority of the sections examined, orthoclase phenocrysts predominated; these are sometimes idiomorphic, but are often irregular and only show partial crystal outlines. The albite phenocrysts may be idiomorphic or hypidiomorphic; generally they are smaller than those of orthoclase. Both minerals are invariably present. The quartz phenocrysts may be idiomorphic, but are more often rounded and corroded, and contain inclusions of the ground mass or of glass. Generally, quartz is subordinate to both orthoclase and albite, and is very often absent, but, in a few sections, the quartz phenocrysts appeared to predominate over those of felspar; in the latter case, the rock could be called a quartz-orthoclase porphyry. Chlorite is distributed through the rocks as irregular flakes and grains or as large irregular patches, and is often present as an inclusion in felspar. Sometimes the felspar phenocrysts are made up of a central area of chlorite around which the crystal has grown, or, the chlorite may form a border around the felspar. Muscovite is present in some sections but is not a common constituent. Epidote may occur as an alteration product of felspar and in some sections forms lenticular aggregates, the individual fibres being arranged in sheaf like bundles. Calcite occurs in some rocks as large irregular patches or as a replacement after albite. Apatite is present as an inclusion in orthoclase or albite. Magnetite, ilmenite, pyrite and zircon occur as accessory constituents; the ilmenite is sometimes altered to leucoxene.

The ground mass may be microcystalline or cryptocrystalline, in the former case it consists mainly of quartz and felspar with felspar subordinate to quartz. Some sections show micrographitic aggregates of quartz, orthoclase, albite and chlorite, with a little ilmenite and magnetite. There is no sign of flow structure.

<u>Albite Porphyries</u>:- In hand specimen, the albite porphyries do not differ greatly from certain types of the orthoclase porphyries. They have been recognised definitely only in one locality, viz. to the north of the Rosebery No. 1A Adit, on either side of northern extension of the slate belt. They are massive, whitish rocks containing phenocrysts of felspar alone, and appear to contain very little chlorite.

In their microscopic characters, these rocks are generally similar to the orthoclase porphyries. The phenocrysts are of albite and orthoclase but albite is the more abundant of the two. No chlorite was observed in the sections examined. The ground mass is generally microcystalline, and consists mainly of quartz and felspar; it sometimes contains a suggestion of flow structure but this may be due to incipient shearing, as in some cases sericite is developed.

<u>Porphyrites</u>. Certain relatively more basic facies of the felspar porphyries are dense slightly sheared chloritic rocks containing scattered phenocrysts of felspar alone. These may be described as porphyrites.

Under the microscope, the phenocrysts are seen to consist of both orthoclase and plagioclase. The orthoclase phenocrysts are large and are more or less broken. The plagioclase phenocrysts are probably more basic than albite, and may be oligoclase or andesine; they are quite as abundant as those of orthoclase, and, like orthoclase, are more or less broken; some are altered to aggregates of epidote and zoisite. The ground mass consits almost entirely of chlorite, though felspar is present in some sections. A little calcite may be present, and large grains of magnetite and ilmenite are fairly common.

The porphyrites occur as irregular patches in areas of quite massive orthoclase porphyry, and doubtless represent segregations formed during the cooling of the porphyry magma. They have been observed only in three localities, viz. along the Stirling Valley Road near Saddle Creek, in the south eastern corner of the area, and along the new track to Tullah.

The chemical composition of the felspar porphyries is illustrated by the following analyses. For purposes of comparison the analysis quoted by Twelvetrees and Petterd (33) has been inserted.

Table 3

Analyses of Felspar Porphyries.

Constituents / Specimen No. / Reg. No.	R11 1647/30	R177 1651/30	R97 1648/30	R265 472/31	R180 2592/31	T & P.
SiO_2	70.00	70.00	69.20	73.89	62.29	75.73
Fe_2O_3	1.86	0.93	0.43	1.28	2.29	)2.25
FeO	2.45	2.77	3.09	1.15	3.02	(
TiO_2	0.22	0.25	0.27	0.22	0.65	-
Al_2O_3	17.81	17.35	15.67	15.02	14.75	12.70
MnO	-	-	0.37	-	0.07	-
CaO	0.15	1.48	1.50	0.40	4.77	2.00
MgO	1.45	0.65	0.79	1.45	1.99	0.60
P_2O_5	0.025	0.075	0.053	-	0.11	-
K_2O	2.92	4.15	4.47	1.43	2.90	2.04
Na_2O	1.65	2.58	2.22	4.06	1.75	3.48
S	Trace	0.068	Trace	-	0.15	-
Ignition Loss	2.50	1.50	3.60	1.44	5.55	1.20
	101.035	101.803	101.663	100.25	100.29	100.00

R11 Orthoclase Porphyry (with abundant quartz phenocrysts). Quarry a few chains east of Primrose No. 2 Tunnel.
R177 Orthoclase Porphyry. Quarry corner of Primrose and Dalmeny Streets.
R97 Orthoclase Porphyry. Ridge near N.W. corner of Dalmeny Lease.
R265 Albite Porphyry. West side of slates 2½ chains north of No. 1A adit, Rosebery Mine.
R180 Porphyrite. Bridge over Saddle Creek, Stirling Valley Road. Quartz Keratophyre. North Hercules Section Mt. Read.

These analyses confirm the microscopic examination of the rocks. The dominance of potash over soda in the orthoclase porphyries corresponds with the dominance of the orthoclase in the rock sections. In specimen R11, the lower alkalies imply an increase in the amount of free silica, and hence an increase in the proportion of quartz phenocrysts. The lower percentages of magnesia and iron in the orthoclase and albite porphyries correspond with the smaller amounts of chlorite present in these rocks when compared with the porphyrite. The dominance of albite phenocrysts in the albite porphyries is confirmed by the high soda in specimen R 265. The porphyrite is somewhat lower in silica, alumina and alkalies, and higher in lime, magnesia and iron than the more acid members of the massive porphyries.

The main points of difference in chemical composition between the quartz porphyries and the felspar porphyries have already been indicated.

The analysis of quartz keratophyre, quoted by Twelvetrees and Petterd, corresponds generally with that of the albite porphyry from this area.

It may be noted that, in four out of five of the above analyses, there is a marked dominance of potash over soda. This implies that theporphyries of this area are characterised by dominant potash, and support is given to this view by the examination of numerous rocks sections. In this respect they differ from other porphyritic rocks of the same belt occurring in the Mt. Read and Mt. Farrel districts, which are characterised by dominant soda.

Closely associated with the massive felspar porphyries described above are sheared porphyries, chloritic schists and quartz-sericite schists which are alteration products of the massive porphyries formed as a result of the shearing preceding ore deposition and the hydrothermal action which accompanied it.

These rocks occur as two main belts, the largest of which is situated in the vicinity of the Rosebery township. This belt is roughly thirty chains wide; its eastern edge co-incides generally with the footwall of the zinc lead ore body of the Rosebery Mine, and its western edge passes about half a chain to the west of the ore bins and thence southward through the Recreation Reserve; it dies out about forty chains south of the township where several tongues of sheared porphyry dovetail into the massive felspar porphyries, and, to the north, it extends only a few chains north of the No. 1 adit on the Rosebery Mine.

Sheared porphyries, chloritic schists and quartz-sericite schists are also exposed in the Koonya Mine workings, and these are probably continuous with similar rocks outcropping on the Rosebery Lodes Lease; these occurrences constitute the second main belt. Another small area of sheared porphyries occurs on the Dalmeny Lease, and minor developments of schistose rocks occur at various places throughout the massive felspar porphyries.

The lithological character of these rocks varies considerably from place to place. In some less altered types, the original felspar phenocrysts still remain and the rocks are readily recognised; in the weathered types, the felspars are represented by kaolintic areas which still retain the form of the original crystal, and even when the kaolin is removed the casts of the phenocrysts still remain. The more schistose forms of these rocks are composed principally of quartz, sericite, and chlorite,

(33) Twelvetrees & Petterd. On the Felsites & Associated Rocks of Mount Read & Vicinity. Proc. Royal Society of Tasmania 1898, p.46.

(11) Sheared Felspar Porphyries, Chloritic Schists and Quartz-Sericite Schists

and may be described as quartz-sericite schists or chloritic schists according to the dominance of sericite or chlorite. The relative proportions of the three constituents vary considerably; some of the coarser grained schists are highly quartzose and contain only small amounts of sericite and no chlorite, while others may be composed principally of sericite or chlorite. The most highly altered forms occur in close proximity to lode formations.

In addition to the rocks described above, two others types somewhat less common are worthy of mention. One of these is a very soft, dark, chloritic schist of a dark green or greenish black colour which has been found only near the walls of lode formations; it has been observed near the lode at the end of the No. 6 and No. 8 level adits on the Rosebery Mine and on the wall of the pyritic copper lode of the Grand Centre Adit. The other is a mottled chloritic schist, occurring at the mouth of the Grand Centre Adit, whose general appearance suggests that it has been derived from a basic porphyrite.

In the field, every gradation may be observed from massive felspar porphyries to sheared porphyries and to highly altered schists; occasionally, the latter contain lenses of unaltered porphyry. In the mine workings, the gradation between the various types is no less striking, though, in this case, occurrênces of massive types of porphyry are rare, and even the least altered rocks are highly sheared and sericitised and are recognised only by the presence of residual felspar phenocrysts. In the Rosebery Mine, for a distance of forty to two hundred feet west of the ore body, the quartz-sericite schists are highly impregnated with pyrite and some of the rocks are carbonated. In many places, the pyritic impregnation is so intense that the schists may be regarded as pyritic lode formations.

Mention has already been made of the weathering of some of the less altered types of these rocks. Many of the schists exposed at the surface are coarse, white, quartzose rocks from which practically everything but quartz has been removed; others are highly sericitic. In neither case do the weathered forms convey any idea of the original character of the rock.

The strike of the schistosity is generally meridional and the dip varies from 45° to 70° east; in some cases the schists are more or less vertical. The strike of the schistose rocks on the footwall of the lode at Rosebery Mine co-incides with that of the slate belt, i.e. it is approximately N. 10° W (N 20° W magnetic), and the dip varies from 40° to 60° east.

<u>Microscopic Characters</u> The less altered forms of these rocks are composed of scattered phenocrysts of felspar and, occasionally, quartz, with irregular areas of chlorite and calcite, set in a fine grained schistose ground mass of quartz and sericite. The felspars occur both as large and small crystals; some are idiomorphic but more often they are broken and irregular and often are partly altered. Orthoclase is the most common, and, in ordinary light, often appears as water clear areas in the section; under crossed nicols, it exhibits simple twinning and sometimes has a peculiar wavy extinction which bears a slight resemblance to the strain shadows of crushed quartz. Albite is also fairly common, but is less abundant than orthoclase and occurs as smaller crystals. Quartz phenocrysts are rare and are usually crushed and broken. In most cases, the felspars are partly altered to sericite, and occasionally

to zoisite and epidote. Chlorite occurs in flakes arranged parallel to the schistosity, also as grains and irregular areas and as inclusions in or borders around the felspars. Magnetite appears in some sections as small irregular grains, and pyrite is generally present. The latter is not an original constituent but has been introduced during ore deposition; it often forms well developed crystals and is frequently surrounded by a border of chlorite. The carbonates occur as large irregular patches or as a replacement after felspar or chlorite but are rarely very abundant. The groundmass is frequently traversed by minute veins of quartz, and, occasionally, by carbonate veins.

Under the microscope, the development of quartz-sericite schists from the sheared porphyries can be followed in all stages, the main process involved being the breaking down of the felspar phenocrysts. Thus, in some sections, the felspars are only partly altered, while in others they are almost completely altered to aggregates of sericite and contain only minute particles of the original crystal. The ultimate product is a rock composed almost entirely of quartz and sericite containing eyes of sericite which still retain the form of the original felspar phenocryst. Most of the highly altered rocks contain cubes of pyrite and a little chlorite.

Generally, the immediate walls of the lodes are composed of an aggregate of quartz and sericite, or of quartz, sericite and chlorite, and contain abundant cubes of pyrite. In these rocks even the residual eyes have disappeared and no trace is left of the original structure of the rock.

The chloritic schists are in many cases variants of the quartz-sericite schists, characterised by increased development of chlorite. The chlorite occurs as large streaks and flakes and often enters largely into the composition of the ground mass. In thin sections, large chlorite flakes are frequently associated with aggregates of pyrite crystals, and, probably, some of the pyrite is developed at the expense of the chlorite. Many of these rocks have doubtless been derived from massive types of porphyry containing abundant chlorite, or from porphyrites; in these cases the chlorite is largely residual. In some sections, however, chlorite appears to have developed at the expense of the felspar, and in others it occurs as minute veins in the rock; this suggests that the development of a second generation of chlorite may have constituted a minor phase in the alteration of the felspar porphyries. This is also suggested by the occasional occurrence of large areas of chloritic schists near the walls of the lodes, e.g. in the ore pass drive on the Rosebery Mine.

The mottled chloritic schists occurring at the Grand Centre Adit are seen to consist of large flakes of chlorite set in a fine grained schitose ground mass composed of chlorite, quartz and felspar, with a little ilmenite magnetite and pyrite. The large chlorite flakes have no definite form and are often associated with sericite or areas of secondary quartz. In hand specimens, they suggest original hornblende phenocrysts, but their microscopic characters hardly support this and they may have been formed by alteration of felspars.

The soft chloritic schists occurring near the walls of the lodes are composed almost entirely of pale green, pleochroic chlorite and carbonates. They contain a good deal of pyrite and are cut by veins of a fibrous, colourless, chloritic mineral. In addition to carbonates and chlorite, they usually contain a little quartz.

Chemical Composition.

The chemical composition of these rocks is illustrated by the following analyses.

Table 4
Analyses of Altered Felspar Porphyries and Schists.

Constituents Spec. No. / Regd. No.	R281 799/31	R243 2622/31	R195 1934/30	R217 1075/31	R228A. 1074/31
SiO_2	67.64	69.20	72.00	58.72	60.84
Fe_2O_3	0.66	0.28	0.73	-	-
FeO	2.72	2.03	1.03	2.23	3.72
Fe	1.39	Nil	0.27	1.31	0.77
S	1.60	Nil	0.31	1.51	0.89
SO_3	0.27	Nil	Nil	0.20	0.17
Al_2O	13.72	17.82	16.29	22.42	19.68
TiO_2	0.50	0.28	0.23	0.64	0.24
MnO	0.06	Trace	Nil	0.12	1.20
CaO	Nil	Nil	Nil	Nil	Nil
MgO	3.90	1.36	1.23	3.26	4.50
Na_2O	2.33	0.49	0.29	1.50	0.37
K_2O	2.10	6.62	7.60	3.03	4.37
P_2O_5	0.07	0.06	0.023	0.21	0.03
BaO	0.08	Nil	Nil	0.69	0.33
Cr_2O_3	Nil	Nil	Nil	Trace	Nil
CO_2 & Ignition Loss	2.84	2.35	1.50	4.31	3.48
	99.88	100.49	101.503	100.15	100.59

R281 Sheared Albite porphyry. 1½ chains east of Primrose No. 2 Tunnel Rosebery Mine.

R243 Sheared and sericitised orthoclase porphyry. Main Adit No. 8 level. Rosebery Mine 1020' from mine datum point.

R195 Sheared and sericitised orthoclase porphyry Main Adit No. 8 level Rosebery Mine 1100' from mine datum point.

R217 Quartz Sericite Schist. End of E X Cut at south end of No. 7 Level Rosebery Mine.

R228A Chloritic Schist. Ore pass drive No. 8 level Rosebery Mine 300' north of mine datum point.

These analyses are placed generally in order of the relative degree of alteration of the rocks and indicate the nature of the chemical changes effected. In the sheared albite porphyry, (R281) there has been a leaching of soda, complete leaching of the lime and an increase in potash (34).

The high magnesia combined with the somewhat lower silica percentage suggest that the original rock may have been a relatively more basic type of felspar porphyry. On the other hand the low silica may be due to leaching. Under the microscope, this rock shows a slight sericitisation of the felspars and a development of sericite in the ground mass. The relatively high magnesia content is rather difficult to understand in view of the absence of chlorite in the section; the low percentage of CO_2 indicated by the analysis shows that it cannot be present as carbonate.

Compared with the unaltered orthoclase porphyries, specimens R243 and R195 show a marked increase in potash, a partial leaching of soda and complete leaching of the lime. The percentage of silica and alumina are essentially similar to those of the unaltered rocks and hence it is apparent that the prinsipal change has been the alteration of felspar. Both rocks contain large phenocrysts of sericitised orthoclase, in addition to others which are remarkably fresh. The ground mass consists of a highly schistose aggregate of quartz and sericite. That the development of sericite is not due to shearing alone is shown by the analyses which clearly indicate an introduction of secondary potash. In some cases, fresh appearance of the orthoclase suggests that it may be of secondary origin, due to recrystallisation of the original phenocrysts.

R.217 is a completely altered rock composed almost entirely of sericite, with subordinate quartz, a little carbonate, a few small fragments of what may be felspar, and a little pyrite. R 228A is a rock somewhat similar to R217 in its microscopic characters but contains a good deal of chlorite; no trace of felspar was observed in the section. Both rocks are fairly close to the lode. In these, there has been a considerable leaching of silica, and, as in the other rocks, complete leaching of the calcium. To the leaching action may be attributed the high percentages of alumina shown in the analyses. The somewhat higher magnesia may be due partly to relative increase, as is the case with the alumina, and partly also to a secondary introduction as carbonate. The alkalis are rather more difficult to interpret. The soda has been partly leached in R217, and almost wholly leached in R228A. If in their less altered state, these rocks had been similar in composition to the sheared and sericitised orthoclase porphyries, then there has also been a leaching of potash. It is of course possible that the potash content may have remained comparatively stable but this is rather unlikely.

In all but one of these rocks, there has been an introduction of sulphur which has combined with some of the iron to form pyrite.

General processed involved in the alteration of the felspar porphyries:- Two periods of metamorphism have been instrumental in effecting the alteration of the massive porphyries. These were:-

(1) A low grade dynamic metamorphism.
(2) Vein alteration more or less contemporaneous with the formation of the lodes.

The forces acting during the first period were purely dynamic. The ground mass was converted to a schistose aggregate of quartz and sericite, and the phenocrysts were crushed and broken.

(34) Compare with R 265 Table 3 page -

Sericite, zoisite and epidote were also developed at the expense of orthoclase and albite.

The period of vein alteration was one of intense chemical activity; the changes effected varied in intensity from place to place, and were greatest in proximity to lode formations. The introduction of potash and the leaching of soda led to the conversion of albite into sericite, and extensive sericitisation of orthoclase also took place. Furthermore any lime present in the original rocks appears to have been removed. Another change has been the formation of pyrite resulting from the introduction of sulphur. Further chemical changes superimposed on the above appear to have been the leaching of silica and alkalis and the introduction of new material as carbonate.

In some cases, silica appears to have been concentrated during the processes of alteration and the resultant product is a quartz-sericite schist in which sericite is subordinate to quartz. Compared with that of other forms the development of these rocks has not been extensive.

Summary of Evidence Regarding Origin of the Schistose Rocks

From the time of Montgomery's report in 1890 up to that of Waller in 1902, the consensus of opinion appeared to be that the schists were largely of sedimentary origin. Both Waller (35) and Twelvetrees and Petterd (36) have noted the presence of bands of porphyry (which they described as felsite or keratophyre) within the schists, and have stressed the difficulty in distinguishing between the sheared porphyries and schistose rocks which they regarded as being of sedimentary origin. In regarding the schists as sediments, the earlier observers were doubtless handicapped by the lack of opportunity for systematic field work and detailed microscopic study of the rocks, and were probably misled by the occurrence of the isolated areas of sedimentary rocks within the massive and sheared porphyries (37).

In Bulletin 23, Hills (38) describes all the schistose rocks of the Rosebery District as being derived from sediments, and groups them with similar rocks occurring in the Mt. Read District. These are referred to as the Read-Rosebery Schists, and, in his bulletins (39), are described as a series of folded schistose sedimentary rocks extending continuously from Mt. Read to Rosebery.

While commencing the extension of the Rosebery mapping into the Mt. Read District, the writer had the opportunity of examining the occurrences of the schistose rocks in some detail. It is conceded that in the Mt. Read District there is a large area of sheared sediments, but its occurrence is similar to that of the sedimentary blocks at Rosebery, i.e. it is a sedimentary block entirely surrounded by massive and sheared porphyries. Furthermore, between Rosebery and Mt. Read, there is in all probability no continuous belt of schists, the various occurrences rather suggesting a number of lenses of highly sheared porphyry strung out "en echelon". Repeates search throughout the schistose rocks of both districts has, with the exception of the isolated areas of sediments already referred to, failed to produce any evidence that the rocks are of sedimentary origin. On the other hand, the more closely these schistose rocks are investigated, the greater becomes the weight of evidence in favour of their derivation from the massive porphyries.

(35) Waller, G.A. "Report on the Ore Deposits (other than those of Tin) of North Dundas".
(36) Twelvetrees, W.H. and Petterd, W.F. "On the Felsites and Associated Rocks of Mt. Read and the Vicinity". Proc. Royal Society Tas. 1899.
(37) See page -
(38) Hills, Loftus "The Zinc-Lead Sulphide Deposits of the Read-Rosebery District". Bulletin 23, 1915.
(39) Do above Bulletins 19 and 23.

In the Rosebery District, a section 1400 feet long, across the strike of the first belt of schistose rocks is afforded by the No. 8 level adit on the Rosebery Mine. Starting from the datum peg in the centre of the main drive, the writer obtained representative specimens along the adit at each important change of country. Of the nine specimens collected, eight contained either comparatively fresh felspar phenocrysts or the remains of altered felspar phenocrysts. These specimens were obtained atthe following distances from the datum peg 295',362',310',560,940', 1020' and 1100'. The specimen numbers are R195, R238-9,R244,R246. The greatest difficulty was experienced with the rocks close to the lode; most of these are completely altered quartz-sericite or chloritic schists and, except for occasional dull opaque areas which resemble original felspars, give no clue to their original character.

Specimens collected from other portions of the Rosebery Mine workings in the footwall country also show residual felspar phenocrysts, e.g. from the No. 1 level and No. 6 level adits. At the portal of the No. 6 level adit, the sheared porphyries are comparatively fresh, i.e. they have not been subjected to vein alteration, and the felspar phenocrysts are quite apparent to the unaided eye.

In addition to that obtained from the mine workings, further evidence of the origin of the schistose rocks was afforded by specimens collected from the following localities, viz. - Rosebery Creek near the Co-Operative Store, the Recreation Reserve, the Stitt River below the Williamsford Road and from Assay Creek near the water race crossing. All the specimens proved to be highly sheared and sericitised porphyries containing the remains of felspar phenocrysts.

The evidence afforded by the second belt of schistose rocks is no less definite. Microscopic examination of schists from the Dalmeny, Rosebery Lodes Mining Coy. and Koonya Leases showed that the rocks were mainly highly sheared and altered porphyries. Hills (40) quotes the occurrence of an anticlinal crest in the schists at the end of No. 1 level drive, on the Koonya Mine, but close examination of the rock exposed in the face of the X-cut, 50' west of the lode, showed that it was a slightly sheared porphyry in which large felspar phenocrysts could be seen with the naked eye. This occurrence is scarcely one hundred feet from the weathered rocks occurring in face of north drive; the latter are weathered porphyries.

It must not be inferred from the above that microscopic examination of any specimen of the schists will reveal the presence of residual felspar. As has been described, many of these rocks are completely altered and give no clue as to their original structure. Nevertheless, the convincing fact remains that wherever the schistose rocks are sufficiently unaltered they do show the remains of felspar phenocrysts. Furthermore, the most highly altered of the schists grade into sheared and sericitised porphyries, and these, in turn, grade into massive felspar porphyries. Perhaps the most significant fact concerning these rocks is that they are best developed near lode formations and have their greatest development where the lodes are strongest. Thus, in the southern portion of the Rosebery Mine where the lode is strong, the sheared porphyries &c. are widely developed in the footwall country, but, at the extreme northern end of the mine where the lode is comparatively small and appears to be dying out, the rocks in the footwall country are fresh felspar porphyries.

Before concluding this discussion, it may be advisable to point out that the northerly extension of the so called Read-Rosebery schists consists of massive and slightly sheared quartz and felspar porphyries. These are well exposed in the railway cuttings between the 66 mile peg and the Pieman River Bridge.

(40) Hills, Loftus Do above (38) pp 25 and 67.

Occurrence and origin of Similar schistose rocks in other areas.

As will be described in a later section, the porphyritic rocks of this area form portion of an almost continuous belt which extends from Low Rocky Point to the Que River, and it is of considerable interest to note that, in other mining fields occurring along this belt, sheared porphyries and schistose rocks similar to those described above are also associated with massive porphyries. It is therefore interesting to compare the Rosebery schists with those of the other districts and to note the conclusions arrived at by the several investigators.

In describing the schists of Mt. Lyell Gregory (41) has divided them as follows:-

"(1) Schists which are completely altered and show no trace of their original constituents. The rocks of this group are sometimes nodular and at other times are regular well bedded schists.

(2) Schists which show traces of their original structure.

(3) Schists associated with the igneous rocks of the Queen River, which can be definitely recognised as of igneous origin, and formed by the alteration of quartz-porphyrites and probably also of acid volcanic tuffs".

In a later section of his book Gregory (42) makes the following statement:-

"Microscopic evidence, however, renders it probable that the supposed plutonic rocks (the Queen River Porphyries) are part of the same primitive series as the Mt. Lyell schists and that they are pre-Silurian in age".

The writer is not in agreement with the view that the schists and prophyries are of pre-Silurian Age (see pages), but this does not concern us at present, and it is sufficient to note that Gregory regarded the schists as alteration products of the Queen River porphyries.

In his descriptions of the felsitic and porphyritic rocks of the Mt. Farrell district Ward (43) states:-

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

Ward also states (p.14).

"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".

Again, in the Jukes-Darwin district, Hills (44) describes the schists as being derived from igneous rocks, though he concludes that they are representatives of sheared fragmental types and tuffs. However, his descriptions of the schists and of their field occurrence, rather suggests that they are derived from massive porphyries. On page 37 he states:-

"These fragmental types and schists are continuous by insensible gradations with the felsites, quartz, porphyries, &c."

The general nature of the above occurrences is similar to those at Rosebery, and it is important to note that, at Mt. Lyell and in the Jukes-Darwin field, the distribution of the ore bodies co-incides generally with that of the schists. It therefore seems probable that the processes which have been responsible for the formation of the schists in these districts were analogous to those at Rosebery, i.e. there was first a period of dynamic metamorphism which was followed by intensive vein alteration, the latter period co-inciding with the formation of the ore bodies.

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(41) J.W. Gregory, D. Sc. F.R.S. The Mt. Lyell Mining Field. Transactions Aust. Inst. of Mining Engineering pp. 39-50.

(42) Do above p.53

(43) Ward, L.K. "The Mt. Farrell Mining Field" Bulletin 3 pp. 11-16.

(c) Gabbro and Serpentine.

Gabbro. A small outcrop of basic gabbro occurs on the banks of the Pieman River, about fifty chains below the mouth of Natone Creek.

Under the microscope, this rock is hollocrystalline and hypidiomorphic, with granitic texture. It consists principally of augite, chlorite, felspar, ilmenite and leucoxene. A little olivine and what appears to be an orthorhombic pyroxene occur in the section. The augite occurs as large irregular plates and, occasionally, as small crystals showing partial crystal outlines; it is largely altered to chlorite. The felspar is mainly interstitial and probably approaches labrodorite in composition. Partial crystals of ilmenite and leucoxene are scattered abundantly through the rock. The olivine occurs as tiny grains, and is not abundant. Only one crystal of what appeared to be an orthorhombic pyroxene occurred in the section; this gave polarisation colours somewhat lower than the augite.

This outcrop probably represents a dyke intrusive into the Dundas slates and breccias. In all probability it is connected in depth with the serpentine dyke described below.

Serpentine. A broad serpentine dyke outcrops along the north-west trending spur of Colebrook Hill which terminates near the 73 Mile Peg. The rock has a dark green colour and, in places, contains numerous small veinlets of asbestos. Small veins of chromite and magnetite are also developed in the rock. In some places, the dyke appears to contain unaltered patches of peridotite, but microscopic examination of a specimen from one of these patches showed that the rock was composed entirely of pale green fibrous serpentine with a few small veinlets of chromite and magnetite.

A dyke of basic or ultra basic composition outcrops on the Wilson River Track about eight chains beyond the western boundary of the area, and, about twenty eight chains beyond this, i.e. at a distance of thirty six chains from the boundary, is a large dyke of serpentine similar to that described above.

These occurrences, together with the basic gabbro outcropping on the Pieman River, form portion of chain of basic and serpentineus dykes which run parallel with, and to the west of, the western boundary of the mapped area. As far as could be determined, no osmiridium has been found associated with this belt, though colours of the mineral are said to have been found in some of the creeks to the north of the Wilson River Track.

....

(d) Sedimentary Rocks occurring within the Porphyries and the Quartz Porphyries

At least four isolated areas of sheared sedimentary rocks occur entirely enclosed by the massive and sheared porphyries and the quartz porphyries. The exact processes by which these rocks attained their present positions cannot be fully explained and they have been interpreted as roof pendants, the remnants of a pre-existing sedimentary series, in the intrusive igneous rocks. They comprise carbonated and pyritised grey and black slates, yellowish brown slates, quartzites, dark grits and calcareous rocks.

The occurrence of these rocks is shown on the accompanying geological map, and, in order to avoid confusion, it has been deemed advisable to describe the individual characteristics of each occurrence.

The most important of them occurs as an elongated band, approximately three thousand feet long and some two hundred feet wide, forming the hanging wall of the large zinc-lead ore body of the Rosebery Mine. All of the rock types enumerated above are represented in this band, though slates constitute the bulk of it. These are generally of a dense, black variety, though some are grey or yellowish brown; they are highly fissile, and, in proximity to the lode, have been intensely sheared and some of the greyish types have been slightly sericitised. The grits are of a fine grained, black type and occur interbedded with the slates. The quartzites occur as thin bands in the slates and are generally dense whitish rocks containing a little sericite. The massive carbonate rock is a dense, whitish-grey, earthy rock which sometimes contains bands of pyrite; it occurs interbedded with the slates, but occasionally forms large masses on the hanging wall of the lode, e.g. at the Magazine X Cut No. 4 level.

As the massive carbonate rock occurs on the immediate hanging wall of the lode, it has been argued that it was formed by the carbonate solutions accompanying ore deposition, and some support is given to this view by the fact that in two cases at least its occurrence co-incides with a great development of carbonates in the lode channel. However, there can be little doubt that the rock is of sedimentary origin, and, in proof of this, it may be stated that it is readily distinguishable from the carbonate formations of the lode channel, and that it occurs at several places definitely interbedded with the slates. Further proof of its sedimentary origin is afforded by one complete and one partial analysis the results of which are tabulated below.

Table 5

Analysis of Massive Carbonate Rock

R225

Constituents	%
$FeCO_3$ & FeS_2	6.40
Al_2O_3	8.00
$MnCO_3$	1.80
$CaCO_3$	35.80
$MgCO_3$	25.00
SiO_2	18.00

R157 (1649/30)

Constituents	%
SiO_2	38.44
FeO	1.42
Fe_2O_3	0.70
FeS_2	1.72
Al_2O_3	22.42
TiO_2	0.35
MnO	5.02
CaO	8.65
MgO	6.01
P_2O_5	0.163

	K_2O	3.92
	Na_2O	0.18
	CO_2	10.60
	Ignition Loss	1.80
95.00		101.393

R.157 Massive Carbonate Rock, 26' N. of 13N Disc No. 4 Level
Analyst L.H. Bath.

R.225 Massive Carbonate Rock 7N-8N Rises No. 8 Level
Analyst G. Ley.

A comparison of these analyses with those of the lode carbonates on page illustrates the essential differences in composition; these are:- (a) the higher magnesium and calcium in R225 and (b) the higher alumina combined with slightly increased amounts of magnesium and calcium in R157. The potassium, manganese and iron have probably been introduced during ore deposition. It will be observed from the analyses that, in some cases, the rock may approach in composition an impure dolomite (R225), in others it is merely a calcareous slate.

The surface exposures of this band of sediments are limited to the northern end of the mine workings and to the creeks immediately to the north of No. 1A level. Black slates have been exposed by small surface excavations at bore sites 30R and 32R, and at a point a few feet from the old air shaft to No. 1 level. North of No. 1A adit slates outcrop in several small creeks and eventually the belt peters out in the massive porphyries at a distance of some fifteen chains north of the adit. Between the northern and southern ends of the mine workings, these rocks are covered by glacial deposits, but they may be seen in the mine workings on the hanging wall of the lode and have been recorded in the numerous bores which have been put down to delineate the limits of the ore body. To the south, the main belt probably tails out a little to the south of No. 6 N. Rise, although a few small isolated patches of slate occur at various points still further south (vide plan of Rosebery Mine plate).

This belt strikes 10° W of N (true bearing), and dips to the east at 36° to 53°, the average dip being 45 degrees. The strike of the shear planes coincides with that of the bedding planes, but the dips vary from 50° to 60° east. Sometimes the shear planes conform in dip with the bedding planes, sometimes they make an angle with it, generally the bedding is masked by the shearing.

It may be noted that, on the eastern side, these rocks are in contact with massive porphyries and, on the western side, with sheared porphyries, while, at the northern end of the mine workings, massive porphyries occur both on the eastern and western sides. Further details as to their occurrence, probable extension in depth and relationships to the ore body are dealt with in a later section and are illustrated on the accompanying plant of the Rosebery Mine.

In the railway cuttings on the Primrose branch line, immediately west of the ore bins, is another belt of sedimentary rocks composed of intensely sheared, fissile, black and grey, pyritous slates. This belt is surrounded entirely by intrusive quartz porphyries (see page .
Both the porphyries and the slates have been intensely

sheared and contorted, and all trace of bedding in the slates has been obliterated. The strike of the schistosity varies from true N. and S. to N.30° W; the dips are generally vertical or at steep angles to the east or west.

Further to the west on the branch line, a small cutting has exposed purple slates which are intruded by a small quartz porphyry dyke. It is not certain whether these slates form another isolated group or whether they are continuous, under the mantle of alluvium and detritus, with the purple slates exposed at Primrose Siding (45).

Another isolated area of sheared, black and grey, pyritous slates occurs along the contact of the quartz porphyries and the sheared felspar porphyries. This belt is exposed in the road cuttings opposite the Rosebery Oval, and may be traced southwards along Barker Street for a distance of approximately twenty chains. Further south, it has been exposed in the cuttings on the Williamsford Road a few chains east of Barker Street. Thus, its total length is approximately forty chains and in width it varies from two to six chains. In this belt, the bedding is generally marked by the schistosity but two measured strikes along bedding planes gave N. 14° E. and N. 39° E; the dips are vertical or at steep angles to the east.

The fourth belt of slates is exposed in the lower workings of the Salisbury Mine, and consists of a narrow band of black slate which forms the footwall of a small galena-fluorite vein. It is approximately a hundred feet long, and varies in width from three to nine feet. This lens strikes N. 4° E, and dips to the east at an angle of 68°. It is surrounded entirely by quartz porphyries.

Another small lens of slatey rocks probably occurs on the old Rosebery Lodes Mine. It does not outcrop at the surface and its occurrence has been inferred from the presence of black slate on the dump of an abandoned shaft.

As has been stated, the exact processes by which these rocks attained their present positions cannot be satisfactorily explained, and the problem becomes more difficult when we examine in detail the one occurrence of which detailed information is available, viz. the block occurring on the hanging wall of the Rosebery Zinc-lead ore body. This block is three thousand feet long and two hundred feet wide, and has a downward extension, on a fairly regular dip, of at least one thousand feet. It is difficult to visualise such a large block sinking as a xenolith into the viscous magma of the porphyry without undergoing a good deal of distortion. It therefore seems probable that the process of intrusion was slow and was analogous to that of magmatic stoping. Furthermore, the blocks as we now see them are probably in the same relative lateral positions as before the intrusion of the porphyries.

A belt of sedimentary rocks similar to those described above, and surrounded by massive and sheared porphyries, occurs on the Hercules and Mt. Read Mines, some five miles to the south of Rosebery. Again, that portion of the Farrell Slates extending from the Stirling Valley Mine to the Murchison River is also enclosed by massive porphyries (46)

(45) see page
(46) see plate VII Bulletin 28 Tas.Geol. Survey

It will thus be observed that, within the main belt of porphyries, the occurrence of such isolated areas of sedimentary rocks is not uncommon. The writer has had the opportunity of examining both the Farrell Slates and the sedimentary rocks occurring at the Hercules and Mt. Read Mines, and has observed a very close resemblance between the rocks of both these areas and the isolated slate belts of the Rosebery District. Hence, these rocks may be correlated, tentatively at least, with the Farrell Slates.

As to the probable age of the Rosebery occurrences there is little or no evidence. The slate members are similar to some of the slates of the Pre-Dundas series, but the grits and calcareous members have no equivalents. However, the relative positions of many of the blocks strongly suggests that they are remnants of the slate members of Lower Slates and Quartzites. It is possible of course that the large block occurring on the hanging wall of the Rosebery Mine may represent portion of a series still older than the Pre-Dundas series.

In his bulletin on the Rosebery District, Hills (47) suggests that the Farrell Slates may have formed portion of the Read Rosebery Schists, but, as we now know that the Read Rosebery Schists are really derivatives of the massive porphyries, this correlation cannot be accepted, though it indicates that Hills regarded the Farrell Slates as being similar to the isolated sedimentary belts of Mt. Read and Rosebery. Ward (48) noted a marked lithological resemblance between the Farrell Slates and certain slatey members of the Dundas Series but at the time of his report the Dundas Series embraced the greater portion of the rocks referable to the Cambrian Ordovisian. On the other hand he suggests that the Farrell Slates may be possibly of Silurian Age.

Generally, the Farrell Slates appear to be older than Silurian, and, as a tentative correlation, the writer would suggest that they, along with the isolated sedimentary blocks of Mt. Read and Rosebery, be placed with the Rosebery or Pre-Dundas Series.

(47) Hills, Loftus - "The Zinc-Lead Sulphide Deposits of the Read-Rosebery District" Bulletin 23, pp.30-31.

(48) Ward, L.K. - "The Mt. Farrell Mining Field" Bulletin 3, page 33.

(e) Relationships between the Quartz Porphyries & Felsites & the Felspar Porphyries.

The field occurrence and distinctive lithological characters of the quartz porphyries and felsites has been deemed sufficient justification for describing them as a separate group. They occur as a fairly definite belt and, where visible, their contact with the felspar porphyries can be mapped with only a small margin of error. This contact is marked in some places by the presence of quartz-tourmaline-pyrite veins, e.g. to the west of the ore bins on the Rosebery Mine and also on the Salisbury Mine; these indicate the presence of an initial line of weakness corresponding with the contact between the two groups.

The definite association of quartz-felspar porphyries with the quartz porphyries &c., and the probable association of a granite porphyry with members of the same group is strongly suggestive of a close genetic relationship with the felspar porphyries, and it is probable that the quartz porphyries &c. have been formed as a result of the differentiation of the main felspar porphyry mass, inasmuch as both groups contain rocks which may be regarded as transition types. Furthermore, the nature of the differentiation of the main mass of felspar porphyries is such that the development of extremely acid types, such as the quartz porphyries and felsites, is more or less to be expected.

It was not possible to determine whether the quartz porphyries &c. were formed by differentiation in situ, or whether they constitute a separate intrusion. The fairly distinct contact and general field occurrence are suggestive of the latter possibility, but, on the other hand, the occurrence of similar zenolith like blocks of sedimentary rocks in both the quartz porphyries and the felspar porphyries indicates that if there was any time interval between the two intrusions it would have been a very minor one.

A similar association of quartz porphyries with felspar porphyries has been observed by P.B. Nye near Low Rocky Point.

In some cases, the quartz porphyries &c. appear to have undergone greater dynamic metamorphism, as distinct from vein alteration, than the felspar porphyries, and it was at first considered that they may have constituted an older series of intrusive rocks. However, their position on the margin of the main porphyry mass renders it probable that they would be subjected to a relatively greater degree of shearing than the felspar porphyries, and hence no reliance can be placed on this evidence as a criterion of their age. When the whole of the evidence is considered there can be no doubt but that they are closely related to the main mass of the felspar porphyries.

(48A) Nye P.B. Personal Communication.

(f) Age and General Relations of the Quartz and Felspar Porphyries.

The quartz porphyries and felsites, the felspar porphyries and the sheared felspar porphyries and schists of this area form part of an extensive series of acid igneous rocks, which extends almost continuously from Low Rocky Point to the Que River. Similar rocks are developed near Deloraine, Sheffield, Lorinna and Mt. Claude. The bulk of this series is composed of massive and schistose porphyries similar to those at Rosebery, but also includes some granitic and syenetic types. To the schistose forms of these rocks the name "porphyroid" was applied by Waller, in 1904. In later years, the use of this term was extended to include the massive types, and the series became known as the "Porphyroid Igneous Series". Some of these rocks, particularly the schists, appeared to be intercalated (or otherwise associated) with sediments and tuffs, and, on occasions, the latter have also been mapped with the porphyroids. The somewhat broader use of this term, than that originally intended, appears to have led to some confusion, and to have obscured not only the exact nature of the relationships between the igneous rocks and the associated sediments but also the true character of the igneous rocks themselves. In this way, the porphyroid series has come to be regarded as consisting of acid lava flows and pyroclastic sediments with hypabyssal and plutonic rocks. Mainly on account of the schistose character of some of these rocks, and for other reasons, which will be stated below, the age of this series has been regarded as being pre-Silurian.

The general conclusions arrived at by Loftus Hills with regard to the igneous rocks of the Rosebery and Mt. Read districts have already been summarized when dealing with the literature on this district. To recapitulate briefly, he described the Dundas Series, the Read-Rosebery Schists and the Porphyroids (quartz and felspar porphyries &c.) as three conformable series, the Dundas-Series being the oldest, and the Porphyroids the youngest. The latter were described as being principally lava flows. The results of the present detailed investigation have led the writer to the conclusion that porphyritic rocks of the Rosebery and adjoining areas are largely intrusive, and there is also a strong probability that they belong to the Devonian period of igneous activity.

As the term "porphyroid" has been used by numerous writers when referring to this series, its use will be retained for the purposes of the following discussion, but will be restricted to include rocks of definitely igneous origin and their schistose derivatives.

The nature of the relationships between the sheared porphyries and schists, &c., with the massive felspar porphyries has already been dealt with, and the existence of the Read-Rosebery Schists as a belt of schistose sediments can no longer be regarded as tenable. Essentially, they form portion of the felspar porphyries. Furthermore, the bulk of the evidence in both the Rosebery and Mt. Read Districts, points to the fact that the porphyries, both quartz and felspar, are intrusive into the Cambro-Ordovician sediments. This is indicated not only by the transgressive nature of the contact of the quartz porphyries with the Rosebery or Pre Dundas Series, but also by the occurrence of small porphyry dykes which are definitely intrusive. Of these the most important is the long dyke like tongue which occurs between the Lower Quartzite and the Breccia conglomerate.

The smaller intrusive dykes occurring along the branch line from Primrose Siding are also important from this point of view. In the text, these have been described with the quartz porphyries, but they could equally as well have been included with the felspar porphyries, as they are almost identical with rocks which occur in both groups. In the Mt. Read District also, dykes of felspar porphyry have been observed intruding the Dundas series, e.g. on the N.E. Dundas tram twenty one chains north of the 17 Mile Peg; this places the age of the porphyries as post Lower Ordovician.

Among the various members of the porphyroid series as represented in this area, there are no rocks which may be regarded unequivocally as effusives, the petrological character and field relationships indicating that the whole of the porphyries are intrusive. The writer has traced the porphyries from within a quarter of a mile of the Que River southwards to Mt. Tyndall a distance of twenty two miles, and as far as could be observed, during the brief reconnaissance trips, and also during the preliminary mapping in the Mt. Read District, their general character is the same, and they consist principally of quartz and felspar porphyries. Near the Que River, the irregular nature of the contact of the porphyries with slates and breccias of the Dundas Series is strongly suggestive that the porphyries are intrusive into them.

In the Mt. Farrell District, Ward (49) has described the porphyries as being intrusive into the Farrell Slates. Unfortunately, the correlation of the Farrell Slates with the Pre-Dundas series, suggested on page , cannot be regarded as other than tentative, but the evidence from the Mt. Farrel District is important, inasmuch as it shows that the porphyries are largely intrusive. Ward has also described some of these rocks as effusives, as, on microscopic examination, some specimens showed the presence of elongated amygdules. Such evidence, although it indicates differences in the conditions under which the various rocks solidified, does not constitute definite evidence of effusive origin.

These are, however, certain rock types occurring within the main belt of the porphyries which do suggest effusive affinities. Thus, microscopic examination of a specimen, obtained from a railway cutting to the north of the Pieman Bridge, showed that the rock was composed almost entirely of tiny spherulites. In this case the rocks in the immediate vicinity were quite normal quartz-felspar porphyries. On evidence such as this, it would be quite unsafe to draw definite conclusions, and, when compared with the general character of the porphyries as observed over large areas, such occurrences are quite rare and indicate nothing more than a difference in the physical conditions under which this particular rock happened to solidify.

It has been stated above that mainly on account of their schistose character the porphroid series have been regarded as being of pre-Silurian age. There can be no doubt that quite a large proportion of these rocks are highly schistose, but a far greater proportion show no signs of schistosity and are quite as fresh as most of the Devonian igneous rocks. Hence, in the following discussion relating to their age, no account will be taken of such evidence as is afforded by schistosity.

(49) Do above (48) p. 12

of the Henty River south of Mt. Dundas, Mr. F. Blake found Silurian rocks occurring on both sides of the southern extension of the porphyries from Mt. Read. The field relationships indicated that the porphyries were intrusive into and younger than the Silurian rocks.

(f) On Madam Howard plains, west of Queenstown Blake had obtained similar evidence in 1928, though its importance was not then realised. In that locality, syenites, similar to some of the Queen River porphyries are intrusive into fossiliferous Silurian slates and sandstones.

(g) On the north-western slopes of Mt. Murchison, about six miles south-east of Rosebery, pieces of sheared porphyry were found to contain fragments of West Coast Range conglomerate. The occurrence is generally similar to that at Mt. Tyndall but on a smaller scale. The specimens were obtained close to the porphyry - conglomerate contact.

(h) In the Mt. Claude district, there is a quartz porphyry dyke on Thomas' Road which is quite definitely intrusive into Tubicolar sandstones (Silurian). This occurrence is again referred to below.

In order to correlate the results obtained from the various reconnaissance trips the Government Geologist, Mr. P.B. Nye, has had compiled a general map of the West Coast region illustrating the relationships of these igneous rocks, with the Cambro-Ordovician and Silurian sediments associated with them. The relationships suggest very strongly that the porphyries are intrusive into the Rosebery, Dundas and Silurian sediments. They are therefore of post Silurian age and may be correlated with the Devonian period of igneous activity.

The principal evidence to the contrary, i.e. in favour of the view that the porphyroids are of pre-Silurian age, lies in the reported occurrences of pebbles of the porphyroids in the West Coast Range (Silurian) conglomerates. Such occurrences have been described at Mt. Lyell by Gregory (50), in the Jukes-Darwin field by Loftus Hills (51) and at Mt. Claude by A.M. Reid (52).

In discussing the age of the Queen River porphyries (which form portion of the porphyroid series) Gregory makes the folllowing statement:- (p.55).

"The available evidence, therefore, renders it probable that the diabase porphyrites of the Queen River are part of a pre-Silurian igneous series of which some of the rocks on the margin were quartz porphyrites, and have been altered into the Mt. Lyell schists".

However, Gregory did not regard this conclusion as final, as the evidence he obtained was somewhat contradictory, and was insufficient to place the relative ages of the Silurian rocks and the porphyries beyond doubt. In the light of our present knowledge

The evidence outlined above shows that the porphyries are principally intrusive rocks and that they are younger than the Dundas series, i.e. they are at least post-Lower-Ordovician. This indicates a very strong probability that they belong to the Devonian period of igneous activity. However, the only place in the vicinity of Rosebery and Mt. Read in which the porphyries are in juxtaposition to Silurian rocks is on the north-western and western slopes of Mt. Murchison. Unfortunately no clean contacts were observed in this locality, but during and since the completion of the Rosebery survey reconnaissance trips have been made to various localities with the object of obtaining any evidence pertinent to the age of this important series of igneous rocks. A brief resume of the total evidence now is given below.

(a) During a reconnaissance trip to Mt. Tyndall, in June, 1932, the writer observed that the main belt of porphyries extended to within two or three chains of the foot of Mt. Tyndall, which is composed entirely of West Coast Range Conglomerate. Working along the line of contact south of Newton Creek it was noted that in many places the porphyries contained xenolithic pebbles and blocks of conglomerate up to two feet in diameter which had been derived from the adjacent conglomerates. The porphyries were quite massive and there can be no doubt that the pebbles etc. are present as true xenoliths. Therefore they must have been caught up during the intrusion of the porphyries.

(b) At the entrance to the gorge in the West Branch of the Queen River, the contact between the porphyries and the Silurian slates may be seen quite clearly, and is quite clean cut and well defined. The slates are often baked and toughened along the margin ahd there are small protrusions of porphyry into the slates. Moreover the porphyries contain small xenoliths of black slate. There can be no doubt that the contact is an intrusive one.

(c) In McCusicks Creek, a small tributary of the west branch of the Queen River, at a point about four chains up the left hand branch, the creek has been washed clean by sluicing. Here the contact between the Queen River porphyries and the Silurian slates may be seen quite clearly. It is quite clean cut and well defined, though the actual line is rather irregular, there being several small protrusions of porphyry into the slates. The rocks are brecciated along the contact and the porphyries contain innumerable fragments of slate. This occurrence has been described by Gregory as a fault breccia, but, when considered along with the occurrences in Lynch Creek, the weight of the evidence favours contact brecciation. Moreover the porphyries are quite massive a few feet from the margin and there are no minor fault planes such as one would expect to see along a fault of any magnitude.

(d) In Lynch Creek, Lynchford, at a point about forty chains above the King River Mine, a large xenolith like block of slates and indurated sandstones occurs wholly within massive porphyries. This block is ten to fifteen chains wide and about half a mile long. The slates and sandstones are generally similar to those of the Silurian rocks occurring to the west and have probably been derived from intruded Silurian strata. In addition to the one large block innumerable smaller fragments may be observed in the porphyries at various points along the creek. The observations in McCusicks and Lynch Creeks and in the West branch of the Queen River were made in November, 1932 and June, 1933.

(e) In June, 1931, while examining the upper reaches of the geology of Tasmania, Gregory's principal observations relating to the age of the porphyroid series may be summarised briefly as follows:-

(a) In favour of pre-Silurian Age

(i) The presence of abundant schist pebbles in the West Coast Range conglomerates on Mt. Lyell and Mt. Owen (P. 52).

(ii) The occurrence of a conglomerate in McCusicks Creek, full of pebbles of the igneous rocks, which was interbedded with Silurian rocks (P. 54).

(iii) The occurrence of a bed of sandstone, largely made up of the igneous rocks, which was also interbedded with the Silurian rocks (P. 54).

(b) In favour of a post-Silurian Age.

The occurrence of bands of slate in the igneous rocks to the east of the west branch of the Queen River (PP 54 -55).

The chief evidence upon which Gregory relied was the occurrence of the schist pebbles in the West Coast Range conglomerates. These schist pebbles are described as being micaceous, some also are quartzite, but there is no certainty that they are exactly similar to the Lyell schists, and, furthermore, since the proportion of the unaltered igneous rocks, in the Mt. Lyell district, is roughly equal to that of the schists derived from them, it would be reasonable to assume that if the schist pebbles in the conglomerates were derived from the Lyell schists, then an equal proportion of the unaltered igneous rocks should also be present in the conglomerates, but such is not the case.

Another point that may be raised is that at Mt. Lyell the formation of the lodes is clearly later than that of the conglomerates, and, though this view is not stated by Gregory, it is highly probable that the hydrothermal action accompanying the formation of the lodes was also responsible for the formation of the schists. If such has really been the case, how then could the schist pebbles in the conglomerates have been derived from the Lyell schists. Furthermore similar schists pebbles occurring in the West Coast Range conglomerates elsewhere have been regarded by other writers as being derived from the Pre-Cambrian (53).

The conglomerate in McCusick's Creek, referred to by Gregory, was made the object of a special trip in November 1932. In his book Gregory infers that it is a crush breccia and not a true sedimentary deposit. The whole of this occurrence may now be seen quite clearly and there can be no doubt that the contact is an intrusive one and that the brecciation is due to the intrusion of the porphyries. In most of the exposures, instead of having a conglomerate full of pebbles of the igneous rock, the porphyries are full of small fragments of slate.

(5) Gregory, J.W. "The Mt.Lyell Mining Field" Proc. and Trans. Aust. Inst. Mining Engineers. 1905. pp 52-55

(51) Hills, Loftus. "The Jukes-Darwin Mining Field" Bulletin 16 p. 42.

(52) Reid, A.M. "The Mining Fields of Mt. Claude, Moina, and Lorinna" Bulletin 29 p.24.

The third piece of evidence favouring a pre-Silurian age for the porphyries is not important, inasmuch as Gregory's microscopic examination of the specimen from the bed of sandstone shows that the only igneous material present is chlorite. This bed could not be located during the trip referred to.

It will thus be observed that the evidence in favour of a pre-Silurian age for the porphyries at Mt. Lyell rests purely on the reported occurrence of schist pebbles in the West Coast Range conglomerates.

In addition to the occurrences in McCusick's and Lynch Creeks there is a certain amount of additional evidence at Mt. Lyell which favours the view that the porphyries are intrusive and that they are of Devonian age. It may be stated however that the additional points raised yet remain to be investigated in the field.

Reference to the geological map (plate XVI) accompanying Gregory's report will show the occurrence of one isolated area of West Coast Range conglomerate (mapped as Devonian) and at least three isolated areas of Silurian slates &c. in the Lyell schists. As the Lyell schists were originally porphyritic rocks, these isolated areas may well represent residual xenolithic blocks derived from the sediments during the intrusion of the porphyries. The present positions of these blocks have been explained as being due to block faulting, but, in many cases, there has been little actual field evidence to justify the explanation, and a far simpler one is accessible if the porphyries are regarded as an igneous series intrusive into the Silurian.

One other point of interest remains to be discussed and that is the general nature of the contact between the West Coast Range Conglomerates and the Lyell schists. This contact, as shown by Gregory's map, is highly irregular and is such as one would expect to find along the margin of an intrusive igneous series. However, its irregular nature has been explained as being due to a complex system of faults. While there can be no doubt as to the existence of some of these faults, a far simpler explanation of the irregularities is offered by regarding the schists (originally porphyries) as being intrusive. This is particularly so with regard to the southern portion of the area mapped by Gregory, where several long dyke like tongues of the schists (porphyries) appear to penetrate the conglomerates. The pronounced shearing along these contacts is only to be expected, for later earth movements would naturally select the line of least resistance.

In his bulletin on the Jukes Darwin mining field, Loftus Hills (54) has discussed, at some length, the question of the relative ages of the porphyroids and the West Coast Range conglomerates. He describes the occurrence of a brecciated conglomerate composed entirely of pebbles of the porphyroid series, which conformably underlies, and forms the base of, the West Coast Range series (p. 41 et seq.) He also states (p.52) that, where the brecciated conglomerate is locally absent from the base of the West Coast Range conglomerates, the latter are full of pebbles of the porphyroids. This would constitute indisputable evidence of the pre-Silurian Age of the porphyroid series if it did not clash, as, unfortunately it does, with the evidence quoted on page , which places the porphyroid series as post-Silurian. Moreover, if the porphyroids are regarded as intrusive rocks of Devonian age, the known facts of their occurrence, in several districts, could be more readily explained, and, in addition it would explain the general absence of porphyroid pebbles in the West Coast Range

(53) Ward, L.K. "The Mt. Farrel Mining Field" Bulletin 3, p.27. Twelvetrees, W.H. "The Middlesex & Mt. Claude Mining Field" Bulletin 14, p.14, and Nye, P.B. Personal Communication.

conglomerates as developed throughout the State.

Microscopic examination of one of the so called porphyroid pebbles, in a specimen of the normal West Coast Range conglomerates collected by Hills, showed that it was probably a highly sheared quartz porphyry. However, in the hand specimen this pebble bore only a slight resemblance to the sheared quartz porphyries described in the previous pages.

A general examination of Hills map of the Jukes-Darwin field indicates that some of the porphyries may be intrusive.

In his bulletin on "The Mining Fields of Moina, Mt. Claude and Lorinna", A.M. Reid (55) states (p.24) that on Mount Claude the Lower members of the West Coast Range conglomerates contain much porphyroid rock (quartz-felspar porphyry) and that some of these pebbles exceed two feet in diameter. During a visit to the Sheffield district, in December 1931, the writer had the opportunity of investigating this occurrence. A careful examination of the conglomerates on Mt. Claude failed to reveal any pebbles which could be definitely referred to the porphyroids. On the other hand, some large reddish pebbles and boulders closely resemble some of the reddish quartz-felspar porphyries which occur in the vicinity, but microscopic examination of specimens of these pebbles showed that they were felspathic grits and not quartz-felspar porphyries. Similarly, some quartz schist pebbles in the conglomerates bear a slight resemblance to the extremely sheared and altered porphyries. In all probability the pebbles of felspathic grit are those referred to by Reid. The matrix of the conglomerate on the Iris Mine (p.27) is stated also to be composed of material derived from the porphyroids, but, although the matrix of this conglomerate is composed principally of quartz and decomposed felspathic material, principally kaolin, it is doubtful if its source could be definitely allocated to any particular rock series.

Near Mt. Claude there is some quite definite evidence of the intrusive nature of some of the porphyries. Thus, the quartz porphyry dyke on Thomas Road (shown on Plate 8 of Bulletin 29 as porphyroid or pre-Silurian) is quite definitely intrusive into the Tubicolar sandstones, which are now regarded as being of Silurian Age. This dyke apparently occupies a fault plane or contact line, as grits occur on one side of it and slates on the other, Furthermore, on the Lorinna Road, about one and a quarter miles from Cethana, a small quartz porphyry dyke appears to be intrusive into slates interbedded with the West Coast Range conglomerates.

Another point worthy of note is that, although igneous rocks of two different ages have been mapped in the Middlesex and Mt. Claude district, some rocks classed with the older group appear to be very similar to certain members of the younger. Thus, in describing granites of the porphyroid series occurring near the junction of the Dove and the Forth Rivers near Lorinna, A.M. Reid has noted that they strongly resemble the tin bearing Devonian granites occurring a few miles to the north. Although he follows Twelvetrees in classing these rocks with the porphyroid group, there is a strong suggestion that Reid was not wholly convinced that the two occurrences of granite were of different ages.

(54) See above (51)
(55) See above (52)

The facts and suggestions put forward in this discussion indicate that there is a considerable amount of evidence in favour of the view that the porphyries really belong to the Devonian period of igneous activity, and that a very large proportion, if not all, of them are intrusive rocks and not lava flows.

(g) Tertiary Basalt.

At a depth of 350 feet in bore R33 on the Rosebery mine, ten feet of olivine basalt was cut. This occurs within the isolated belt of slates. Under the microscope the rock is seen to consist of phenocrysts of olivine set in a fine grained ground mass consisting of augite and laths of felspar. It is generally similar to the Tertiary basalts occurring north of the Que River. The occurrence probably represents a small intrusive dyke.

An outcrop of olivine basalt was also observed on the western side of the Pieman River at a point fifty-five chains north of the north western angle of the mapped area.

VI THE ORE DEPOSITS.

The Rosebery District lies within the belt of metalliferous country which parallels the West Coast Range. To the north and north east are the silver-lead and the tin deposits of the Waratah District and the silver-lead deposits of the Mt. Farrell, while to the south, south-west and west are the copper deposits of Mt.Lyell, the silver-lead deposits of Zeehan and Mt. Dundas and the tin fields of North Dundas. Immediately to the south are the zinc-lead deposits of Mt. Read which are similar in nature and mode of occurrence to those of Rosebery.

Zinc and lead form the chief metal products, the whole output being produced by the Rosebery Mine, which is the largest and only payable mine within the district. In addition, there are lodes containing tin and copper, as well as certain quartz-tourmaline and flourite veins containing variable amounts of metallic sulphides. Small quantities of alluvial gold, derived from the denudation of the zinc-lead deposits, occur in several of the creeks and in certain of the Tertiary and Pleistocene gravels.

The primary ore deposits are here grouped according to the metal or metals of which they constitute the ore. Much of the data concerning the zinc-lead deposits was obtained while examining the Rosebery Mine, but the descriptive matter also applies generally to other zinc-lead ore bodies within the district.

(1), ZINC LEAD ORE BODIES.

(a) Composition The typical zinc-lead ore bodies of this district are massive sulphide lodes consisting of a fine grained intimate admixture of zinc blende, pyrite and galena, with minor quantities of carbonates and quartz as gangue minerals. While the fine grained massive ore constitutes the bulk of the ore mined, the schist walls of the massive lodes are highly pyritised and, in some cases, contain sufficient zinc and lead to warrant mining. Furthermore, there are certain low grade portions of the lodes consisting mainly of carbonates, with felspar and some quartz, which contain variable quantities of sphalerite, galena and other metallic minerals. Hence, throughout the deposits, we may recognise three main types of ore. These are:-

(1). Fine grained massive sulphide ore consisting mainly of sphalerite, galena and pyrite, with very minor quantities of gangue.

(2). Schistose ore consisting of a pyritic impregnation of the schist walls carrying small quantities of sphalerite and galena.

(3). Low grade carbonate ore consisting mainly of carbonates and felspar, with streaks and veins of pyrite, galena, chalcopyrite, sphalerite, tetrahedrite and bournonite.

The average chemical composition of the zinc-lead ores is illustrated by the following analyses of a composite sample of the Rosebery crude ore treated at the Zeehan Experimental Mill during the period July 1929 to February 1930. Most of this ore was obtained from development work on the Rosebery Mine, and hence covers a wide range throughout the lode. It consists mainly of massive sulphide ore, but contained a little carbonate ore and possible some schistose ore.

TABLE 6

Analyses of Composite Sample of Rosebery Crude Ore.

Constituents	1 Per Cent.	2 Per Cent.
SiO_2	11.080	9.5
Pb	6.050	6.4
PbO	0.169	
Zn	21.400	21.3
ZnO	.037	
Cu	.490	.50
Sb	.0057	.10
As	.330	.305
Ca	Trace	.082
S	28.190	28.7
SO_3	1.280	
Fe	13.550	16.9
FeO & Fe_2O_3	5.028	
Al_2O_3	4.816	6.10
TiO_2	0.119	
CaO	.500	.54
MgO	.960	
BaO	1.446	2.70 ($BaSO_4$)
MnO	1.420	.99
K_2O	.713	
Na_2O	.110	
CO_2	2.440	
H_2O	.210	(8.5oz. Ag
As & Sb (as oxides)	Traces	(12.12 dwts Au.
	100.785	94.117

1. Analyst L.H. Bath. 2. Taken from Zeehan Mill Returns 1929.

In connection with analysis 1, it is necessary to explain that the crude ore is sampled after it has passed through the Hardinge Ball Mill, and hence the sample probably contained a small amount of comminuted iron and about .03% of Na_2CO_3. Furthermore, the lead, zinc, arsenic, antimony and the major portion of the iron shown as oxides probably represent original sulphides in the unground ore.

Although both analyses were made of the same composite sample, any slight discrepancies are probably due to slight differences in the composition of the particular portion of the sample selected for analysis.

In terms of the known mineral constituents, these analyses have been interpreted as shown in the following table. For the metallic minerals the mean values of the figures in the above analyses have been adopted.

TABLE 7

Mineralogical Composition of Rosebery Ore.

Metallic Minerals.		Non Metallic Minerals.	
Constituents.	Per Cent.	Constituents.	Per Cent.
Sphalerite	35.2	Quartz	7.8
Pyrite	31.0	Sericite & Aluminous) Silicates)	6.7
Galena	7.3	Barite	2.5
		Rhodochrosite	2.2
Chalcopyrite	.9	Dolomite)	
Arsenopyrite	.7	Calcite)	3.2
Tetrahedrite & Bournonite	25-.40	Ankerite)	
Magnetite & Ilmenite	.5	Orthoclase	.9
		Albite	.7
Total	76%	Total	24%

Silver 8.5025 ozs. per ton Gold 2.12 dwts. per ton

In addition to the Minerals enumerated above, small flakes of chlorite are present in the ore but are apparent only on microscopic examination and probably constitute less than .1% of it.

It is not proposed to give detailed descriptions of the various minerals occurring in the zinc-lead ore bodies, as most of them are of the usual fairly common varieties. A few, however, do call for special mention. These are sphalerite, tetrahedrite, bournonite, magnetite and ilmenite.

Sphalerite. The sphalerite of these ores contains from 3% to 6% of iron present as FeS, the iron replacing some of the zinc in the sphalerite molecule. The iron content is reflected in the colour of the mineral which varies from pale yellow to dark brown the darker varieties containing a relatively greater proportion of iron than the lighter ones. The sphalerite content of the ore, shown in the above table as 35/.2%, is made up of 31.9% ZnS and 3.3% FeS.

Tetrahedrite. This mineral has the usual steel grey colour and metallic lustre, and is generally massive. It has been observed mainly as small veins and splashes in the ore, and is probably present as very small particles in the fine grained, massive sulphides. A specimen has been analysed with the following result

Analysis of Tetrahedrite Regd. No. 1721/31

Constituents	%	Per Ton.
Ag	2.436	(795ozs. 15dwts. 5grs.) Total
Au	0.014	(4ozs. 11dwts. 11grs.) -
Pb	Tr.	
Sb	11.81	
As	5.70	
Cu	29.57	
Fe	3.78	
S	23.52	
Zn	8.06	
	84.89	Analyst L.H. Bath.

The chemical composition of tetrahedrite is given by Prior and Spencer (55A) as $3R'_2S,R'''_2S_3 + x(6R''S,R'''_2S_3)$ where R'=Cu,Ag,R''=Zn,Fe, and R''' = Sb,As,Bi, and x is a small fraction, often 1/10 and 1/5, but rising to ½ in the case of the highly ferriferous tetrahedrite known as coppite. The analysis indicates that copper, silver, zinc and iron are all present and that the R''' constituent comprises both antimony and arsenic. Some of the iron and zinc in the above analysis is doubtless due to the presence of pyrite and sphalerite. in the specimen selected. The gold is present probably as minute particles mechanically associated with the tetrahedrite.

Bournonite. Probably on account of its close resemblance to tetrahedrite, from which it is difficult to distinguish, this mineral has not been recorded previously. It has dark steel grey colour and metallic lustre and is generally massive. In mode of occurrence it is similar to tetrahedrite. The result of an analysis of a fairly pure specimen is shown below.

Analysis of Bournonite (Regd. No. 1633/31)

Constituents.	%
Cu	12.80
Pb	41.60
Sb	23.20
S	18.12
Zn	1.80
As	0.36
Fe	2.52
Ag	0.03 (9oz. 16dwt. per ton).
Σ	100.43

The composition of the mineral corresponds generally with that of bournonite i.e. $3(Cu_2,Pb)S.Sb_2S_3$ (with Pb:Cu=2:1)

(55A) G.T. Prior and L. Spencer "Chemical Composition of Fahlerz" Mineralogical Mag. Vol.12 p.193.

In all probability this mineral is not a very abundant constituent of the ore.

Magnetite and Ilmenite. Neither of these minerals have been observed in the uncrushed zinc-lead ores. Magnetite has been detected from time to time during treatment operations, and the occurrence of ilmenite is inferred from the presence of TiO_2 in the analysis (see table 6).

The Gangue. The non-metallic minerals present in the massive sulphide ore occur as such fine particles and are so intimately admixed with the sulphides that they are not readily visible to the naked eye, and, in many cases, their presence is detected only on microscopic examination of the ore.

As has been indicated, the carbonate formations consist principally of non-metallic minerals. The analyses of two fairly typical specimens of this gangue material are tabulated below. These are free from all metallic sulphides but pyrite.

TABLE 8
Analysis of Carbonate Gangue.

Constituents	R283 Regd. 1077	R282 Reg. No. 1076
SiO_2	31.06	9.30
Fe_2O_3	4.46	3.70
FeO	2.93	7.28
Fe	4.45	5.84
S	5.20	6.70
SO_3	0.24	0.18
Al_2O_3	15.94	8.42
MnO	12.92	24.01
TiO_2	0.68	0.10
CaO	1.60	8.40
MgO	1.66	1.52
Na_2O	3.52	1.38
K_2O	2.45	0.65
P_2O_5	0.14	0.06
BaO	0.61	0.17
CO_2	10.10	22.44
Ignition Loss	3.10	-
	101.06	100.15

Analyst L.H. Bath

R282 Carbonate Gangue, No. 8 Level Rosebery Mine 50ft. N. of 13N Rise.
R283 " " No. 4 " " " Crosscut opposite 15N Rise.

6. STRUCTURE AND PARAGENESIS.

Massive Sulphide Ore. A marked banded structure and extreme fineness of grain are characteristic features of the massive zinc-lead ores. In some cases, there is no banding, and the ore consists of a granular homogeneous admixture of zinc blende, pyrite and galena. The banded appearance is due to the segregation of the various constituents. Thus, one band is characterised by the predominance of zinc blende, another by the predominance of pyrite, and the third by the predominance of galena.

No. 2 Level, Rosebery Mine

Fig. 2 is a diagramatic sketch, of a specimen from the No. 2 level Rosebery Mine, which shows the presence of all three bands. In no case is the mineral separation entirely complete. Thus, bands apparently consisting entirely of pyrite are found, on microscopic examination, to contain galena and blende, and bands of blende are found to contain pyrite and galena; their degree of association is such that, in some cases, effectual separation of the minerals is only attained by grinding the ore so that it will pass a 200 mesh sieve. All three minerals are intimately intercrystallised, but the predominance of one constituent determines the apparent character of the band. A point of considerable interest is the presence in the pyrite bands of small lenticles and streaks of blende, which are strung out "en echlon". Conversely, similar pyritic lenticles are present in the sphalerite bands (Fig. 3). The banding is invariably parallel to the walls of the lode, and, furthermore, the contact between these massive sulphide lodes or veins and the enclosing schist or slate walls is remarkably clean, and is of the type generally referred to as "frozen". These features are illustrated by Fig. 3. The widths of the various bands varies from a fraction of an inch to an inch, and, in some cases, to two or three feet, as in the No. 3 lens, No. 2 level Rosebery Mine. Among the coarser grained ores, which are relatively subordinate, the banding is not always present.

Massive pyrite veins containing minor quantities of zinc and lead sometimes take the place of the normal zinc-lead ores. These are similar in all respects to the banded ores described above. The grain size is similar, and their contacts with the enclosing walls are of the same "frozen" type. A variation of this type was observed at the No. 2 level, Rosebery Mine, where, with an increase in the silica content of the gangue, a massive pyrite vein was seen to merge into a dense cherty lode highly impregnated with pyrite. This is quite an uncommon feature with the massive sulphide veins.

Under the microscope the fine grained ore is seen to consist mainly of sphalerite, pyrite and galena, with minor quantities of quartz, barite and carbonates, and occasional flakes of sericite and chlorite. The metallic minerals are all of similar size and are intimately intergrown.

The massive sulphide ores exhibit features similar to those of normal veins or intrusive dykes. Thus their contact with the enclosing walls is always sharp and well defined, and is similar to that observed in intrusive igneous rocks (Fig. 3). Furthermore, they give off numerous small vein like tongues or lenses which penetrate the wall rock, and whose contacts appear as sharp as those of the main sulphide mass. Excellent examples of these small tongues occur on the slate hanging wall of the Rosebery Mine between the 11N and 12N rises on the No. 4 Level, at the north end of the No. 2 level and at many other places. Again, any prominent bulges in the ore are marked by a corresponding compression of the wall rocks.

Occasionally, the massive ore is traversed by small veins of quartz, sphalerite, galena and chalcopyrite which have been deposited in fractures formed during the deposition of the fine grained ore. These veins are sometimes parallel to the banding but frequently cross it. The later sulphide veins are more coarsely crystalline than the sulphides of the massive ore, and their presence indicates that there were at least two stages, the second probably a minor one, in the deposition of the sulphides.

This is illustrated by Fig. 4 which shows veins of coarsely crystalline blende, and quartz veins containing blende, traversing the normal fine grained ore. Other instances could be cited of quartz veins containing chalcopyrite or galena. In these veins the deposition of the metallic sulphides appears to have been contemporaneous with that of the quartz.

Within the zinc-lead ore bodies, there are veins, up to two feet wide, of coarsely crystalline blende and/or galena. Veins of this type occur both in the Rosebery and Koonya Mines, and, although their relationships to the fine grained ore were not always apparent, they may be correlated with the second stage of sulphide formation. The contact of these veins with the enclosing schists or carbonates is often sharp, but there may be a certain amount of impregnation of the walls.

Schistose Ore. When dealing with the general geology of the district, mention was made of the alteration and pyritic impregnation of the sheared porphyries and quartz-sericite schists in the neighbourhood of the lodes. The amount of impregnation depends on the permeability of the wall rocks. Thus, the pyritisation of the quartz-sericite schists forming the footwall of the Rosebery lode, and of similar rocks forming the hanging wall of the Koonya lode, has a lateral extension of one to two hundred feet, whereas the dense slates forming portion of the hanging wall of the Rosebery lode have not been pyritised by the lode solutions. On the immediate walls of the massive sulphides, the pyritised schists often carry galena and sphalerite, sometimes in sufficient quantity to warrant mining, but the lateral extension of this schistose ore is never more than a few feet, and, although occasional patches are found within the massive sulphide veins, the general nature of its occurrence is as a thin selvage on the walls.

A thin section of this ore shows the main constituent to be sericite or damourite, and that the pyritic impregnation preceded the deposition of sphalerite and galena. This is illustrated by Fig. 5 which is a diagramatic sketch of a section of the ore showing the impregnation of the pyritised schist by sphalerite-galena veins, parallel to the planes of foliation of the schist and containing small crystals of pyrite. Other types of this ore consist of schist almost wholly replaced by pyrite and cut by later veins containing tetrahedrite, sphalerite and galena.

<u>Low Grade Carbonate Ore.</u> Occurring within the lode channels at the ends of lenses of massive sulphide ore, or between two such lenses, are carbonate formations which, though generally low grade, sometimes contain appreciable quantities of sphalerite, galena and chalcopyrite. Although the bulk of the non-metallic mineral constituents of the carbonate ore are similar to the gangue minerals of the massive sulphide ores, the relative proportions of the minerals vary and their formation does not appear to be due altogether to the development of a superabundance of the gangue minerals, but, generally, to have constituted a separate phase of ore deposition.

In hand specimen, this ore appears to consist of a mixture of rhodochrosite, calcite, barite, ankerite (?), dolomite (?) and a little quartz containing veins and irregular patches of sphalerite, galena, pyrite, chalcopyrite and tetrahedrite. Although not apparent to the naked eye, felspar is also present and is revealed on microscopic examination of the ore. The deposition of the metallic sulphides is clearly later than that of the carbonates, as the metallic minerals occur as infillings of tiny joints and fissures (in the carbonates) from which replacement has gone on laterally. With regard to the order in which the metallic minerals were deposited, no conclusive evidence could be obtained, but pyrite appears to have been first and tetrahedrite last. The metallic minerals are not invariably present in the carbonate formations portions of which are frequently barren.

Under the microscope, the ore is seen to consist mainly of a mosaic of mixed manganese, iron, calcium and magnesium carbonates containing felspar, quartz, barite and pyrite. The felspar, which is fairly abundant, is remarkably fresh, and contains numerous inclusions of apatite; both orthoclase and albite are present, the latter showing the usual lamellar twinning; some felspar is present as veins and associated with it is a little quartz. Considerable replacement of the felspar by carbonates has taken place. Quartz which is relatively subordinate is present as veins and irregular patches, and as a fine mosaic replacing carbonates; its formation appears to be contemporaneous with that of pyrite which was observed. Veins of calcite or rhodochrasite, contemporaneous with those of quartz, cut the ground mass. No definite stage in the order of crystallisation could be assigned to barite, but its formation appears to have been contemporaneous with that of the mixed carbonates.

In some cases, the carbonate ore replaces the quartz-sericite schists associated with the lodes, and all stages of the replacement may be observed. Despite the fact that the quartz-sericite schists were derived from sheared porphyries, the felspar present in the carbonate ore probably does not represent unaltered felspar remaining in the quartz sericite-schists, but has been deposited from the solutions which deposited the carbonates. This is indicated not only by the fresh appearance of the felspar, but also by the fact that in unreplaced portions of the quartz-sericite schists no felspar has been observed.

The sphalerite, galena and chalcopyrite of these ores is generally coarsely crystalline and is similar to that deposited in the fissures of the massive ore as described on page . In addition to the minerals enumerated, orthorhombic crystals of arsenopyrite occur associated with the lode carbonates but are embedded in an altered earthy carbonate rock of sedimentary origin which forms portion of the hanging wall of some of the lode carbonates of the Rosebery Mine. The presence of ilmenite and magnetite, is indicated by the analyses in Table 8.

(c) Processes involved in the Deposition of the Zinc-Lead Ores.

The relationships between the pyritised and sericitised wall rocks and the ore bodies, and the relative order of deposition of the various lode constituents, indicate three main stages in the formation of the zinc lead lodes. These stages are phases of one general period of ore deposition and in all probability there was no marked time interval between them.

The first stage in the formation of the lodes was the alteration and pyritisation of the porphyries with which the lodes are associated. The solutions causing these changes were rich in potash and sulphur, and, as indicated by the extensive alteration near the lodes, had great power of penetration. These solutions ascended along major fracture zones in the porphyries or along the contacts of included sedimentary xenoliths. The rocks in the neighbourhood of such fractures were subjected to the greatest amount of alteration and pyritisation, the intensity of which diminished laterally from the fractures.

Following the alteration of the porphyries came the deposition of the fine grained sulphides associated with minor quantities of gangue minerals. That the massive sulphides were formed at a later stage than the alteration of the porphyries is demonstrated by the fact that the massive ores contain chlorite and sericite as well as inclusions of pyritised schist. Further evidence is afforded by the transgressive nature of some of the contacts between the pyritised schist and the massive ore and also by the microscopic study of the ore.

An extensive development of carbonates and other gangue minerals, accompanied by minor deposition of sulphides, appears to have constituted the third and final stage in the development of the lodes. The bulk of this material occurs along those portions of the lode channel not already occupied by the fine grained sulphide ore. It must not be considered that the deposition of carbonates and other gangue minerals was confined wholly to this stage. Some carbonates were deposited during the alteration of the porphyries and to a greater extent during the formation of the fine grained ores. The point to be emphasised is that the maximum development of carbonates along the lode channels appears to have taken place after the formation of the fine grained sulphide ore.

The exact mode of deposition of the fine grained sulphides has been described by Loftus Hills (56) as replacements of beds of dolomitic limestone in schistose sedimentary rocks. This theory, however, does not harmonise with the facts that the greater portion of the rocks associated with the lodes are of igneous origin and that the only calcareous rocks associated with the lodes are the small patches of earthy carbonate rock interbedded with the hanging wall slates of the Rosebery mine. The greater portion of the carbonates described by Hills are undoubtedly lode carbonates. Further as the analyses of sheared porphyries etc. in table - page - show only minor quantities of CO_2, no extensive carbonation accompanied the alteration and pyritisation which preceded the formation of the massive sulphide ore.

Two possible modes of deposition of the fine grained sulphide ore are (1) replacements of the quartz-sericite schists and (2) simple fissure veins.

Evidence of the replacement of the schists is afforded by the presence of sericite, chlerite, magnetite and ilmenite in the fine grained ores. These minerals may be regarded as residual or unreplaced portions of the schists. Among the other gangue minerals, orthoclase and albite may represent material which has recrystallised during the formation of the lodes but barite, rhodochrosite and probably the whole of the calcite (see analyses table) represent new material brought in by the mineralising solutions. The microscopic examination of the schistose ore affords evidence of replacement but as previously stated (page) the schistose ore is generally limited to a thin selvage on the walls and is not representative of the ore body as a whole. A replacement theory suggests that the banded structure of the ores may be due to the partial control of the schistose planes in the course of the replacements, first by pyrite, and latterly sphalerite and galena.

On the other hand the ore bodies possess some of the features of simple fissure veins. Their contacts with the enclosing schist or slate walls are sharp and well defined. Prominent bulges in the ore are marked by a corresponding compression of the wall rock as is especially the case with the slate hanging-wall of the Rosebery mine. Further, small vein-like tongues extend from the massive sulphide ores into the hanging-wall slates. A similar effect is also sometimes seen at the end of a lens of sulphide ore where the main mass of sulphide breaks up into a number of vein-like tongues which penetrate the enclosing schists.

(d) <u>Distribution of the Gold & Silver.</u>

The analyses on page shows that the average amount of gold is 2.12 dwts. per ton of zinc-lead ore and of silver 8.5 ozs. With regard to the distribution of the gold, careful examination of the assay plans shows that there is no relationship between the gold content and that of zinc and lead but on the other hand those portions of the lode containing excessive pyrite appear to contain slightly increased quantities of gold. The bulk of the silver is apparently not associated with galena and there is no constant relationship between the amounts of silver and lead in the various portions of the lodes. Thus a general examination of the assays showed that in about half the assays examined high lead corresponded with high silver and that low lead corresponded with low silver. On the other hand many portions of the lodes high in lead were low in silver and other portions low in lead were high in silver. These observations regarding the silver take no cognisance of the presence or absence of tetrahedrite but it may be noted that although the tetrahedrite constitutes, on the average, only .4% of the ore, or about 8 lbs. per ton, it contains appreciable quantities of silver (see analysis p.) and its presence may influence the distribution of the silver. This question is discussed more fully below.

<u>Gold.</u>

Interesting facts relating to the distribution of the gold and silver have been obtained as a result of recent experimental work carried out by the metallurgical staff of the Rosebery Mine. Assays of the concentrates, obtained by differential flotation of the ore, showed that the gold was distributed as follows, viz:- Lead (Galena) Concentrate 58% and Zinc (Sphalerite) Concentrate 15%; the remaining 27% is included in the residues, which contain a considerable amount of pyrite. Furthermore, in the Lead Cleaner Concentrate there is shown an increase in the gold content of 30% to 100% above that contained in the Lead Rougher Concentrate. By making a bulk float of the sphalerite and galena, and then floating the pyrite, some of the gold was found to follow the pyrite, the distribution in the final concentrates being as follows:- viz:- Bulk Concentrates of Sphalerite and Galena 70.5%, Pyrite Concentrate 21.5%, Residues 8%.

In the Zeehan Mill a considerable amount of free gold, evidently concentrated mechanically, was found in the boot of the elevator carrying the discharged pulp from the grinding mill to the classifier, before any flotation had taken place. Free gold has been detected also in many places during the treatment of the ore. It seems probable that the gold in the ore is present in the free state and that it occurs as minute particles in the sulphides. The fact that the bulk of the gold finds its ways into the galena concentrate may be due to particles of gold set free during grinding being floated along with the galena. As the greater part of the tetrahedrite is also floated with the galena, any minute particles of gold present in the tetrahedrite would also find their way into the galena concentrate. Particles of gold present in sphalerite or pyrite which were not set free during grinding would naturally be included in the zinc concentrate or in the residues.

If such portions of the lodes as are oxidised, there is generally a relative concentration of gold, due to leaching of the more soluble constituents of the ore; thus the gossaneous capping of the Koonya lode is said to have contained from 5 to 10 dwts. of gold.

The occurrence, in the Recent & Tertiary Gravels, of large waterworn particles of free gold, which have evidently been shed from the zinc-lead lodes, suggests that there has been solution and redeposition of gold in the oxidised lode cappings.

No definite information could be obtained relating to the possible downward migration of gold in the zinc-lead ore bodies by the action of meteoric waters. The absence of secondary minerals in the upper sulphide zones indicates that there has been little if any secondary enrichment, and no marked increase in the gold content of this zone has been observed.

<u>Silver.</u> At present the only potentially argentiferous mineral known to exist in the Rosebery ores is tetrahedrite, that is if we exclude galena. Silver bearing minerals containing arsenic, antimony, copper and sulphur are known to exist in many zinc-lead sulphide deposits, and it is possible that portion of these elements, present in the lode, may enter into the composition of a silver bearing mineral (other than tetrahedrite) the presence of which has not yet been recognised. In view of this a consideration of the possible source of silver is given below.

In the experimental work referred to, the distribution of silver in the final concentrates was found to be as follows:- Lead (Galena), Concentrates 65%, Zinc (Sphalerite) Concentrate 25.2%, Residue 11.5%. In the concentrates obtained by making a bulk float of sphalerite and galena, and then floating the pyrite, the distribution was found to be:- Bulk float of Sphalerite and galena 94%, Pyrite float 5%, Residue 1%. These results apparently lead to the conclusion that silver shows some affinity for galena and to a lesser extent for sphalerite. However, it is found that on refloating the Lead Rougher Concentrate, in the ordinary treatment process, there is proportionally more lead floated than silver. In a few cases there is an increase in the silver content from 1% to 10% but usually there is a decrease. This supports the examination of the assay plans, which showed that there was no fixed ratio between silver and lead.

The following table, compiled from analyses in connection with the Zeehan Mill returns, illustrates the distribution of silver with respect to such other elements with which it is likely to be associated.

Table 9

Analyses of composite Samples for the period July 1929 to Feb.1930.

Constituents	Pb%	Zn%	Ag ozs.	Cu	As	Sb	Ag oz : Sb% ratio
Crude Ore	6.4	21.3	8.5	.50	.305	.10	8.5 : .1
Lead Concentrate	50	17.1	40	1.85	.15	.49	8.16: .1
Zinc Concentrate	4.6	51.8	10.2	.66	.157	.14	7.28: .1
Residue	1.3	3.2	2.4	.21	.454	.036	6.66: .1

These figures show still further the absence of anything approaching a constant ratio between lead and silver. Furthermore, there is no connection between zinc and silver. On the other hand, the ratio between silver and antimony, although not constant, is strongly suggestive that the silver is largely associated with tetrahedrite, and, while little reliance can be placed on the copper content, on account of the presence of chalcopyrite, it may be noted that copper, in each of the above analyses, is present in sufficient quantity to satisfy antimony in the formation of tetrahedrite.

The inferential value of the Ag : Sb ratio is somewhat lessened by the presence in the ore of the antimonial mineral bournonite, but, as has been indicated, bournonite is probably not very abundant and the amount present may not affect the ratio to any appreciable extent.

In the analysis of tetrahedrite on page the value of the Ag : Sb ratio is 6.73 ozs. Ag : .1% Sb. This agrees very closely with the results shown above, and affords further evidence that the bulk of the silver in the ore is present in tetrahedrite. Furthermore, it may now be deduced that if bournonite were present in appreciable amounts it would lower considerably the Ag : Sb ratios shown in the above table with respect to that obtained from the analysis of tetrahedrite.

It is possible, though not probable, that other sources of silver may exist and that bournonite may be present in such amounts that the ultimate silver antomony ratios in the crude ore &c. may not be affected. Against this idea it may be stated that other argentiferous minerals have not yet been detected, and, furthermore the fact that bournonite has not been recorded by previous observers is suggestive that it is present in very small amounts.

(2) Tourmaline & Fluorite Veins.

(a) General:- Several lodes and veins containing tourmaline and fluorite occur between the southern end of the Rosebery Mine and the Koonya Mine. The most important of these are situated on the following properties, viz. the old Mt. Black Mine (now portion of consolidated lease 9075/M), sections 10548 and 10549, the Salisbury Mine and on section 10455 previously held by the Rosebery Lodes Mining Company. These deposits are of no economic importance, but they are of some geological interest, inasmuch as they represent a distinct stage in the general processes of ore deposition within the district.

(b) Composition:- The following list includes all the minerals which have been observed throughout these deposits:-

Metallic Minerals:- Pyrite, Chalcopyrite, Galena Jamesonite, Bismuthinite and Sphalerite.

Non-metallic Minerals:- Tourmaline, Fluorite, Quartz, Siderite, Ankerite and Calcite.

In addition small amounts of gold and silver are generally present. Tin was reported as being present in one of these veins by Loftus Hills (57).

The relative amounts of these minerals present in the several different lodes show considerable variation. Thus, the sulphides may be fairly abundant, or they may occur as small particles scattered through the veins. Furthermore, different lodes are characterised by the presence of different sulphide minerals. Similar conditions prevail with regard to the non-metallic minerals; some lodes contain quartz and tourmaline, with no fluorite, while in other fluorite and carbonates are the principal gangue minerals and the lode may contain little or no tourmaline; again, quartz, tourmaline and fluorite may all be fairly abundant in the one lode. A general idea of the character of these deposits will be best conveyed by describing a few of the most important of them.

Perhaps the most important of these veins is that worked by the old Mt. Black Company. Unfortunately, none of the workings were accessible, and all that could be seen at the surface was a pyritic outcrop containing tourmaline. An excellent description of the lode is contained in Waller's report (58).

Waller states (p.12). "The ore deposit is a true fissure vein, consisting of quartz tourmaline, fluospar, iron and copper pyrites, and, in parts a good deal of wolframite and bismuth sulphide. The structure is banded, but not symmetrical, the bands of fluospar, with bunches of bismuth sulphides, being found principally near the hanging wall, and the quartz on the footwall. The tourmaline does not occur as bands but forms little veinlets and bunches through the other minerals. The quartz contains a large quantity of tourmaline in the form of fine needles".

Some analyses of ore from this mine are shown in the table below.

On the Salisbury Mine, quite close to the Williamsford road, is a small fissure vein about six inches wide composed of galena, jamesonite and a little pyrite, set in a gangue of fluorite with some siderite and a little tourmaline. The vein carries about 12 ozs. of silver per ton of ore. The ore is roughly banded, the sulphides occupying the centre of the vein with pale greenish fluorite and siderite on either side. The jamesonite is of a light steel grey colour and is readily distinguished from the galena; a somewhat impure sample was analysed with the following results:-

Analyses of Jamesonite

Constituents.	%
Pb	41.00
Sb	18.70
S	15.57
Cu	1.10
Fe	4.99
Al_2O_3	1.08
Mn	2.92
MgO	0.64
Insolubles	11.20
Ni. Co. Zn	Nil
	97.20

A little over three hundred feet up the hill from the above workings, a long adit has intersected a lode about four feet wide composed of quartz, tourmaline and pyrite. In some places, the lode material resembles dark cherty quartz, probably due to the presence of minute needles of tourmaline, and appears to contain no pyrite. In other places it contains abundant pyrite. This formation contains small amounts of gold, silver and copper.

On the section previously held by the Rosebery Lodes Mining Company, an adit has been driven for a distance of one hundred and forty feet on a fissure vein which varies in width from a few inches to a foot. The vein is composed principally of quartz, tourmaline and pyrite, with a little galena, sphalerite and jamesonite. In addition to these, ankerite, siderite and calcite are present in small amounts. Other veins occurring on this section appear to consist mainly of quartz, tourmaline and pyrite.

The veins occurring on leases 10548 and 10549 are generally simple fissure veins a few inches wide composed of quartz, tourmaline and pyrite. A formation a good deal larger than the majority of these veins occurs near the centre of lease 10549. This is a well defined lode, about 4 feet 6 inches wide, containing quartz, tourmaline, pyrite and carbonates. The pyrite is coarsely crystalline and has an extremely pale colour, though it is not arsenical. The quartz is vuggy and crystalline. Tourmaline occurs in seams and veins through the ore, and is also found in the country rock near the walls of the lode. Some of the formations in these sections are said to have carried a little gold.

Other small tourmaline veins, similar to those described above, occur to the south-west of the Dalmeny lease, on the old Berry Consols Mine.

The analyses of five samples of lode material from the Mt. Black and Salisbury Mines are shown below. These illustrate in a general way the chemical composition of some of the deposits.

(57). Hills, Loftus "The Zinc Lead Sulphide Deposits of the Read Rosebery District, Bulletin 23, p. 61, 1915.

(58). Waller, G.A. "On the Ore Deposits (other than those of tin) of North Dundas" 1902.

Table 10
Analyses of Lode Material from Tourmaline & Fluorite Veins.

Constituents	1	2	3	4	5
Au ozs. per ton	0.44	0.95	0.75	0.15	0.20
Ag " " "	0.34	0.48	0. 62	0.31	0.10
Cu %	1.40	0.82	1.26	1.52	0.93
Bi "	Tr.	7.44	-	Tr.	-
Pb	Tr.	Tr.	-	Tr.	Tr.
Zn	Tr.	0.31	-	Tr.	Tr.
Fe	16.83	9.45	18.90	16.83	9.53
SiO_2	21.30	32.85	20.10	46.90	69.83
Al_2O_3	5.39	12.02	11.90	12.96	12.42
MnO	0.14	0.12	-	0.15	0.21
Ca	18.20	15.39	14.73	Tr.	Tr.
CaO	-	-	-	3.32	-
MgO	0.94	0.40	-	0.95	Tr.
F	17.30	14.75	13.94	-	-
S	13.24	0.90	18.00	6.64	5.69
O_2(in CaO)	0.66	-	-	-	1.10
O_2(in FeO)	1.67	0.94	0.90	3.49	
	97.07	95.39	99.73	92.76	99.71

Analyst C.M. Henrie.

(1). Mt. Black Mine. Sample from face of south drive about 12' from main crosscut.

(2). Mt. Black Mine. Sample from face of south drive main lode near hanging wall.

(3). Mt. Black Mine bulk Sample.

(4). Mt. Black Mine, bulk sample No. 1 lode 100' level.

(5). Salisbury Mine. Upper adit 300' above Williamsford Road.

Analyses after Waller 1902 "Report on The Ore Deposits (other than those of tin) of North Dundas" p.13 and 17.

The presence of boron and fluorine (tourmaline and fluorite) in these deposits indicates that they belong to the gaseous or pneumatolytic phase of ore deposition, and that they were formed at much higher temperatures than the zinc-lead sulphide deposits, although both types are genetically of similar origin.

(c) Structure and Occurrence:- The majority of the tourmaline and fluorite veins strike in a general north-south direction and dip to the east at angles ranging from 40° to 60°. With the exception of the jamesonite bearing vein on the Salisbury Mine, and possibly also of some of the veins on the Rosebery Lodes Mine, they occur entirely in massive and slightly sheared quartz and felspar porphyries. The vein on the Salisbury mine is situated on the eastern margin of a small band of slate, a few feet wide, which is entirely enclosed by quartz porphyries; the dip of this vein is practically vertical. Some of the veins on the Rosebery Lodes Mine also appear to be associated with thin slate bands included in massive porphyries, but the exact nature of the occurrences could not be determined.

(3). Pyritic Copper Ore.

The only deposit of this type is that occurring in the Grand Centre Adit, which is situated a little to the south of the Koonya workings. The ore body is about thirty feet long and one foot wide, and consist of a dense vein of pyrite and chalcopyrite containing a little quartz and siderite as gangue minerals. In many respects the ore is identical with some of the dense pyritic portions of the massive zinc lead-sulphide ore bodies. No complete analyses of this ore were made, but a bulk sample was assayed with the following results:-

Cu 5.26%, Au 1 dwt. 1 gr., and Ag 1 oz. 17 dwts. 11 grs.

The country rock consists of sheared porphyries, chlorite schists, and quartz-sericite schists. The strike of the schistosity is north and south, and the dip is to the east at 40° to 60°. Some of the schists have been highly mineralised, and certain highly pyritised shear zones occur, on the surface, within a short distance of the workings.

The lode is conformable, both in strike and dip, with the enclosing schists and its contact with the country rock is sharp. In some places on the walls of the lode is a greenish black to black schist containing a little pyrite and chalcopyrite; the presence of chalcopyrite indicates some replacement or impregnation during the deposition of the ore. This dark greenish schist is similar to the greenish-black schists occurring on the footwall of the Rosebery Lode in the No. 6 and No. 8 level adits.

(4) The Axinite - Chalcopyrite Deposits of Colebrook Hill

(a) General:- These deposits occur entirely within the slates and breccias of the Dundas Series, and consist of several massive ore bodies of variable length and width situated near the top and on the steep flanks of Colebrook Hill. Among the individual ore bodies there is considerable variation in form, some being elongated lode like formations with a fairly definite strike, while others are very irregular and have indefinite boundaries. The strike and dips are also variable; in some cases, the strike is roughly meridional and thus conforms to that of the enclosing rocks; other ore bodies strike a little to the north of east and cut across the planes of sedimentation.

(b) Mineralogical Composition:- Placed in order of relative abundance the minerals constituting the bulk of the deposits are as follows:-

Metallic Minerals:-	Pyrrhotite, Chalcopyrite, Arsenopyrite, Pyrite, Marcasite (?), Native Copper, Galena, Zinc-Blende and Tetrahedrite.
Non-Metallic Minerals:-	Axinite, Actinolite, Calcite, Quartz, Datolite, and Danburite.

The predominant feature of these deposits is the abundance of axinite which along with actinolite constitutes at least 75% of the ore. Calcite is next in order of abundance, and is followed by quartz, these two minerals forming from 10% to 15% of the ore. Datolite and danburite occur in vugs and cavities but are otherwise rare. With regard to the metallic minerals the most common are pyrrhotite, pyrite, chalcopyrite and arsenopyrite. Small pieces of native copper are sometimes found in the country rock but have not been observed in the massive ore. In addition to these Waller (5 p3) has recorded the presence of marcasite and traces of galena, sphalerite and tetrahedrite.

In the absence of chemical analyses and assays, it is impossible to form an accurate estimate of the average mineralogical composition, and the figures above, for axinite, actinolite, calcite and quartz, must be regarded as approximations. The total metallic sulphide content would not exceed 15%, and is probably less. The copper content varies from .5% up to 3%, and averages a little more than .5%. Traces of gold and a little silver are also present, the latter rarely exceeding 1 oz. per ton of ore.

The ore bodies show comparatively little oxidation, and, generally, the unweathered ore may be found a few feet below the surface. Several gossanous outcrops do occur but are never very extensive; they sometimes contain small quantities of malachite.

(c) Structure & Paragensis of the Ore.

While the general character of the deposits is fairly constant, two types of ore may be recognised, one being banded, the other massive. Between these types there is no sharp line of demarcation; they may occur in adjacent masses in the same ore body and one grades readily into the other.

The banded ores, which are the more common of the two types, consist of alternating bands of axinite and actinolite, which vary in width from half an inch to an inch. Calcite, quartz and the greater portion of the metallic sulphides are associated with the axinite, but the actinolite bands, which consist of radiating and irregular aggregates of tiny acicular crystals, are very often remarkably free from the other constituents. The axinite is coarsely crystalline, the crystals ranging in size from a quarter to half an inch. Calcite occurs as coarse rhomboidal crystals, and, in certain portions of the lodes, is quite as abundant as axinite. Quartz, is never very abundant and generally occurs as irregular patches. The metallic sulphides, of which pyrrhotite and chalcopyrite are the most abundant, occur as irregular patches disseminated through the axinite veins, or as small seams between the veins of axinite and actinolite. Occasionally some of the sulphides are associated with actinolite.

The massive ores resemble a coarsely crystalline igneous rock and are composed of large idiomorphic crystals of axinite, coarse radiating patches of actinolite, large hypidiomorphic crystals of calcite and veins and irregular patches of quartz. The metallic sulphides occur either as small particles disseminated through this rock like mass or as large irregular veins and patches in it. Pyrrhotite and chalcopyrite are often closely associated and form the bulk of the metallic constituents. Pyrite is fairly abundant in some portions of the deposits but is absent in others. Arsenopyrite occurs as small crystals or irregular patches dispersed through the mass and is also associated with irregular veins or patches of quartz. In certain portions of the deposits arsenopyrite is more abundant than either pyrrhotite or chalcopyrite.

In his report on the Colebrook Mine, Waller (59) refers to the occurrence of large bands and masses of pyrrhotite, up to ten or fifteen feet in thickness, which were associated with chalcopyrite, and which contained crystals of axinite interbedded in the mass, but, as these bands had been worked out prior to the writer's examination, it is not possible to include descriptions of them.

A fairly definite order of crystallisation, similar to that of igneous rocks, may be observed throughout the bulk of these ores. This is as follows:- axinite, actinolite, metallic sulphides, calcite, quartz. Thus axinite and actinolite are always idiomorphic towards calcite, and calcite is idiomorphic towards quartz. The sulphides appear to have crystallised at a stage intermediate between that of actinolite and calcite.

On account of their rock like texture, these deposits were regarded, by Twelvetrees and Petterd (60) and later by Harcourt Smith (61), as being intrusions of a basic igneous rock containing segregations of metallic sulphides. The rock itself was described as a limurite. Furthermore, it was thought that the formation of axinite, datolite and danburite was due to the action of vapours and gases containing boron which accompanied the intrusion. On the other hand, Waller (62) who examined the deposits in 1902, described them as replacements of an impure limestone.

(59) Waller, G.A. "The Ore Deposits (other than those of tin) of North Dundas. 1902 p. 3.
(60) Twelvetrees and Petterd "On the Occurrence of Limurite in Tasmania". Proc. Royal Socy. of Tasmania 1897.
(61) Smith, J. Harcourt "Report on the Mineral Fields in the Neighbourhood of Mt. Black etc." 1898 p. 9.
(62) Do above (59) p.4

There can be little doubt but that Waller's view is the correct one, and that the deposits were formed as a result of the hydrothermal and pneumatolytic action of hot ascending solutions rich in the various metallic sulphides, CO_2 and boron, and that the process was one of replacement, but, in view of the fact that the country rocks are typical of the slates and breccias of the Dundas Series, and are not impure limestones, it is necessary to modify, Waller's views.

Throughout the deposits, the boundaries of the several ore bodies are nowhere very well defined, and veins of axinite and actinolite frequently penetrate the country rock. The banding does not conform to the strike of the individual ore bodies, but, generally is more or less parallel to the planes of sedimentation. The ore bodies frequently contain areas of unreplaced slate or breccia, and, in many cases the process of replacement may be observed in all stages. Frequently, the early stages of its development may be observed along tiny cracks, fissures, or bedding planes which contain axinite and actinolite. Another effect of the replacement is the conversion of portions of the country rock into a rock composed largely of actinolite. It seems probable that the banded ores have been formed by these solutions which were controlled by the bedding planes, but that the formation of the massive ores has taken place where the replacement was more or less general.

With regard to the nature of the mineralising solutions, it has already been remarked that they were hot ascending solutions containing boron and carbon dioxide as well as metallic sulphides. No chemical analyses were made of the enclosing slates and breccias, but the breccias are composed largely of igneous material and contain abundant chlorite, augite and felspar. Hence, it seems probable that some at least of the lime contained in the actinolite, axinite and calcite, and the iron and magnesium in the actinolite may represent material derived from the breccias. This applies more particularly to iron and magnesium than to calcium, the latter being so abundant in the deposits as to suggest that it was a fairly abundant constituent of the mineralising solutions.

Quite apart from the metasomatic metamorphism, the temperature changes accompanying the formation of these ores have resulted in the conversion of many of the slate bands, adjacent to the ore bodies, into hard dense cherts.

(5) Tin Deposits

(a) General.

Occurrences of tin ore within the mapped area are restricted to its extreme south-western portion, and form part of the X River Tinfield described by Ward (63). As only one mine, the Athenic, comes within the purview of this report the following descriptive matters refers mainly to observations made during the examination of that mine.

(b) Composition.

The deposits consist mainly of quartz veins containing cassiterite, pyrite, chalcopyrite, actinolite and tourmaline. The cassiterite is extremely fine in grain and is rarely visible to the unaided eye; this is particularly so with regard to the cassiterite occurring in oxidised portions of the veins. Pyrite occurs disseminated through the veins and is never very abundant. The chalcopyrite is present as small irregular patches associated with pyrite. Both actinolite and tourmaline occur as needle like crystals. The greater number of the occurrences examined were exposed in shallow workings on the surface, and consisted of limonitic quartz veins containing small amounts of finely disseminated cassiterite, the presence of which could be determined only by crushing and panning the ore. Assays of samples from some of the veins in the deeper workings ranged from .1% to 1% tin, though some of the oxidised veins, of which no assays were made, are said to contain up to 5% tin.

(c) Structure & Occurrence.

The veins occur entirely within the Dundas Slates and Breccias, and penetrate small joints, fractures and bedding planes within these rocks. The largest vein has been traced over a distance of 500 feet on the surface, and for 120 feet underground; it strikes N 45°W and dips to the south-west at an angle of 85°. Other smaller veins strike north and south.

Except for the fact that some of the slates in close proximity to the veins have been slightly baked and toughened there has been comparatively little alteration of the country rock, though there is a little pyritic impregnation in a few places.

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(63) Ward L.K. "The X River Tin Field" Bulletin 12.

(6) Relationships between the Ore Bodies and the Geological Features.

A consideration of the distribution of the ore deposits with respect to the several lithological types indicates that ore deposition within the district has been controlled to a large extent by the geological structure and relationships of the various rock types.

Viewed broadly, the area is divisible into two main portions, viz. a western portion composed mainly of sedimentary rocks ranging in age from Cambrian to Ordovisian, and an eastern portion compgsed of acid porphyries and felsites. The contact between the sedimentary and igneous rocks, being fundamentally a line of weakness, has provided relief for dynamic earth movements, the major portion of which has taken place in the quartz porphyries and along the western margin of the felspar porphyries. Furthermore, the shearing forces have attained their maximum in the vicinity of isolated areas of sedimentary rock occurring within the porphyries and felsites.

Theoretically, this sheared margin of the acid igneous rocks should form a favourable zone for the formation of metalliferous deposits, and, in fact, this has been the case. Ore deposits have been formed within the quartz porphyries, within the sheared felspar porphyries, along the contacts of sheared porphyries with included sedimentary bands and, occasionally, within massive porphyries.

The ore bodies occurring within massive felspar porphyries are of no importance, and consist mainly of quartz-tourmaline-pyrite veins and lodes, which may carry a little galena, sphalerite, jamesonite or bismuthinite, and, occasionally, a little gold. The majority are small fissure veins a few inches wide.

Within the quartz porphyries the lodes are of a type generally similar to those occurring in the massive felspar porphyries. Some of the tourmaline veins are somewhat larger, but they are almost devoid of valuable mineral content. An exception to the general run of lodes in the quartz porphyries occurs in the lower adit of the Salisbury mine, where a small galena-jamesonite fluorite vein occurs on the hanging wall of a small included lens of slate; this vein, however, is of no economic importance.

The sheared felspar porphyries, with which are included the quartz-sericite and chloritic schists, contain lodes of greater relative importance. These include the zinc-lead lodes of the Koonya, Dalmeny and Black P.A. Sections and the pyritic copper lode of the Grand Centre Adit. In the vicinity of these lodes, the porphyries often exhibit a considerable degree of alteration, the extent and nature of which is roughly proportional to the size of the contained ore body; thus, to take a specific case, there is a considerable development of intensely altered porphyries, chlorite schists and pyritised quartz sericite schists immediately east of the Koonya Lode. Although the sheared porphyries have provided lodes which may have warranted prospecting, they have so far produced no ore body of any value, most of the lodes being too small to warrant mining.

The most important and only payable lode within the district is the zinc-lead sulphide ore body of the Rosebery Mine. This occurs along the contact of a large isolated belt of sedimentary rocks, consisting principally of slates, which is enclosed within massive and sheared porphyries etc. The longitudinal extent of the lode coincides roughly with that of the slates, and, although the point of termination of the lode, at both its northern and southern ends, does not coincides EXACTLY with that of the slates, it is apparent that the contact between the slates and the sheared porphyries has provided a favourable line of weakness for the injection of the metalliferous solutions.

The Nos. 2 and 3 lenses and the southern portion of No. 1 lens on the Rosebery mine certainly occur in sheared porphyry but the Nos. 2 and 3 lenses are less than 50 feet from the slate-porphyry contact and the southern portion of No. 1 lens extends in a direct line from it. In the Hercules Mine at Mt. Read the "G" lode also occurs entirely in sheared porphyries but, although the geology of that mine was not studied in detail, most of the lodes occur close to a large included belt of slates occurring within sheared porphyries.

Other smaller lodes associated with included slatey bands are the small tourmaline-pyrite vein of the Rosebery Lodes Mine and the galena-jamesonite-fluorite vein already referred to. In these cases, the sedimentary bands are small, and, although they provide lines of weakness for the shearing forces, they were not sufficiently large to provide adequate fissures for the deposition of large ore bodies.

Among the sedimentary rocks of the western belt, the Dundas slates and breccias alone have been found to contain metalliferous deposits. Neither of the deposits occurring in the slates and breccias in this area, viz. the tin bearing veins of the Athenic Mine and the Copper deposits of Colebrook Hill, are of any economic importance, but, as the Dundas slates and breccias have been found to contain payable ore bodies elsewhere, they must not be regarded as being barren, and, though they themselves are not to be regarded as a possible source of mineralising solutions, they form favourable hosts for their deposition.

A zone of pyritic impregnation, containing a little galena in places, occurs along the contact of the purple slates with the upper members of the breccia-conglomerate horizon, but the indications are not sufficient to warrant further prospecting. The mineralisation is probably connected with the pneumatolytic action which gave rise to the impregnation of the breccia-conglomerate by fuchsite.

The relationships between the ore bodies and the geological features indicate that, with the exception of the Dundas slates and breccias, the sedimentary rocks are likely to prove barren, and that the most favourable zone for future prospecting operations in the vicinity of this area is the sheared and fractured margin of the acid igneous rocks. Furthermore, payable ore bodies are most likely to occur near isolated sedimentary belts occurring within this sheared margin. The fact that there are included sedimentary belts with which no ore bodies are associated does not detract from the value of this theory, and, it must be regarded as significant that the only payable zinc-lead ore bodies of both the Rosebery and Mt. Read Districts are associated with isolated areas of slatey sedimentary rocks which are enclosed by massive and sheared porphyries. The nature of the association in each case differs, but the underlying principle remains the same, viz. that the vicinity these sedimentary bands provides adequate lines of weakness for the injection and percolation of the mineralising solutions.

(7) Summary of the Genesis of the Ore Deposits.

(a). General.

Modern conceptions relating to the origin of primary metalliferous deposits agree that their formation is closely connected with periods of igneous activity. The ore deposits are not derived from the igneous rocks themselves, but from a primary igneous magma which contained the necessary constituents for the formation of both the igneous rock and the ore deposit. The metalliferous solutions or ore magmas, whose deposition forms the lodes, are derived from the igneous magma by processes of differentiation, which take place during the final stages of its cooling. We need not concern ourselves with the exact processes by which this differentiation is effected, except insofar as to state that in the case of sulphide ore bodies, such as the zinc-lead deposits of this district, it is probably due to the limited miscibility of sulphides in silicate melts, and in the case of tin deposits, such as those of the Athentic Mine, to segregation of the gaseous constituents of the magma, or, as it has been called, to gaseous extraction. Ore deposition follows the intrusion of the igneous rock and takes place after its consolidation. The mineralising solutions rise by the most favourable channels available, and, when conditions as to temperature and pressure are suitable they are deposited and form lodes or veins. As the deposition follows the solidification of the igneous rock, a lode or mineral deposit may be formed either in, or of the margin the rock with which it is genetically connected, or in the surrounding country rock.

Moreover, it has been found that certain minerals or groups of minerals tend to be deposited under certain conditions of temperature and pressure. Thus, if the primary metalliferous solutions contained tin, copper, zinc and lead, and these were deposited by rising solutions in one vertical plane, the tin or cassiterite which is deposited at higher temperatures would be precipated first; copper, which is deposited at a somewhat lower temperature, would be next and the zinc and lead which are deposited at still lower temperatures would be last. Hence, the lode would be split up into zones such that zinc and lead would be found in the upper portions of the deposit, copper lower down and tin still lower. The underlying principle is that the temperature decreases as the distance from the source increases. Excellent examples of this vertical zoning are found in the tin, copper and zinc-lead lodes of Cornwall. Vertical zoning does not always take place and there are many lodes which contain only one valuable metal or group of metals, but, at the same time it is necessary to recognise the possibilities of its occurrence.

In addition to the general association between igneous rocks and metalliferous deposits, there is very often a much closer relationship, inasmuch as certain types of ore deposits are allied to certain fairly definite types of igneous rock. Thus, tin is often genetically associated with granite, osmiridium with serpentine and gold with rocks of intermediate composition.

Hence, in considering the genesis or origin of the ore deposits of this district, it is important to determine if possible, the particular igneous rocks with which they are genetically associated, the nature of the metalliferous solutions, the channels traversed by the solutions and also the nature of the relationships between the several types of ore deposit. As the nature of the solutions and the channels traversed by them have been discussed in previous pages, it is proposed to restrict the present discussion to the origin of the solutions and the nature of the relationships between the several types of ore deposit.

(b). Origin of the Mineralising Solutions.

The theory, of the genetic relationship between certain types of metals and certain kinds of igneous rock, has been developed mainly as a result of the observation and correlation of the known facts regarding the occurrence of particular types of ore deposits. Thus, the derivation of tin ores from granitic magmas was suggested, primarily, by the constant association of tin deposits with granitic rocks, and, similarly the derivation of metals of the platinum group from ultra basic magmas was suggested by the constant association of platinum deposits with ultra basic rocks. If, therefore, we can find a similar relationship for the ore deposits with which we are dealing, we will have established a "prima facie" case for the origin of the metalliferous solutions.

In the area under discussion, there are two main groups of ore deposits which on account of their mineralogical composition and occurrence may be considered separately. Of these, one group comprises the zinc-lead sulphide ore bodies, the deposit of pyritic copper ore and the tourmaline and fluorite veins, the other group comprises the tin veins and the axinite-chalcopyrite deposits of Colebrook Hill. It is not suggested, at present, that these two groups are of different origin, but the zinc-lead group has certain features in common with other ore deposits occurring along the West Coast, and a consideration of these will be useful in elucidating our present problem. The inclusion of the tourmaline and fluorite veins with the zinc-lead group has been considered justifiable on the grounds that the principal metallic minerals, apart from pyrite, present in them are sulphides of lead, zinc, copper and antimony.

Most of the important ore deposits of the West Coast Mineral belt occur along the margin of the belt of intrusive quartz and felspar porphyries described in the preceding pages. Thus we have copper-silver-gold deposits at Jukes-Darwin, copper at Mt. Lyell, zinc-lead at Mt. Read, the zinc-lead group at Rosebery, copper and silver-lead at Mt. Farrell, pyrite-chalcopyrite at Mt. Chester and zinc-lead at the Pinnacles. At Mt. Read, Rosebery, Mt. Chester and the Pinnacles, the ore bodies occur along the western margin of the porphyries. At Mt. Lyell and Mt. Farrell, they occur along the eastern margin. Sometimes the lodes occur within the porphyries, sometimes in the adjacent sedimentary rocks. This constant association of the ore deposits with the intrusive porphyries is, therefore, suggestive evidence of a close genetic relationship between them. Furthermore, these lodes exhibit a close mineralogical similarity. The chief primary minerals are pyrite, galena, sphalerite, chalcopyrite, gold, various sulphantimonides of silver, copper and lead, barite, rhodochrosite and siderite. With the exception of rhodochrosite and siderite, practically all of the above minerals are common to most of the deposits. The production of the various types of ore deposits is probably due to variations in the composition of the ore bearing solutions at numerous centres within the magma.

In addition to their close association with the porphyries and their general mineralogical similarity, these deposits exhibit other features which stamp them as the product of an acid magma. Thus, when the lodes occur within porphyries, as at Rosebery, Mt. Read, Mt. Lyell and Mt. Farrell (64), the characteristic type of alteration of the wall rocks is sericitisation. This implies an introduction of potash which is a common constituent of acid derived magmas. Other available evidence at Rosebery also supports this conclusion, e.g. the presence of the tourmaline veins and the occurrence of felspar in the zinc-lead lodes.

With regard to the tin deposits of the Athenic Mine and the axinite-chalcopyrite deposits of Colebrook Hill, Ward (65) has suggested that they were probably derived from underlying granites, and has correlated them with tin deposits of North Dundas, which are associated with granite porphyries. While there is no proof of the existence of granites at shallow depth, the fact that tin deposits in Tasmania are almost invariably associated with granites, renders it possible that Wards view is the correct one. This subject is discussed more fully below.

(c). Relationships between the Zinc-Lead Ore Bodies and the Tourmaline & Fluorite Veins.

While their mineralogical composition indicates that the tourmaline and fluorite veins were deposited over a fairly wide range of temperature, they belong generally to a high temperature or pneumatolytic phase of ore deposition. On the other hand, the zinc lead-ores are characteristic of deposits formed at low or moderate temperatures. It was thought, at first, that these two groups were an expression of the temperature range of deposition from a common magmatic source. In other words they appeared to represent successive vertical zones in a single phase of ore deposition.

However, the following table shows that there is a considerable overlap in their known vertical ranges, and at the same time, indicates that they probably represent distinct phases in one extensive period of ore deposition.

Table 11
Table Showing Vertical Ranges of Lodes.

Tourmaline & Fluorite Veins		Zinc-lead Lodes	
Mine	Height of lode above sea level.	Mine	Height of lode above sea level
Salisbury	665 to 950 feet	Koonya	1,400 to 1,537 feet (approx)
Mt. Black	450 to 550 "	Rosebery	150 to 1,225 "
Rosebery Lodes	500 "	Dalmeny	500 "
Sections 10548 and 10549.	500 "	Black P.A.	335 "

(64). L.K. Ward, "The Mt. Farrel Mining Field" Bulletin 3 p. 60, 1908.
(65). L.K. Ward, The X River Tinfield, Bulletin 12 p.14, 1911.

Although no occurrences are known which would place the relationships between these two groups beyond doubt, it seems probable that the tourmaline and fluorite veins were formed at an earlier stage than the zinc-lead lodes.

(d). Relationships between the Zinc-lead Group & the Tin & Axinite-chalcopyrite Deposits.

The question of the relationships between these two groups is really part of the broader question of the general relationships between the tin and other high temperature mineral deposits of Tasmania and those of zinc-lead, silver-lead and pyritic-copper which constitute the low or moderate temperature deposits. Generally, the former are closely associated with the Devonian granites and the latter with the intrusive porphyries. If the view stated on page , that the main belt of porphyries is of Devonian age, is correct, then the granites and the porphyries probably represent the plutonic and hypabyssal phases, respectively, of the Devonian igneous activity. Thus, while each of these phases is genetically associated with a fairly definite suite of ore deposits, it would not be surprising, in view of their close relationships, if there was some overlapping. Hence while it is possible that the tin and chalcopyrite deposits are genetically associated with granites, it is also possible that, like the tourmaline and fluorite veins they represent a high temperature phase of the period of mineralisation, associated with the intrusion of the porphyries.

(8). Alluvial Gold.

Small amounts of alluvial gold occur in many of the Recent and Tertiary gravels and in the beds of the present streams. The gold is present as very fine particles about the size of a pins head and as larger particles approximately one-tenth of an inch in diameter. The amount of gold in the gravels is never sufficient to make the working of them a payable proposition, although, in the past a certain amount has been won from gravels in Assay Creek and from the fluvio-glacial deposits lying to the east of the Rosebery Mine workings.

The greater portion of the alluvial gold in this district has been shed from the oxidised lode cappings of the Rosebery and Hercules Mines. The gold in gravels occurring to the north of the Stitt River has been derived from the Rosebery Mine, and that in the gravels of the Natone Valley has been derived from the Hercules.

In view of recent activities in connection with the Williamsford Deep Lead, there has been much speculation as to the probable position of the outlet in this district. Although it would be difficult to determine the exact position of the outlet, reference to the general geological map will show that glacial boulder beds, sands, gravels and clays extend from the Rosebery railway station southwards towards Williamsford. The glacial beds generally overlie the gravels, sands and clays. It seems probable that the Natone Valley is really the old valley of the Ring River and that in pre-glacial times it drained a large portion of the country in the vicinity of Mt. Read. The main portion of this old valley appears to extend between the 70½ and 71 Mile Pegs on the Emu Bay Line, and to enter the Pieman River somewhere between the mouths of the Stitt River and Natone Creek. From the following considerations, it is highly improbable that gold is present in payable quantitites in the basal gravels of this old valley. These are:-

(1) Any gold present in the gravels of the old Natone Valley (or former course of the Ring River) must have been derived from the Hercules and Mt. Read Mines.

(2) The Williamsford Deep Lead, which is quite close to the source of gold, has been proved, quite definitely, to be unpayable.

(3) As the distance from the source of the gold increases, the gold content of the gravels will decrease. The deeper ground in this district is at least five miles from the source of gold.

VII. THE MINING PROPERTIES.

(1). The Electrolytic Zinc Company of Australia Limited.

This company's holdings in the Rosebery district include a section of 939 acres forming part of Special Consolidated Lease 9075/M, an 80 acre section forming part of Consolidated Lease 9749/M one 14 acre and two 40 acre sections forming part of Special Lease 10635, Special Lease 9300/M of 158 acres, and Lease 10002/M of 80acres, Lease 10002/M is generally known as the Dalmeny section. Leases 9075/M and 9300/M embrace the former holdings of the Tasmanian Copper, North Tasmanian Copper and Primrose Companies, and the whole of the mine workings are now known as the Rosebery Mine, although the individual names are sometimes retained for purely local usage. Lease 9075/M also embraces the old Mt. Black Mine, which is situated immediately east of Lease 10547/M, and the old Black P.A. Mine, which lies a few chains below the railway bridge over the Stitt River.

(a). The Rosebery Mine.

(i). Location & Access.

This mine, which is situated immediately to the north of the township is the largest and only payable mine within the district. It is connected by road with the Rosebery railway station and is also served from the railway by a branch line from Primrose Siding.

(ii). Previous Reports.

(1). A. Montgomery. Report on "The Mineral Fields in the neighbourhood of Zeehan, viz. :-Mackintosh River, Mt. Black, Mt. Read, Mt. Dundas, Mt. Zeehan, Stanley River and Mt. Heemskirk", 1895.

(2). A. Montgomery. Report on "The Zeehan-Dundas Mineral Fields in February 1896".

(3). J. Harcourt Smith. Report on "The Mineral fields in the neighbourhood of Mt. Black, Ringville, Mt. Read and Lake Dora", 1898.

(4). G.A. Waller. Report on "The Ore Deposits (other than those of tin) of North Dundas" 1902.

(5). G.A. Waller. Report on "The Primrose Mine, Rosebery", 1903.

(6). Loftus Hills. Preliminary Report on "The Zinc-Lead sulphide deposits of the Rosebery District".

(7). Loftus Hills. "The Zinc-Lead Sulphide Deposits of the Read-Rosebery District, Part 11. Rosebery" Bulletin 23, 1915.

(8). Loftus Hills. "The Zinc-Lead Sulphide Deposits of the Read-Rosebery District, "Part 111 Bulletin 31, 1919.

(iii) History.

The history of this mine has been dealt with in an earlier section and need not be recapitulated.

(iv) Geology.

Most of the important points in connection with the general geology of this mine have already been mentioned during the course of this report, but, in view of the importance of the one lode occurring on it, it may be advisable to give a brief resume of the salient geological features.

Once the true character of the rock alteration has been recognised, the geology of the mine is comparatively simple. The lode, which extends over a total linear distance of 4000 feet, lies for the greater part of its length on the western side of an elongated band of slate, whose width varies from 100 to 200 feet and whose length is about 4,400 feet. The slate belt strikes N. 20° W (magnetic) and dips to the east at an average angle of 45°. The lode adheres to the slates in dip as well as along their strike. The rocks on the eastern side of this slatey band are all massive felspar porphyries. Those on the western side, i.e. forming the footwall of the lode, consists principally of sheared porphyries, chloritic schists and quartz-sericite schists; many of these rocks are pyritised, particularly when in close proximity to the lode. The schistose footwall rocks are derivatives of the massive felspar porphyries, and in their unaltered condition were similar to the massive porphyries occurring on the eastern side of the slate belt; they have been altered to their present state by the shearing which preceded ore deposition and by the hydrothermal action which accompanied it. The fact that the porphyries on the eastern side of the slate belt are quite unaltered is probably due to the impervious nature of the slates; these appear to have acted as a dam and have prevented the mineralising solutions from penetrating the porphyries occurring on their eastern side; at the southern end of the mine where the lode is entirely in the sheared and altered porphyries, and in other portions of the mine where the lode lies a little to the west of the slates, the schists occurring on the hanging wall are similar to those of the footwall.

This brief resume will serve to emphasise the principal features in connection with the general geology and mode of occurrence of the lode. The details will be best comprehended by a study of the accompanying plan of the Rosebery Mine (Plate), which shows the actual occurrences of massive sulphide ore, and the position of the western boundary of the slate belt at each of the mine level horizons. The position of the slates has been determined from actual observations in the mine, and from a close study of the diamond drill data. At the No. 8 level horizon, the full width of the slates has been shown from their southern termination as far north as bore 29R. The surface features of the northern and southern ends of the mine are also shown on the plan.

(V) The Lode.

While the lode may be said to be continuous over a total length of four thousand feet, there are at least four fairly consistent breaks in the continuity of the massive sulphide ore, so that the lode may be split up into five shoots or lenses. On the plan these have been numbered from south to north. The most northerly lens and the one adjacent to it appear to junction in depth and have, therefore, been designated Nos. 4B and 4A, respectively. Between the lenses of sulphide, the lode consists either of mineralised quartz-sericite schist, or of low grade carbonate ore.

The No. 1 lens has a total length of, approximately

1,400 feet and varies in width from 10 to 50 feet; the mean width, measured horizontally, is, approximately, 20 feet. It extends from a mean position corresponding with the General Service, or 13N, Rise to the southern end of the No. 8 level; the main portion really terminates near the No.IS Rise. For a distance of 1,000 feet on the No. 5 level, and for 750 feet on the Nos. 6,7, and 8, levels this lens is on the contact of the slates and the quartz-sericite schists &c.; at Nos. 3 and 4 levels it is also on the contact. On the Nos. 6,7, and 8 levels from the No. 6 Rise southwards, this lens is entirely within the quartz-sericite schists and sheared porphyries.

The breaking up and final termination of the slate belt at the southern end of the mine appears to have some influence on the occurrences of ore, and it is significant that, with the exception of two small seams of pyritic ore occurring to the east of this southern end of the No. 7 and 8 levels, no fresh makes of massive sulphide occur further to the south. A fairly wide zone of mineralised schist persists beyond Bore D.

The northern end of No. 1 lens corresponds with a position where the lode leaves the slate contact and enters the quartz-sericite schists &c. Thus, on the Nos. 6,7, and 8 levels, the slates could not be traced farther north than the 12 N Rise, and, in each case, a distinct break in the ore occurred a few feet north of this rise. On the No. 5 level, the No. 1 and No. 2 lenses are continuous. At the No. 3 and No. 4 levels, the end of the No. 1 lens occurs at the 12 N and 13 N Rises respectively; the position corresponds generally with that of the break in the ore at the lower levels of the mines.

The No. 2 lens is separated from the No. 1 by a zone of low grade carbonate ore, the extent of which varies in each of the mine levels. Thus, at No. 3 level it is nearly 400 feet long, while at No. 6 level it is only 30 feet. The full extent of the No. 2 lens is not yet known, as it has been developed only over a portion of its total length. At No. 3 level it is about 250 feet long, and at No. 4 it is about 400 feet, but the development work and diamond drill bores indicate that it is considerably longer at the lower levels. From the 16 N.Rise at No. 3 level, its southern end appears to have an irregular southerly pitch in the direction of the 13 N Rise at No. 6 level; below No. 6 level the pitch is northerly. The northern end of this lens appears to pitch to the north between the No. 3 and No. 4 levels, but, below No. 4, very little is known of its occurrence. However, from the information provided by bores 19 and 21, and bores 16, 17 and 29 it seems probable that the northern end of this shoot lies generally in a vertical plane extending in an easterly direction from the air shaft at No. 2 level. This shoot occurs entirely within the quartz-sericite schists and sheared porphyries, and lies at a distance varying from 10 to 50 feet from the western boundary of the slate belt.

The relative positions of the No. 1 and No. 2 lenses with respect to the slates are illustrated by the cross sections accompanying the plan of the mine.

The No. 3 lens is a comparatively small, low grade shoot of ore occurring two hundred feet north of the No. 2. It has been exposed only on the No. 2 level, and consists of a shoot of sulphide ore 140 feet long which varies in width from 5 to 13 feet. Below the position of this lens on the No. 2 level, bores Nos. 16 and 17 have cut ore at horizons corresponding with the Nos. 4 and 5 levels, respectively. Bore No. 35, which diverged upwards and to the south west, cut a narrow seam of ore at 722 feet above sea level. The projected position of this ore, at 760 feet above sea level, lies immediately north of the ore cut by No. 17 bore; on the plan, these two occurrences have been connected. The ore at No. 2 level and the occurrences in the diamond drill bores constitute the total available evidence with regard to the distribution of the ore in the No. 3 lens. Bore No. 29, which should have cut this lens in depth, diverged upwards and to the north west, and, although it penetrated the slates and passed three hundred feet beyond them, it failed to cut ore; the position of the lode channel and the slate belt, as revealed by the available data with regard to Bore 29, are shown on the plan of the mine. The position of the No. 3 lens with respect to the slates is similar to that of No. 2 lens; it occurs entirely within the quartz-sericite schists and sheared porphyries at a distance varying from 40 to 50 feet from the western boundary of the slates.

From the start of the No. 2 level drive up to the south end of No. 3 lens, the lode consists of highly mineralised quartz-sericite schists and low grade carbonate gangue containing a little sphalerite and galena. In some places it is highly siliceous. Between the Nos. 2 and 3 lenses, the lode also consists mainly of low grade carbonate gangue and mineralised schist.

The No. 4A lens is exposed in the mine workings at the southern end of No. 1 level and at the northern end of No. 2 level; it has also been cut at the horizon of No. 3 level by bore 30R. At the No. 1 level it is 120 feet long, and varies in width from 5 to 20 feet. At the No. 2 level, it is, approximately, 350 feet long, and has a maximum width of 20 feet. In the face of the No. 2 level drive the ore still persists.

The No. 4B lens, occurs a short distance north of No. 4A. In the drive of the No. 1A level, it consists of a few small sulphide veins occurring within the slates, but, just below the floor of the drive, in a winze about twenty feet from the adit-crosscut, there is about four feet of solid sulphide ore. At the northern end of No. 1 level this lens is about eighty feet long; this ore has been cut at, approximately, at horizon of No. 2 level by bore No. 32R. On the plan, the ore cut in bore No. 31R has been projected to the horizon of No. 2 level. It will be seen that this ore occurs midway between the end of No. 2 level and bore No. 32, and, directly below the blank patch in the lode at No. 1 level. Hence, it seems probable that the No. 4A and No. 4B lenses may junction at, or immediately below the horizon of No. 2 level. What is probably the northern extension of No. 4 B lens has been cut by bore No. 33R at, approximately, the horizon of No.5 level.

At No. 1 level, the No. 4A and 4B lenses occur on the contact of the slates. At No. 2 level and in bores 31R and 32R the ore is entirely in the quartz-sericite schists, and lies about twenty feet from the slates, but, from the information supplied by bores 30R and 33R, it seems probable that any ore below the No. 2 level will occur on, or within a few feet of, the western margin of the slates.

The general mode of occurrence of these lenses with respect to slate contact is illustrated diagramatically by the sketch plan at the foot of Plate . It will be observed that, out of a total length of four thousand feet, the lode occurs for three thousand three hundred feet of its length on, or close to, the contact of the slates with the quartz-sericite schists. Of the five lenses of massive sulphide ore, Nos. 4A and 4B occur on the contact, Nos. 2 and 3 occur within fifty feet of it and the No. 1 lens occurs along it for, approximately, two thirds of the length of the lens.

It is quite apparent that this line of contact has provided a favourable channel, or line of weakness, for the injection of the pasty sulphide solutions, and it is significant that the southern termination of the lode should co-incide, generally, with that of the slates.

Unfortunately, no detailed figures as to assay values were made available for publication, and it has not been possible, therefore, to indicate the variations in the valuable metal content of the ore throughout the various lenses. The average metal content of the ore from Nos. 1 and 2 lenses is indicated by the figures published in the "Report and Statement of Accounts" of the Electrolytic Zinc Company for the financial year 1929-30. These figures are as follows:-

Pb%.	Zn%.	Cu%.	Ag ozs.	Au dwts.
6.4	21.3	.50	8.5	2.12

The average grade of the ore is also indicated by the figures as to production tabulated below. In connection with these figures it is necessary to point out that, with the exception of the year 1929-30, the Rosebery ore was mixed with ore from the Hercules Mine, the crude ore sampled at the Zeehan Mill consisting of a mixture of ore from both mines.

From its general appearance, the ore in No. 4A and 4B lenses is of similar grade to that from Nos. 1 and 2.

The ore from No. 3 lens appears to be a good deal lower in grade than the others.

(vi) Production.

The following tables give the tonnage and value of the ore produced from the lode up to the end of 1914.

Table 12

Tasmanian Copper Company

TONS	Average Metal Content					Approximate
	Au dwts	Ag ozs.	Zn%	Pb%	Cu%	Value £
40,551	2.9	12.3	28.0	7.9	0.5	35,000
10,275	3	10.3	25.3	7.3	0.53	12,500
50,826						£47,500

Primrose Mining Company

TONS		Average Metal Content				Approximate
	Au dwts	Ag ozs.	Zn%	Pb%	Cu%	Value £
45,864	3.06	12.5	30.0	10.0	-	50,000

North Tasmanian Copper Company.

200 tons valued at, approximately, £100.

From the end of 1914 until 1919, all of the mines were idle and no ore was produced. In 1919, the Mt. Read and Rosebery Mines Limited extracted over 1,000 tons of ore, the amount and value of the products being as follows:-

Au	171	ozs.	valued at	£727.
Ag	11,400	"	" "	£2,280.
Zn	285	Tons	" "	£13,110.
Pb	81	"	" "	£2,592.
Cu	5	"	" "	£420.

From 1920 until the end of 1923, the mine was idle and no ore was produced.

The tonnage and value of the ore produced under the Electrolytic Zinc Company's management is shown by the following table.

Table 13

Tonnage and value of Ore from Rosebery Mine from 1924 to 1931.

Financial Year	TONS	Average Assay.					Approximate
		Au dwts.	Ag ozs.	Zn%	Pb%	Cu%	Value £
1924-25	2,012	2.8	9.1	23.3	7.1	-	
1925-26	29,881	2.6	8.4	23.3	6.7	-	
1926-27	28,525	2.2	7.6	23.8	6.7	-	
1927-28	24,324	2.2	7.1	22.1	6.5	-	
1928-29	28,395	1.8	7.4	21.7	5.9	.57	
1929-30	25,881	2.12	8.5	21.3	6.4	.5	
1930-31	8,100	1.8	7.0	21.0	6.0	.5	

(vii) Probable Extension of the Lode.

It is proposed, in this section to deal with possibilities as to the extension of the lode beyond its present known limits. It has already been stated that the southern end of the lode corresponds with that of the slate belt, and there appears to be no hope that large lenses of sulphide ore will be found south of the southern end of No. 1 lens, or, to give a maximum position, further south than Bore No. 25. We have, therefore, only to consider the possibilities of the lode in depth, and the chances of its northerly extension.

Unless other factors, now unknown, come in to alter the general conditions, it seems probable that the downward extension of the lode will depend largely on that of the slates. The deepest diamond drill bores are R27, R28 and R29. Bore R27 proves that, towards the southern end of the lode, the slate belt is 200 feet thick at 284 feet above sea level and that ore of average grade exists 104 feet below the slates i.e. at a depth of 374 feet below the No. 8 level (see cross section). As will be seen by the plan, this bore intersects the lode at the point where the No. 1 lens leaves the slates; hence, no importance can be attached to the fact that the lode, as shown by the bore position, is not actually on the contact. Bore 28 shows that, on the No. 2 lens, the slates are 90 feet thick at 420 feet above sea level, i.e. 140 feet below the No. 8 level, and that ore of average grade exists 60 feet below the slate contact, i.e. 200 feet below No. 8 level; thus the general conditions with regard to No. 2 lens persist asfar as the deepest bore on that lens. Bore R29, which passed through a blank patch in the lode, proves that, in the vicinity of No. 3 lens, the slates are only 48 feet thick at 390 feet above sea level, i.e. at 170 feet below the horizon of No. 8 level.

From the above, it will be seen that the slates and the sulphide ore persist below the positions of the No. 1 and No.2 lenses, and that the slates in that vicinity retain their normal thickness at a depth of 270 feet below the No. 8 level in the case of No. 1 lens, and at a depth of 140 feet below the No. 8 level in the case of No. 2 lens. Hence the chances of the downward extension of the Nos. 1 and 2 lenses, beyond the positions as shown by the diamond drill bores, are favourable.

The evidence afforded by Bore 29 indicates that the slates are pinching out in depth towards the northern end of the mine.

It is highly probable that the ore will persist for some distance below the Nos. 4A and 4B lenses. The present indications are that these lenses are junctioning in depth, and it is possible that they will form one large shoot of ore. To what depth this shoot will extend is highly problematical; the obvious method of prospecting it is to extend some of the present deeper level drives in a northerly direction.

With regard to the possible northerly extension of the lode, beyond its present known limits, the general conditions are not favourable. At the No. 1A level, the top of the lode is entirely in the slates. No. 1B adit, which is 200 feet north of No. 1A, contains a thin pyritic seam occurring entirely within the slates, and, on Innes track, directly above No. 1B adit, there is a quartz-pyrite vein also occurring entirely within the slates. If these are to be regarded as the northern continuation of the lode, then it seems probable that it has turned into the slates at the northern end of the mine, and, from the general conditions, there appears to be no possibility of its living in them. Moreover, other geological factors also point to the fact that the lode dies out a short distance north of No. 1A level. Thus, the porphyries, on the western side of the slates to the north of No. 1B adit, are quite massive, there being only a thin selvage of schists about two feet thick along the actual contact; this indicates a diminution in the action of the minerelising solutions at the northern end of the slates. There is also definite evidence that the slate belt terminates at a position, approximately, 1,000 feet north of the No. 1A adit; this is shown by the fact that an adit and several trenches, extending eastwards from the N.E. corner of lease 8277/M, were all in massive porphyry. These workings should have cut the slate belt had it persisted further north than the position shown on the plan. The pyritic ore encountered in Bore No. 34 probably represents the approximate northern limit of the lode.

(viii) Conclusions.

The conclusions as to the probable extension of the lode, combined with a consideration of the present state of development on the various lenses of ore, indicate that there is ample scope for future development work. This may be discussed under two main headings :- (a) Above the No. 8 level and (b) Below the No. 8 level.

(a) Above No. 8 level. The No. 1 lens has been developed over its total length and there is but little to be said in connection with it. The small lens of ore, to the east of the main body, at the south end of Nos. 7 and 8 levels is not very important, at present though it may possibly yield a little ore in depth.

The No. 2 lens yet remains to be developed over its total length by continuing to drive north from the various levels below No. 2 level. This work was in progress when the mine shut down in October 1930. As the difference in vertical height between Nos. 6 and 8 levels was only 120 feet, the No. 7 level drive was not continued north.

At present the No. 3 lens does not appear to be very promising, but Nos. 4A and 4B lenses, which will possibly junction in depth, should yield a large quantity of ore. The Nos. 4A and 4B lenses could be readily tested in depth by continuing one or two of the deeper level drives northwards beyond No. 2 lens. It is suggested that Nos. 4 and 6 levels would be suitable for this work. In their progress from No. 2 lens to Nos. 4A and 4B lenses, these drives would also test the No. 3 lens. The northern extension of No. 8 level, beyond the north end of No. 2 lens would depend on the results obtained from the No. 6 level drive. Work such as this would be more satisfactory, and, in the end, more economical, than further diamond drill boring on the Nos. 3, 4A and 4B lenses.

(b). Below No. 8 level. The present indications are that the Nos. 1 and 2 lenses persist some distance below the No. 8 level. These lenses could be readily prospected in depth by an internal inclined shaft put down from No. 8 level from a position adjacent to the General Service, or 13N Rise. This shaft would be in a cantral position for developing both the Nos. 1 and 2 lenses.

Insufficient is known of the deeper portions of the Nos. 4A and 4B lenses to indicate their possibilities below No. 8 level. Work on these lenses below No. 8 level would depend on the results of the work outlined when discussing the development work above No. 8 level.

In developing the No. 1 lens below No. 8 level, the small lens of ore occurring to the east of the main ore body, at the south end of Nos. 7 and 8 levels, could be readily tested by long hole drills.

(b) THE MOUNT BLACK MINE.

(i) Location and Access.

The Mount Black Mine is situated on the Electrolytic Zinc Company's consolidated lease 9075/M. It lies immediately east of the eastern boundary of Section 10547/M.

(ii) Previous Reports.

(1). A. Montgomery. "Report on The Progress of the Mineral Fields in the neighbourhood of Zeehan viz:- Mackintosh River, Mount Black, Mount Read, Mount Dundas, Stanley River and Mt. Heemskirk" 1895.

(2) J. Harcourt Smith. "Report on The Mineral Fields in the neighbourhood of Mt. Black, Ringville, Mt. Read and Lake Dora". 1898.

(3). G.A. Waller. Report on "The Ore Deposits (other than those of tin) of North Dundas. 1902.

(iii) History.

The Mount Black lode was pegged by A.J. Allom in December 1890, and was the first important mineral discovery made in the Rosebery district. The find was named the Hauraki P.A., but in 1897 the property was transferred to the Mt. Black Proprietary Mining Company, and the mine became known as the Mt. Black. The Mt. Black Company carried out extensive development work on the lode, and, during 1899-1900, erected a small plant to treat the ore for its gold content. The lode proved to be too low grade to be payable, and active operations on the mine ceased in 1902. The lease was declared void in 1905, on the application of A.C. Gordon, by whom it was transferred to the Primrose Mining Company in 1906. The Primrose Company's leases were transferred to the Mt. Read and Rosebery Mines Limited and these in turn, were transferred to the Electrolytic Zinc Company, by whom the section is still held.

(iv) Geology.

The mine is situated in an area of fairly massive porphyry, which is slightly sheared in the vicinity of the lode.

(v) The Lode.

At the surface, the lode is exposed in a few small trenches and at the mouth of an inclined shaft which has been put down on the lode. It strikes N. 14° W and dips to the east at 45° to 50° To the south of the inclined shaft, a portion of the lode appears to turn to the west along a cross fracture. Very little of the original ore if left at the surface, and all that could be seen was a pyritic lode formation, about 5 feet wide, containing quartz, pyrite, chalcopyrite and tourmaline.

Waller describes the lode as follows :- "The ore deposit is a true fissure vein, consisting of quartz, tourmaline, fluorspar, iron and copper pyrites, and, in parts, a good deal of wolframite and bismuth sulphide. The structure is banded, but not symmetrical, the bands of fluorspar, with bunches of bismuth sulphide, being found principally ..../over principally near the hanging wall, and the quartz on the footwall. The tourmaline does not occur in bands, but forms little veinlets and bunches through the other minerals. The quartz contains a large quantity of tourmaline in the form of fine needles".

At a distance of approximately 200 feet east of the inclined shaft, a main vertical shaft was sunk to a depth of 100 feet, and a crosscut was put out to intersect the lode. From the nature of the rock on the dump, it is apparent that this shaft was sunk in massive felspar porphyry. These workings have been under water since 1902, but Waller's report contains some valuable notes, supplied to him by Mr. C.M. Henrie, who was then metallurgist to the Tasmanian Copper Company. These notes are as follows :- "The crosscut from the main shaft cut through three separate formations before striking the main lode. No. 1 lode was 4 feet wide, consisting of bands of quartz-tourmailine, with a little fluospar, iron pyrites, and a little copper. At 37 feet from the shaft, a siliceous rock was cut, carrying a considerable amount of iron pyrites, and some copper pyrites scattered through it. At 61 feet from the shaft, No. 3 lode was cut, this was 15 to 18 inches in thickness, and of the same general character as No. 1. At 100 feet from the shaft, No. 3 lode was cut; this was small, and composed principally of iron pyrites. At 140 feet, the main lode was cut; this was 8 feet wide, with 6 feet of fair looking ore. The main lode appears to have been cut at its richest and widest part, for, in driving north and south on the lode, it pinched away very considerably and the metallic contents also fell away.

Waller condluded that the principal portion of the lode consisted of a short shoot of ore having a vertical pitch. This corresponds generally with the available evidence on the surface.

The following assay results, taken from Waller's report, and the analyses in table 10 (page), give a general idea of the valuable mineral content of the ore. These samples were taken from the main lode at the point intersected by the main crosscut.

Table 14.

Valuable Metal Content of Mt. Black Ore

Constituents	1.	2.	3.	4.	5.	6.	7.
Gold ozs. per ton	0.85	0.26	0.70	0.84	0.30	0.09	0.42
Silver " " "	1.15	0.74	0.80	0.66	0.60	0.48	0.58
Copper%	0.61	0.10	1.15	0.48	Tr.	Tr.	0.52

(1). Iron pyrites, fluorite and quartz.
(2). Fluorite, with iron pyrites.
(3). Iron pyrites, fluorite and quartz.
(4). Iron pyrites and fluorite.
(5). Quartz.
(6). Quartz.
(7). Iron pyrites, fluorite and quartz.

(vi). Production.

In 1899 the Mt. Black Company sent away 21 tons of ore for experimental treatment: 5 tons each to Wallaroo, Dapto and Dry Creek, and 6 tons to the Tasmanian Smelting Company, Zeehan. These parcels averaged 16 dwts. of of gold and 2% of copper per ton, of crude ore.

During 1901 a few tons of concentrates were produced at the mine. These carried a little over an ounce of gold to the ton, and between 2 and 3 per cent of copper.

(vii) Conclusions.

The fact, that 21 tons of crude ore from this mine averaged 16 dwts. of gold and 2% of copper per ton, shows that the lode contained some fair grade ore, but the companies operations proved that the shoot of payable ore was too small to enable the mine to be worked at a profit. Although the surface features are now somewhat obscured, portion of the lode to the south of the inclined shaft appears to take a right angled turn along a cross fracture; it is possible, therefore, that the shoot of payable ore was an enriched portion of the lode formed near the intersection of a cross fracture with the main lode. It is unlikely that other shoots of payable ore exist on this mine.

(c) THE BLACK P.A. MINE.

This mine is situated on the north bank of the Stitt River about five chains below the railway bridge. The original section was held by the Mt. Black Prospecting Association, but it now forms part of the Electrolytic Zinc Company's Consolidated Lease 9075/M. The mine workings are shown on the accompanying plan.

The rocks in the vicinity of the mine are all massive and sheared quartz-felspar porphyries.

The lode outcrops in the bed of the river, the outcrop consisting of a dense vein of pyrite about eighteen inches thick. It has been prospected by means of an adit-crosscut driven into the north bank of the river, and from the adit a drive has followed the lode for a distance of 265 feet north. For the first 100 feet of the drive the lode is highly pyritic; in addition to pyrite, it contains quartz, sericite, siderite, calcite, rhodochrosite, and a little galena and chalcopyrite. In some places only pyrite can be seen, in others it is highly siliceous. One hundred feet north of the adit, the drive turns slightly to the west and leaves the pyritic ore in the east wall. From this point to the end of the drive the lode consists of pyritised quartz-sericite schists containing a few small lenses of galena and a little chalcopyrite. The lode strikes in a general north-south direction and dips to the west at an average angle of 55°. The westerly dip is rather unusual as most of the other lodes in the district dip to the east.

As no samples were taken, it is impossible to give an accurate idea of the valuable metal content of the lode. It is said to contain a few per cent of lead and zinc, but, although galena is present, no sphalerite was observed in the lode.

The size and nature of this lode, taken in conjunction with the fact that it occurs entirely within massiveand sheared quartz-felspar porphyries, indicate that no important developments are to be expected from it. The mine is of no value.

(d) DALMENY SECTION.

(i) Location and Access.

Section 10002 of 80 acres. This section is situated about one mile south-east of the Rosebery Township.

(ii) Previous Reports.

(1) Report on "The Mineral Fields in the Neighbourhood of Zeehan, via. Mackintosh River, Mount Black, Mount Read, Mount Dundas, Mount Zeehan, Stanley River and Mount Heemskirk" .... A. Montgomery, 1895.

(2) Report on the Mineral Fields of Mt. Black, Ringville, Mt. Read and Lake Dora, J. Harcourt Smith, 1898.

(3) Preliminary Report on "The Zinc-Lead Sulphide Deposits of the Rosebery District" Loftus Hills 1915.

(4) The Zinc Lead Sulphide deposits of the Read - Rosebery District, Part II. Bulletin 23, Loftus Hills.

(iii) History.

The portion of this section containing the principal lode originally formed part of Balstrup's section, 141/93M of 80 acres, which was applied for in 1894 and was held until 1899. During that time, a little prospecting work was carried out on a lode which outcrops on the banks of the Stitt River. The original Dalmeny section was applied for by J.F. Riley and P.E. Karlson in 1906. It was transferred to Louis Simson in 1907 and was held by him until 1913. In 1906 the outcrop referred to above was prospected by means of a shaft sunk on the lode to a depth of 10 feet; in the bottom of the shaft, two seams of ore, each about six inches wide, were exposed; these are said to have contained from 15% to 20% of lead and about 15% of zinc per ton. In 1907 two diamond drill bores were put down to test this lode in depth. The position of these bores is shown on Plate 9, Bulletin 23. The No. 1 bore was situated, approximately, 140 feet east of the outcrop. It was put down at an angle of 70° west, and was continued to a depth of 170 feet without encountering any ore. The No. 2 bore was then started 60 feet nearer the shaft and in the same direction; at a vertical depth of 80 feet, a zinc-lead lode was said to have been penetrated, the core showing ore for 16 feet. In one portion of this 16 feet, 3 feet of the core was said to have given the following assay results:-

Au ozs.	Ag ozs.	Pb %	Zn %
.250	15.00	31	17.

However, the general results obtained do not appear to have been very promising as the lease was declared void in 1913.

In June 1913, this section was applied for by F.L. Coates, but the application was cancelled in July 1914. It was applied for by J.C. MacMichael in 1914 and was held until 1925, when the lease was declared void. The section was held by Denis Connolly from June 1925 until March 1926, when it was transferred to the Electrolytic Zinc

Company of Australia Ltd. who are the present holders of the lease.

In addition to the work described above, a shaft was started, a short distance to the east of the outcrop, to test the lode in depth. This was sunk through river gravels and alluvium to a depth of 15 feet, but did not reach bottom; it was abandoned on account of excess water. It is uncertain as to what year this work was carried out.

(IV) Geology.

This section is situated entirely within massive felspar porphyries. A large portion of the surface is covered to a depth of 6 to 15 feet by Recent gravels and alluvium.

(V) The Lode.

The lode referred to above outcrops on the east bank of the Stitt River, at a distance of, approximately, seven chains from the northern boundary of the section. The outcrop consists of a small mineralised shear zone in massive felspar porphyry, and is composed principally of quartz, sericite and chlorite, with small amounts of pyrite, galena and sphalerite. The porphyry on either side of the lode is fairly fresh, but contains a little pyrite and galena impregnating the joint planes. This formation strikes N. 4° W, and dips to the east at an angle of, approximately, 50°.

The shaft sunk on the outcrop could not be examined, but most of the broken rock on the dump consisted of fairly fresh felspar porphyry, some of the joint planes of which contained small amounts of sphalerite and galena.

Apart from the assay results reported from the No. 2 bore, and from the shaft sunk on the lode, the only information available as to the metal content of the lode is that contained in J. Harcourt Smith's report. Smith obtained a sample from the outcrop, the assay results of which were as follows:-

Au	Cu	Ag	Pb
Tr.	Tr.	1 oz. 12 dwts. 6 grs.	6.6%

Just over the northern boundary of this section, two deep trenches have been cut in a general east-west direction, and a shaft has been sunk near the 6136 foot peg on the Lake Margaret Transmission Line survey. The rock exposed in the trenches consists of massive and slightly sheared felspar porphyries, the latter containing a few small seams of pyrite. The rock on the dump of the shaft was quite massive felspar porphyry, and no ore of any kind could be seen. The workings are possibly the results of attempts to pick up the northern extension of the lode described above.

(VI) Production.

No ore has been marketed from this section.

(VII) Conclusion.

Despite the assay results reported from No. 2 bore, the fact, that this lode occurs in what is practically massive porphyry, renders it highly improbable that payable ore will be met with in depth. Further prospecting or development work on the property does not appear to be justified.

(2) THE KOONYA MINE.

(a) Location & Access.

This mine is situated near the south boundary of the area on J. Dunne's 40 acre section 10536/M. A track from Dunkley's tram goes to within a few chains of the mine workings.

(b) Previous Reports.

(I) Loftus Hills "Preliminary Report on the Zinc-Lead Sulphide Deposits of the Rosebery District" 1915.
(2) Loftus Hills "The Zinc-Lead Sulphide Deposits of the Read-Rosebery District" Bulletin 23? 1915.
(3) Loftus Hills "The Zinc-Lead Sulphide Deposits of the Read-Rosebery District" Bulletin 31 1919.

(c) History.

The zinc-lead lode on the Koonya Mine was discovered by Joseph Will in 1913. Prior to 1913, a considerable amount of prospecting work had been carried out in the vicinity, and the pyritic copper lode of the Grand Centre Adit had been opened up. The zinc-lead lode was discovered as a gossanous outcrop, and is reported to have contained from 5 to 10 dwts. of gold per ton. It was prospected by means of several shallow trenches and an incline shaft, and, later, two adits were put in to intersect the lode in depth. From the No. 1 adit an incline winze was sunk to a depth of 45 feet, and, from the bottom a short drive was opened out for a distance of 25 feet south. Practically the whole of this work was carried out by the Colebrook Prospecting Association, who were the holders of the lease from 1912 to 1929. The development work was carried out during the years 1913 to 1917. In September 1929, the Colebrook Prospecting Association's lease was declared void on the application of J. Dunn, who is the present holder of the section.

(d) Geology.

The whole of this section lies within massive and highly sheared porphyries, chloritic schists and quartz-sericite schists. A good deal of the surface is covered by glacial erratics.

(e) The Lode.

The principal mine workings are shown on the accompanying plan (plate). At the surface the lode consists of a gossanous outcrop. Most of the gossan has now been removed but some of it is exposed in a trench, which lies immediately to the west of the incline shaft. Below the gossan, the lode consists of highly pyritised schist, which persists to within a few feet of No. 1 Level. No means were available for examining the whole of the shaft, but, as far as could be ascertained, no sphalerite or galena were present in the pyritised schist. It seems probable that the pyritised chloritic and quartz-sericite schists in the shaft represent an upper, leached portion of the zinc-lead sulphide ore exposed at No. 1 level.

On No. 1 level, which is 110 feet below the collar of the shaft, a lens of massive zinc-lead sulphide ore extends about 10 feet north and 60 feet south of the main adit-crosscut. At the cross-cut, the ore is about 1 foot wide, but, at the east crosscut 40' S, the width has increased to 10 feet. This ore appears to peter out about 10 feet south of the crosscut 40'S. From this point southwards, the lode is rather broken and irregular: only a few small seams occur and these are principally along joint planes. Twenty feet from the end of the south drive, there is an irregular bulge of ore, approximately four feet wide, consisting of sphalerite, galena, pyrite, quartz and carbonates; this peters out in the end of the south drive, where only a few oxidised seams are exposed. In the face of the east crosscut at the end of the south drive is a small seam of siliceous ore about 2 feet 6 inches wide; a gossanous seam is exposed in the west crosscut. At the end of the main north drive, the lode appears to have died out. In the No. 1 level adit-crosscut the rocks on the western side of the lode are quite massive felspar porphyries; those on the eastern side are sheared porphyries, and pyritised chloritic and quartz-sericite schists.

At the junction of the No. 1 level adit and the drive, an inclined winze has been sunk on the lode for a depth of 45 feet, and, from the bottom, a drive has been opened out for a length of 25 feet south. In the winze, there is about a foot of massive sulphide ore which persists from top to bottom, but at the end of the drive, ore is exposed on the western side over a width of four feet.

On No. 2 level, which is 137' below the No. 1, the same general conditions persist as on No. 1 level. The lode lies between massive porphyries on the west, and sheared porphyries and chloritic schists &c. on the east. It is somewhat broken and irregular, and contains only four or five small seams of sulphide ore. One of these is a highly pyritic seam about 1 foot wide, extending 17 feet north and 9 feet south from the adit crosscut. The lode appears to have died out in the face of the north drive. Another small lens of sulphide ore extends from 18 feet south to 38 feet south of the adit crosscut; this is about 2 feet wide. At the bend in the south drive, 60 feet from the adit crosscut, there is approximately four feet of ore consisting of quartz, carbonates and galena; this extends only a few feet to the south. In the west crosscut at the south end of the drive, there is about 1 foot of sulphide ore close to the west wall of the drive; this ore contains a good deal of coarse galena. In the east crosscut, there are a few small seams of pyritic zinc-lead ore.

The valuable metal content of the lens of ore at No. 1 level, and of the several small seams described above, is shown by the following assay results. The positions from which the samples were obtained are shown on the accompanying plan.

Table 15

Valuable Mineral Content of Koonya Ore.

Sample No.	Width of Ore in feet.	Au ozs.dwts.grs.	Ag ozs.dwts.grs.	Pb %	Zn %
1	1	n.d.	4 19 7	13.09	10.91
2	4	n.d.	2 19 6	4.5	11.12
3	5	n.d.	4 6 5	8.38	15.50
4	4¼	n.d.	2 1 20	Nil	6.32
5	1	0 1 7	2 9 16	n.d.	n.d.
6	4	n.d.	2 17 11	7.33	15.30
7	4	0 1 7	1 17 22	n.d.	n.d.

Note: Sample No. 7 was obtained from some gossanous material on the outcrop of the lode. It was assayed for gold and silver only.

(f) Production.

As far as could be ascertained, no ore has been marketed from this mine.

(g) Conclusion.

It will be seen, from the above description of the lode, that the largest lens of sulphide ore is that at No. 1 level. This lens has a maximum length of 70 feet and a maximum width of ten feet; the mean width is probably about 5 feet. It is probable that the widest portion of this lens persists below the No. 1 level and is continuous with that exposed in the end of the south drive off the bottom of the winze. It is difficult to say whether this lens persists down to No. 2 level, but if it does, it has diminished considerably in width. The remaining seams of ore exposed by the workings are exceedingly small.

Hence, the amount of ore available from this mine is small, and this combined with a consideration of the assay values shown above, indicates that the property is not of any great value, though it may yield a small tonnage of medium grade ore.

(3) THE ROSEBERY LODES MINING COMPANY N.L. SECTION 10455/M (ABANDONED)

(a) Location & Access.

This section is situated about one mile to the south of the Rosebery township. Most of the workings are within easy access of Dunkley's tram which passes right through the section.

(b) Previous Report.

J. Harcourt Smith. Report on "The Mineral Fields in the neighbourhood of Mt. Black, Ringville, Mt. Read and Lake Dora, 1898 (Section 141/93M)".

(c) History.

The Rosebery Lodes Mining Company was formed in 1915, and, during 1916-17, carried out extensive prospecting work on a pyritic lode formation. In all, the Company sank three shafts and diamond drilled from the bottom of each of these shafts. This work failed to disclose any payable ore, and active operations of the Company ceased in March 1917.

In 1920, work was recommenced at an old shaft put down by Karlson and Balstrup in 1898. (This shaft is mentioned in Harcourt Smith's report as being sunk on a strong manganiferous outcrop). Owing to excessive water, work on this shaft was abandoned, but another was sunk some distance to the north. The company then commenced driving an adit with the object of getting below the manganiferous formation which had been prospected by Karlson and Balstrup. This work failed to locate payable ore and the company ceased operations in December 1920. In 1929 the Company's leases were consolidated and included in lease 10455/M of 78 acres. This lease was declared void in November 1931.

(d) Geology.

This section is situated in an area of massive and sheared porphyries, chloritic schists and quartz-sericite schists. The lodes occur mainly within the schists, but a portion of one of them appears to be associated with a small band of slate occurring within the schists.

(e) The Lodes.

The principal lode is that exposed in the adit mentioned above. It consists of a vein of the quartz-tourmaline-pyrite type, and varies in width from a few inches to a foot. In addition to the minerals mentioned, the lode contains galena, sphalerite, jamesonite, ankerite, siderite, mangane-siderite and calcite. In some places, the lode consists of dark cherty material containing pyrite alone. This lode has been driven on for a distance of 143 feet; it strikes N8°E and dips at a steep angle to the east. The hanging-wall consists of massive and sheared porphyries, and the footwall of quartz-sericite schists highly inpregnated with pyrite. Near the portal of the adit, on the eas side, is a small lens of arenaceous slate.

What is probably the southern continuation of this lode has been cut by the old shaft put down by Karlson and Balstrup, which is situated about seven chains to the south of the adit. This shaft was inaccessible, and all that could be seen on the dump was a small heap of ore containing mangano-siderite or rhodochrosite and pyrite.

The pyritic lode formation is situated in the extreme south-east corner of the present section. It consists mainly of a pyritic impregnation of quartz-sericite schists, chloritic schists and sheared porphyries, and contains a little galena. The three shafts referred to lie in an east-west line within a few chains of one another. All are now inaccessible and only a little ore is present on two of the dumps. As far as could be determined the lode strikes a little to the east of north and dips to the east., at 45°.

Other small mineralised shear zones, containing veins of the quartz-tourmaline type occur on the property.

(f) Production.

No ore has been marketed from this mine.

(g) Conclusion.

The prospecting work carried out on this section shows that the lodes are too small and their valuable mineral content too low to warrant further development on them. The total development of intensely altered forms of the porphyries is not very extensive, and quite a large proportion of the rocks on the lease are only slightly sheared. Some of the rocks are quite massive. No slates were observed on the surface, and the slate on the dump of the old shaft and the arenaceous slate near the portal of the adit probably represent small xenolithic lenses included in the porphyries. These lenses appear to have been too small to provide adequate fissures for the circulation of the mineralising solutions. No further development work on this property can be recommended.

(4) THE SALISBURY MINE (Abandoned).

(a) Local and Access.

The Salisbury Mine is situated in the northern portion of lease 8687/M, which was last held by the Electrolytic Zinc Company. Two independent lodes have been worked; one of these, the No. 1, is quite close to the Williamsford-Rosebery Road, at a distance of twenty four chains south of the turn-off to the railway station; the No. 2 lode is situated on the hillside a short distance above the No. 1.

(b) Previous Reports.

(1). G.A. Waller, "The ore deposits (other than those of tin) of North Dundas" 1902.

(2). Loftus Hills. Preliminary report on "The Zinc-lead sulphide deposits of the Rosebery District, 1915".

(3). Loftus Hills. "The Zinc-Lead sulphide Deposits of the Read-Rosebery District, Part II, Rosebery, 1915".

(c) History.

The early history of the Salisbury Mine is rather obscure. Most of the development work on the lodes has been completed prior to Waller's examination in 1902. In 1914 the original lease was included in an 80 acre section, 6834/M, pegged by S.W. White. This lease was transferred to the Hercules Gold and Silver Mining Company in 1916. The lease then passed to the Mt. Read and Rosebery Mines Ltd., and, eventually, to the Electrolytic Zinc Company. The section was abandoned in 1923.

(d) The No. 1 Lode.

The workings on the No. 1 Lode consist of two short adits, one being driven on the lode at road level, the other being an adit crosscut put in about 20 feet below road level. From the end of the lower adit the lode has been driven on for distances of 20 feet north and 10 feet south. The upper and lower adits are connected by a winze. These workings are shown on the accompanying plan of the mine.

In the upper adit, the lode consists of a small fissure vein, a few inches wide, composed of galena, jamesonite and a little pyrite set in a gangue of flourite with some siderite and a little tourmaline. In the face of the drive, there is only a little pyrite with a few small veins of quartz and carbonates. A sample from these workings gave a result of 12 ozs. of Silver per ton.

In the lower adit the lode, is composed mainly of fine grained galena, with a little pyrite, quartz, siderite and calcite.

This lode occurs along the eastern margin of a thin band of black slate present as a xenolith or inclusion in the quartz porphyries. In the upper workings, the slate band is 2 feet wide, and, in the lower workings, it is 9 feet wide. The lode strikes N.40° E (magnetic) and dips to the east at 70°.

(e) The No. 2 Lode.

This lode is composed mainly of quartz, tourmaline and pyrite. In some places it resembles dark cherty quartz, probably owing to the presence of minute needles of tourmaline. It contains small amounts of gold, silver and copper. A sample, assayed in the Government Laboratory, Launceston, showed that this lode contained no tin.

The following analysis, taken from Waller's report, illustrates the chemical composition of the ore:-

Au.................	4dwts. per ton.
Ag.................	1 oz. 2dwts. per ton.
Cu.................	0.93%
Fe.................	9.53%
SiO_2...............	69.83%
S..................	5.69%
MnO_2...............	0.21%
Al_2O_3..............	12.42%
O_2 (with FeO).....	1.10%
Zn, Pb, Ca & Mg...	Traces

The workings on No. 2 lode are shown on the accompanying plan. They consist of a long adit crosscut from the end of which drives have been opened out both to the north and to the south. In the drives, the lode varies in width from 3 to 5 feet; it strikes N. 15°E and dips to the east at 45°. An underlay shaft sunk on the lode meets the south drive 10 feet from the main crosscut.

As far as could be ascertained, the No. 2 lode occurs entirely within sheared quartz porphyries. The rocks in the main adit-crosscut are somewhat weathered, but they closely resemble the typical quartz porphyries as exposed elsewhere in the district. In a creek to the east of these workings, there are outcrops of quite massive felspar porphyry, and it is possible that this lode may be situated near, or along, the contact between the quartz porphyries and the felspar porphyries.

A lode formation consisting of quartz, tourmaline and pyrite has been cut in a creek about six chains to the north of the underlay shaft. This is probably the northern continuation of the No. 2 lode.

(f) Production.

No ore has been marketed from this mine.

(g) Conclusion.

The No. 1 lode is too small and its silver content too low for the lode to be of any value. The valuable metal content of the No. 2 lode is also low. The mine is of no value.

(V) THE CHAMBERLAIN MINE (Abandoned).

(a) Location & Access.

The section on which this mine is situated was last held by the Electrolytic Zinc Company as 8687/M. The mine is situated on Salisbury Creek and is, approximately, 12 chains above the Rosebery-Williamsford Road.

(b) Previous Reports.

(1) J. Harcourt Smith, Report on "The mineral fields in the neighbourhood of Mt. Black, Ringville, Mt. Read and Lake Dora, 1898".

(2) G.A. Waller, Report on "The Ore Deposits (other than those of tin) of North Dundas, 1902".

(3) Loftus Hills. Preliminary Report on "The Zinc-Lead Sulphide Deposits of the Rosebery District, 1915".

(4) Loftus Hills, "The Zinc Lead Sulphide Deposits of the Read-Rosebery District" Part II. Rosebery, 1915.

(c) History.

The lodes on the Chamberlain mine were discovered prior to 1898, and most of the development work on the mine, which consisted of driving two adits and cutting a few trenches, was carried out between 1897 and 1903. The property was held by various people between 1904 and 1914, but no fresh development work was carried out. In 1914 the original lease was included in an 80 acre section, 6835/M, pegged by S.W. White. This lease was transferred to the Hercules Gold and Silver Mining Company in 1916. The lease then passed to the Mt. Read and Rosebery Mines Ltd., and, eventually, to the Electrolytic Zinc Company. It was abandoned in 1923.

(d) Geology.

The lodes occur in sheared and altered quartz porphyries, and in chloritic schists.

(e) The Lodes.

About ten chains up the creek from the road a pyritic lode has been cut in a fairly large trench. This consists mainly of chloritic schist densely impregnated with pyrite. No other sulphide minerals were observed.

The two adits, referred to above, are situated about two chains higher up the creek, or, at a distance of approximately 12 chains from the road. Their positions are shown on Plate 9 of Bulletin 23, and on the general plan accompanying this bulletin. Neither of the adits were accessible at the time of the writer's examination, and all that could be seen was a small heap of ore on the dump. This ore consisted mainly of coarse pyrite, chalcopyrite, tourmaline, quartz, carbonates and a little galena. Some quartz-sericite-chlorite schist present on the dump evidently represents material from the walls of the lodes. From the descriptions given in Waller's and Harcourt Smith's reports, it would appear that these lodes are generally similar to the siliceous lode on the Salisbury Mine. They strike in a general N-S direction and dip to the east at an angle of 45° to 50°. Some ore from the Chamberlain Mine is said to have assayed up to 16 dwts. of gold per ton (66).

(66) J. Harcourt Smith "Report on the Mineral Fields of Mt. Black, Ringville, Mt. Read & Lake Dora" 1898 p. 8.

(f) Production.

No ore has been marketed from this mine.

(g) Conclusion.

The general nature of the ore exposed on the dump and the fact that the lodes occur within sheared quartz porphyries and chloritic schists indicate that these lodes are of little value. Moreover, the mine appears to have been resampled many times, the results not being sufficiently encouraging to warrant further development work than that carried out prior to 1903.

(6) THE BERRY CONSOLS SECTION (Abandoned).

(a) Location & Access.

This section was last held as 2281 of 28 acres. It adjoins the south-eastern portion of the Dalmeny Section.

(b) Previous Report.

J. Harcourt Smith, "Report on the Mineral fields in the neighbourhood of Mt. Black, Ringville, Mt. Read and Lake Dora", 1895.

(c) History.

This section was first applied for by F. Scott in 1895, but, three months later, the name of the applicant was changed to that of J.G.A. Stitt, by whom it was held until 1901. During that time, some trenching and shaft sinking was carried out on six small lodes which had been discovered on the property; in addition, a short adit was driven on what was then known as the No. 3 lode. In 1906, the lease was applied for by J. Coleman, who transferred it to George Laidlaw in February 1908. The lease was declared void in December, 1908.

(d) Geology.

The whole of the section is situated in an area of massive felspar porphyry, which is slightly schistose near some of the veins. A good deal of the surface is covered by Recent gravels and alluvium.

(e) The Lodes.

Of the six lodes reported to have been discovered on the property, only three could be found by the writer. The largest of these is exposed in an adit driven into a small knob, which is situated three chains south of the south boundary of the Dalmeny section and four chains east of the Stitt River. This lode corresponds with the No. 3 lode described by Harcourt Smith. The adit is 31 feet long; in the face, the lode is about 4 inches wide, and consists of a quartz vein containing a little pyrite and tourmaline. Near the portal of the adit, the lode is fifteen inches wide and is composed of dark cherty quartz, pyrite and tourmaline, with a little chalcopyrite. The lode strikes N 15° E and dips to the east at an angle of 80°. The country rock of this lode is quite massive felspar porphyry.

About ten chains to the south east of the adit described above, and quite close to the junction of the two logging tracks shown on the general geological map (Plate), a shaft has been sunk on a small quartz-tourmaline vein containing pyrite and chalcopyrite, with a little siderite. The rocks on either side of the shaft are quite massive felspar porphyries.

The third vein examined is situated about five chains to the south-east of the S.E. corner of the Dalmeny section, and is immediately east of the Lake Margaret Transmission Line survey. Here, a shaft had been sunk on a small quartz-tourmaline vein containing a little pyrite. The rock exposed in the shaft is quite massive felspar porphyry.

(f) Production.

No ore has been marketed from this property.

(g) Conclusion.

The veins examined were all too small to be of any value, and, in view of the fact that the section is situated within the massive porphyries, no discoveries of any consequence are to be expected.

(7) Sections 10547, 10548 and 10549.

These sections comprise one 28 acre and two 40 acre sections which extend in a southerly direction from the Rosebery township. They were last held by A. Nicholas.

Section 10549 and the greater portion of 10548 are entirely within the massive felspar porphyries, as is the south-eastern portion of 10547. The northern and western portions of Section 10547, and a thin strip along the western portion of lease 10548, are in sheared porphyries, chloritic schists and quartz sericite schists.

Several small lodes of the quartz-tourmaline-pyrite type occur on these sections but none of them are of any importance. The largest of these occurs near the centre of section 10549; this lode is well defined and is about 4 feet 6 inches wide. It is composed principally of quartz, tourmaline, pyrite and carbonates. The pyrite is coarsely crystalline and has an extremely pale colour, though it is not arsenical. The quartz is vuggy and crystalline. Tourmaline occurs in seams and veins through the ore, and is also found in the country rock near the walls of the lode. This formation is said to have carried traces of gold.

Some of the other veins contain a little chalcopyrite and galena.

These properties are of no value.

(8) THE COLEBROOK MINE

(a) Location and Access.

This mine is situated on Colebrook Hill, which is about two and a half miles to the south-west of the Rosebery township. The mine workings may be reached from Rosebery, either by the old Zeehan pack track, or by a track which leaves the Emu Bay Railway near Hill's farm. The sections on which the mine is situated were last held as 239/93M and 9127/M.

(b) Previous Reports.

(1) A. Montgomery, "Report on the Zeehan-Dundas Mineral Fields in February 1896".

(2) J. Harcourt Smith, Report on "The Mineral fields in the neighbourhood of Mt. Black, Ringville, Mt. Read and Lake Dora, 1898".

(3) W.H. Twelvetrees, "Mineral Industry of Tasmania, 1901".

(4) G.A. Waller, Report on "The ore deposits (other than those of Tin) of North Dundas 1902".

(c) History.

The original Colebrook sections were first pegged as silver mining leases by Messrs. Adcock, Reeves and Luttrel in 1891. The sections were declared void in 1893, and in 1895 were pegged for copper by Messrs. Quinn and O'Brien. The Colebrook Prospecting Association took over the properties during 1896-1897. This company did a considerable amount of work in opening up the deposits and erected a small plant to smelt the ore. However, the deposits proved to be too low grade to be mined and treated at a profit, and active operations on them ceased some time prior to 1907.

(d) Geology

The whole of the deposits occur within the Dundas slates and breccias.

(e) The Ore Bodies.

The mineralogical composition and structure of the ore have been dealt with in a previous section of this bulletin and need not be recapitulated .

The occurrence of the several ore bodies is illustrated by the accompanying sketch plan which is largely adapted from that accompanying Wallers' report. In view of the irregular distribution of the lenses of ore, it has been found necessary to adopt a different system for numbering the several occurrences than that adopted by Waller. On the plan the principal lenses or masses of ore have been numbered from 1 to 5.

The No. 1 lens is exposed on B bench and in the No. 2 adit. It is approximately 60 feet long and, where exposed in the adit, is 22 feet wide. Its known vertical depth is 35 feet. The boundaries of this lens are ill defined, and several small stringers of lode matter penetrate the enclosing country rocks. Waller (67) states that some of the richer ore from this lens assayed 5.9% Cu and 1 oz. 15 dwts. of silver per ton.

(67) Waller, G.A. - The Ore Deposits (other than those of tin) of North Dundas. 1902. p.6.

The No. 2 lens has been developed by D open cut and by means of the No. 1 adit and C tunnel. In the open cut, this lens is 53' long and, at the northern end of the cut, is 27' wide. In the No. 1 adit, which is connected to the northern end of D open cut by a rise, the ore is exposed over a width of 60 feet. This adit is, approximately 100 feet below the floor of the open cut. C tunnel is about 40 feet above and 35 feet south of No. 1 adit; in it the ore is 60 feet wide. Thus, No. 2 lens has a total length of 70 feet a maximum width of 60 feet and a known depth of over 100 feet. In the open cut this lens strikes a little west of north, but has no definite dip; it will be seen from the above description that it widens considerably in depth. The average of 49 bulk samples taken from D open cut and C tunnel is said to have given 2.9% Cu and 1 oz. 1 dwt. of Ag per ton (68).

The No. 3 lens occurs near the top of the hill, and has been developed mainly by the 150' level (East) and summit tunnels. At the entrance to the 150' level tunnel the ore is 30 feet wide. On the surface this ore is continuous with that cut in the summit tunnel and may be traced up the steep face of the hill. Half way between the two tunnels the ore is only 8 feet wide, and at the summit tunnel it is about 5' wide. The ore continues up the hill to the summit trench, where it is 7 feet wide, but appears to die out a short distance down the western fall of the hill. In the 150' level (East) tunnel ore occurs over the first 50 feet from the portal and also for a distance of 30 feet at the end of the tunnel; the middle portion contains no ore. The ore in the end of the tunnel consists mainly of innumerable stringers of lode material which trend diagonally across the tunnel. An average of 23 samples taken while the tunnel was being driven is said to have given 1.6% Cu and 9 dwts. 5 grs. of Ag per ton (69).

The No. 4 lens occurs on the western fall of the hill. At the floor level of the open cut it is 35' wide, but narrows to 12' in the top bench of the cut. From the top bench the ore continues up the hill towards the summit trench for a distance of 35'. In addition to the open cut, this lens has been developed by means of two adits which were driven into the hill at the 150' level. A little ore is exposed in the face of the northern adit, and 20 feet of ore is exposed in the end of the southern adit, As far as could be determined, the ore in B trench does not appear to be continuous with that in this lens. An average of 16 bulk samples taken from No. 4 lens and B trench is said to have given 3.12% Cu and 1 oz. 3 dwt. 16 grs. Ag per ton (70).

The No. 5 lens is situated on the eastern fall of the hill, and is exposed principally at the end of the south drive from No. 1 tunnel. It is approximately 70' long and 25' wide. A little ore is exposed at the northern end of the drive. The ore exposed in the south of the tunnel is probably continuous with the outcrops immediately to the south. A bulk sample from D trench is said to have given a result of 3.06% Cu and 16 dwts. Ag. per ton (71).

In addition to these, several small outcrops of axinite-chalcopyrite ore occur at various places in the vicinity of the hill. None of them are very extensive and they have the same irregular mode of occurrence as

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(68) G.A. Waller 'The Ore Deposits (other than those of tin) of North Dundas' p.6.

(69) as above p.7 (70) as above p.8 (71) as above p.7

the main ore bodies described above. A little ore also occurs in H tunnel but is of no importance.

In the past, a good deal of diamond drilling was carried out on the ore bodies, but the results were disappointing. Some details of the bores are given in Waller's report (72).

In 1908 these deposits were sampled by Mr. George Barker. Mr. Barker estimated that the average copper of the principal portions of the deposits was about .5%, but states that some portions contain up to 3% Cu. In view of the time and labour involved no sampling operations were carried out by the writer.

(f) Production.

As far as could be ascertained, no copper has been marketed from this mine.

(g) Conclusions

Although the deposits include some fairly large bodies of copper ore, the results of Mr. Barker's sampling indicate that their average copper content is far too low to enable them to be mined at a profit.

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(72) G.A. Waller "The Ore Deposits (other than those of tin) of North Dundas" pp.8 and 9.

(9) THE ATHENIC TIN MINE.

(a) Location & Access.

The section on which this mine is situated was last held as 9128M of 31 acres. The mine is on the western slope of Colebrook Ridge and is approximately thirty five chains south of the Colebrook Mine. A branch track, connecting the old Zeehan pack track with the X River tramway, passes quite close to the mine workings.

(b) PREVIOUS REPORT.

Ward L.K., The X River Tin Field Bulletin 12, 1911.

(c) HISTORY.

The first discoveries of tin ore on this section were made by Messrs. S. & A. Fenton and J. Hill, in the middle portion of 1910. The original lead, 5156/M of 74 acres, was applied for in November 1910. During 1910-11, the prospectors did a considerable amount of trenching on a lode trending north-westerly across the property and drove an adit (the No. 1) to cut the lode in depth. The lease was transferred to the Athenic Tin Development Company in 1914, and the mine became known as the Athenic. The total amount of work done by this company could not be ascertained, but it seems probable that the No. 2 adit was driven during its tenure of the lease, which extended up to 1917. The present section, which comprises only a portion of the original one, was applied for by John Wesley in 1923 and was transferred to the Williamsford Tin Mining Company N.L. in 1926. This company resampled the property but the results were disappointing. The lease was declared void in 1927.

(d) GEOLOGY.

The whole of the lease is situated within the Dundas slates and breccias.

(e) THE LODES.

The principal workings are shown on the accompanying plan of the mine, plate .

The main lode trends in a general north-westerly direction across the western portion of the property. At the surface, it has been prospected by means of several trenches which are shown on the accompanying plan. In A and B trenches, the lode consists of several small gossanous seams carrying small amounts of cassiterite. In C.Trench, there is a ferruginous seam, about 9 inches wide, which is said to contain up to 5% of tin. D. & F. trenches have exposed a few small seams of pyrite which contain a little cassiterite.

The No. 1 Adit intersects the lode at a depth of 50 feet below the surface. From the end of the main crosscut, the lode has been driven on for a distance of 120 feet; for the first sixty feet, it consists of two small quartz veins containing limonite, pyrite, chalcopyrite, tourmaline, actinolite and minute amounts of cassiterite. At the end of the drive, it consists of a broken irregular quartz vein in which no metallic minerals could be detected. The south-westerly and north-easterly crosscuts at the end of the drive contain no signs of lode material.

The tin content of the lode, in the No. 1 level workings, is shown by the following assay results.

Table 16

Sample No.	Position	Tin Content.
1.	Intersection of main crosscut and drive	1.23%
2.	Main drive 63 ft. from crosscut	.14%
3.	Face of main drive	.11%

A sample from a small vein in the main crosscut gave a result of 0.05% Sn.

A vertical shaft connects the end of the No. 1 level main crosscut with the surface. This was inaccessible and therefore could not be examined.

The portal of the No. 2 level adit is 370 feet north of the above-mentioned shaft and is 126 feet below the No. 1 level workings. It has been driven in a southerly direction for a distance of 250 feet, but has not been extended sufficiently to cut the main lode. No tin bearing veins are exposed in this adit.

In addition to the main lode described above, an oxidised tin bearing vein occurs in "A" adit. This vein is very small and contains only minor amounts of cassiterite.

(f) PRODUCTION.

No ore has been marketed from this mine.

(g) CONCLUSION.

It will be seen from the above that the main lode is extremely small, and that it contains very minor quantities of tin. The mine is of no value.

VIII. CONCLUSIONS.

The future of the district depends entirely on that of the Rosebery Mine. The other zinc-lead ore bodies, viz. those of the Koonya, Dalmeny and Black P.A. Mines, are quite unlikely to yield the large quantities of ore which are necessary to make a successful mine. The Black P.A. and Dalmeny sections do not warrant further prospecting or developmental work. The Koonya Mine offers greater promise than either of these and may yield a small quantity of ore, but no extensive developments are to be expected from this mine, and any future work should be restricted to testing the lens of ore exposed on the No. 1 level and in the drive off the winze. The tourmaline and flourite veins, the pyritic-copper deposits and the axinite-chalcopyrite deposits of Colebrook Hill are of little or no value.

With regard to the Rosebery Mine, there is ample scope for future development work. The Nos. 2, 4A and 4B lenses should yield a large quantity of ore above No. 8 level, and conditions are favourable for the downward continuation of the Nos. 1 and 2 lenses below No. 8 level. The profitable working of this mine is dependent on the ruling prices for lead and zinc.

The present detailed survey has revealed some interesting and useful facts regarding the general and economic geology of the district. Chief among these, from the economic standpoint, are :-

(1). The greater number of the ore bodies occur along the sheared and fractured margin of the porphyries; and

(2). Ore bodies are likely to occur along the margin of sedimentary xenoliths occurring within the sheared porphyries.

These facts should be generally applicable to the main belt of porphyries of the West Coast and should be borne in mind in future prospecting operations along that belt.

K.J. Finucane, M.Sc., A.M. Aus. I.M.M.
Field Geologist.
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