GSREP 3

Tasmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY REPORT

No. 3

Preliminary Report

ON THE

Zinc-lead Sulphide Deposits of Mount Read

BY

LOFTUS HILLS, M.Sc., Assistant Government Geologist

Issued under the authority of

The Honourable J. E. OGDEN, Minister for Mines

Tasmania:

JOHN VAIL, GOVERNMENT PRINTER, HOBART

B67913

1914

TABLE OF CONTENTS.

Preliminary Report on the Zinc-lead Sulphide Deposits of Mt. Read.

I.—CIRCUMSTANCES AND SCOPE OF THE INVESTIGATION.

THIS report deals with the results of an examination of an area consisting of Mt. Read and the country in its immediate vicinity.

The area constitutes one unit of a continuous mineral belt extending from Kelly Basin in the south to Mt. Farrell in the north, the systematic investigation of which has been planned by the Geological Survey. The southernmost unit, the Jukes-Darwin Field, was examined by me last year. Next in logical sequence should have followed the study of the Lyell Field, but in view of the industrial deadlock in connection with the working of the complex zinc-lead sulphide ore-bodies of Mt. Read and Rosebery, it has been deemed advisable to postpone the examination of the intervening units, and thus concentrate attention on that portion of the belt which, although containing large and high-grade ore-bodies, yet, through a variety of circumstances, is now in a languishing condition.

The length of the belt along which these complex zinc-lead deposits have been proved to exist at different points is 7 miles. The thorough examination of the mine workings and the exposed ore-bodies throughout the whole of this belt was deemed to be too gigantic a task for one field journey. Accordingly, it was decided to divide the belt into two portions, a southern half extending from Dunne's Blocks on the south to Jupiter on the north, and a northern half extending from the latter mine to the North Tasmanian Copper Company's mine on the north. The present investigation was confined to the southern half, which contains the following mines:—Hercules, Mt. Read, Jupiter, South Hercules, Ring P.A., Dunne's Blocks, and the Ring Hercules. When the complete results of this investigation have been written up, the northern portion of the belt will be submitted to the same detailed examination.

It is the policy of the Geological Survey to systematically study and map the general geology of as large an area surrounding a mining field as is compatible with the study of the ore-bodies themselves. This practice has been followed in this case, and an area has been examined and mapped far greater than that in which the zinc-lead deposits are known to occur. That this was advisable and justifiable I can unhesitatingly state, as the special knowledge thus obtained has been partly at least instrumental in enabling me to achieve the success in the investigation detailed below.

The special object of the present investiation, and the one constantly kept in view, was the study of the ore-bodies, their characters, inter-relations, origin, and life-history, all of these factors leading ultimately to the formulating of a statement as to their extent both in length and depth, as well as to their character or probable value at a depth. Incidentally to this it was sought to explain why certain levels and bores did not penetrate ore-bodies, when, arguing from all theories as to their origin held up to the present time, ore should have been found. The discovery of the actual mode of origin must satisfactorily explain all these apparent anomalies.

In only one mine has development work been carried out sufficiently to enable reliable estimates of ore-reserves to be made. This is the Hercules Mine, and it is precisely here that an estimate of ore-reserves has been made by a consulting mining engineer (Mr. G. H. Blakemore) which was so much below that given by the mine manager (Mr. C. H. Moxon) as to lead the public to believe that the amount of ore available had been greatly overestimated. The study of this question was undertaken with the object of indicating, in the light of the results of the investigation into the behaviour and size of the ore-bodies, the true position in this regard. In the Mt. Read Mine sufficient cannot be seen as to the exact size of the ore-bodies to enable similar calculations to be made; although one estimate at least has been published as to the amount of ore available. The conclusions arrived at in regard to the general behaviour of the ore-bodies has been applied in making a determination as to the reliability of such estimates.

Following upon the discovery of the factors governing the extension and trend of the ore-bodies in the mines themselves, the investigation was continued with the object of determining the position of the ore-bearing

zone in the gaps existing between the present mine workings.

Attention has also been paid to the character of the ore in its relation to metallurgical treatment. In addition to this the present position in regard to the economic treatment of the ore has been thoroughly gone into, in order to place before the general public the actual facts in connection with this most vital question. Finally, the industrial history of the field has been studied, with the object of deciding what factors have been responsible for the present deadlock.

The field was first reported on by A. Montgomery in 1894; Harcourt Smith made an examination in 1897, and W. H. Twelvetrees paid a visit of inspection in 1900. G. A. Waller made a somewhat exhaustive report in 1902, this being the latest official examination up to the time of making the present investigation. Thus for a period of 12 years no attention has been paid to the district by any officer of the Geological Survey. Numerous private reports and examinations have been made from time to time by men of repute, but all of these have failed to make that complete study of the ore-deposits which is essential to a thorough understanding of their inter-relations. Thus quite recently G. H. Blakemore reported on the Hercules Mine, and he, as others before him, formed incorrect conclusions as to the behaviour of the ore-bodies in depth, and thereby gave to the general public the impression that the resources of the field were limited as far as the downward continuation of the zinc-lead deposits was concerned.

To make my investigation complete, all workings of any kind whatsoever were thoroughly examined, as although some of these had previously been described, yet the particular structural features which I have established as controlling the deposition of ore, had not been noticed by any previous observer.

II.—OBJECT OF THIS REPORT.

The success of my investigations into the mode of origin, and therefore the extent, continuation, and general behaviour of the ore-deposits, has been greater than I at first anticipated. They have resulted in the discovery of the factors governing the deposition of the ores—a set of conditions which had been undreamt of in connection with these ore-bodies, and which will prove somewhat startling to those who regard themselves as conversant with the field, but which are destined to prove of inestimable value in exploitation, both in the mines already worked and in the undeveloped sections along the mineral belt.

The fullest proof of my conclusions has been obtained throughout the whole area examined, but as these require some considerable space for their proper presentment they cannot be fully included in such a report as this.

Accordingly, it is my intention in this purely preliminary statement to make available to the public as quickly as possible, and in as simple language as the essentially technical nature of the subject will allow, the more important conclusions arrived at. This concise epitome therefore lacks the completeness of detail which will appear in the bulletin to succeed the writing of this report, and, in addition must be incomplete in the statement of certain exact predictions, the making of which will depend on the more complete investigation which will accompany the preparation of that bulletin.

III.—THE ORE-DEPOSITS.

In the portion of this mineral area referred to above, and generally known as the zinc-lead sulphide belt, there occur two distinct classes of ore-deposits, namely:—The zinc-lead sulphide ore-bodies proper, and the relatively pure pyritic copper ore-bodies which occur in juxtaposition thereto. The country in the immediate vicinity of this belt contains deposits of tin, fahl-ore, galena, nickel, &c., but attention was wholly confined to the abovementioned two types of ore-deposits.

The zinc-lead sulphide and pyritic copper ore-bodies occur in a series of schists, generally known as "the Hercules schists." They are of many varieties, but briefly are in character either argillaceous, calcareous, or siliceous. The most obvious feature of these schists is their cleavage or fissile tendency along planes of schistosity. At the same time the ore-bodies are laminated or banded in structure, *i.e.*, they consist of alternating, approximately vertical seams of ore of varying character, such as zinc blende, galena, pyrites, &c. These bands coincide in strike and dip with the planes of schistosity, and the ore-bodies themselves likewise conform to this strike. It is this most obvious characteristic that has been noticed by all previous investigators, and the measurements repeatedly reported are these:—Strike, 12° to 45° W. of N.; dip, 55° to 70° to E. of N.

It has been deduced from this that the ore-bodies continued downwards in conformity with this dip. It has further been deduced by Mr. C. H. Moxon, manager of the Hercules Mine, as the result of exploration and development work, that the ore-bodies had a decided pitch to the north, the idea being that they consisted of a series of separate lenses conforming in every way with the planes of schistosity, with, however, a pitch or inclination downwards in a northerly direction.

The character of the schists has always been regarded as obscure, and although some of them were thought to have been originally sedimentary in origin, yet it was accepted that the schist-planes coincided with the original bedding-planes.

The results of my investigations, however, conclusively show that these schists, without exception, even including the hard, dense keratophyre or felsite, are essentially bedded deposits, the keratophyre having been extruded

as a lava-flow and intercalated with the accompanying sediments of varying character. They, in fact, belong to an old series of mixed igneous and sedimentary rocks known in Tasmania as the porphyroids, and are Pre-Silurian in age. These sedimentary accumulations contained amongst them beds of more or less pure limestone. The whole series was subjected to an intense crushing and metamorphic action, during which the beds were folded and the schistose structure developed. The purer limestone beds were converted into a crystalline schistose rock, consisting of bands of varying composition; these bands conforming, of course, with the schist-planes in the other sediments. Some of the calcareous sediments have been converted into argillaceous schists; the calcium carbonate having assumed the form of calcite crystals or blebs scattered throughout the argillaceous groundmass. These are the calcite schists of Waller.

Now, it must be remembered that the planes of schistosity are developed at right angles to the direction of the pressure responsible for both the schistose structure and the folding. The schist-planes, therefore, in folded strata need not, and generally do not, coincide with the original bedding-planes.

In this we have the secret of the origin of these ore-bodies. It was my discovery that the planes of schistosity did not coincide with the bedding-planes, which has laid the foundation for the solution of the problem of ore-genesis. It is the keynote to the understanding of the distribution of the ore throughout the whole belt. The planes of schistosity and the bedding-planes cross each other at all angles, being coincident only in few localities, and this structure can be seen all over the field when diligently searched for, but is particularly noticeable in the neighbourhood of the old No. 1 workings on the Hercules. The stratification is there quite apparent. The "slides" mapped by Waller, as occurring in the Hercules workings, are almost without exception the original bedding-planes, accentuated by the effect of the passage of ore-bearing solutions along them.

The origin of the ore-deposits is this:—The ore-bearing solutions travelled upwards along the schist-planes and the old bedding-planes. The deposition of ore from these solutions has been determined in the first place, of course, by decrease in temperature and pressure, but mainly, and for practical purposes wholly, by the nature of the rock met with. The zinc-lead sulphides were deposited by metasomatic replacement of the bed or beds of crystalline and

schistose limestone, the banded structure of the ore resulting from the bands of varying composition; while the pyritic copper deposits were formed by the interaction of the ore-bearing solutions and the "black schists." In the case of the zinc-lead sulphide ore-bodies the solutions travelled along the bedding-planes separating the limestone bed from its neighbours, thence reaching the interior of the bed *via* the schist-planes. This explains why most of the ore-bodies have such clean walls. This bed of argillaceous limestone, as explained above, was folded. Consequently the zinc-lead sulphide ore-bodies are folded. Here we have the secret of the distribution of the ore throughout the belt. The location of the continuation of the ore-bodies depends therefore on the study of these folds. It must be understood, however, that it is not the ore-body itself which has been folded, but that it has resulted from the replacement of a limestone bed by the sulphides after that bed had already been folded. When the ore-bearing solutions travelling along planes of schistosity spread into the surrounding beds which contain very little or no calcareous matter, the low-grade disseminated deposits were formed. These have no definite form or extent, for the solid, well-defined ore-bodies have only been formed where there existed a bed of relatively pure calcareous rock.

There is apparently only one horizon in the old sedimentary series which contained these limestone deposits. This horizon now carries the zinc-lead sulphide ore-bodies, and the tracing of the ore-deposit resolves itself into the mapping and plotting of the folds of that particular horizon. In places there was only a single stratum or bed, but at other points that single layer was split up into smaller beds separated by argillaceous or siliceous sediment. These smaller beds, however, generally unite in a comparatively short distance to form the main stratum.

The investigation of and search for these folds soon showed that the problem was a difficult one, for not only is there a succession of folds rolling up and down from west to east with axes slightly west of north, but another series exists, rolling up and down from south to north, with axes slightly north of east. This structure on a small scale can be clearly seen in Dawson's open-cut on the Hercules, where both series of folds are represented. In addition to this, the occurrence of three sets of fractures of totally different origin greatly complicates matters, and it is mostly difficult, although by no means impossible, to decide whether one is observing the schistose planes, the

original bedding-planes, or true fault-planes. After much trouble, however, I have succeeded in locating these folds. They will now be briefly indicated. Their greatest value, however, lies in their accurate plotting, which must be left to accompany the compilation of the complete bulletin.

I propose to name the folds rolling from west to east, with their axes slightly west of north, the Alpha series; and the folds rolling from south to north, with axes slightly north of east, the Beta series.

The Mt. Read Company's ore-body consists of at least one complete fold of the Alpha series. There is a crest of an anticlinal fold at Williams' shaft, constituting what has been called the western or No. 2 ore-body. From there the ore-body plunges downwards towards the east to an unknown depth (probably not more than 70 or 80 feet below the main adit), and then swings upwards again, thus forming a synclinal trough situated to the west of the main adit. After rising upwards to form an anticlinal crest along the axis of which the main adit happened to be driven, the ore-body again plunges downwards towards the east. Any further continuation of the folds eastwards has not been penetrated by the mine workings. The tracing of the ore-body on this property is still further complicated by the occurrence of folds of the Beta series. At the southern end of the main adit the ore is plunging downwards towards the north. This brings the ore-body down to the adit-level and below it. Between the 910-feet and 810-feet points, measured from the adit-mouth, there occurs a synclinal trough, from which point the ore-body rises, going northwards until, at 810 feet from the entrance, it passes above the the adit-level. This trend continues until it again rolls over, forming an anticlinal crest somewhere northwards of the 810-feet point. It again plunges downwards, and enters the drive at 587 feet. The ore-body is seen in the adit from this point continuously to 210 feet from the entrance, where it is seen pitching underfoot to the north. This plunge downwards of the ore-body at this point is important, for it continues northwards with a few unimportant minor folds of same (Beta series), taking the horizon of the replaceable beds below the level of the workings of the South Hercules Mine, to swing upwards again at a point somewhere between the South Hercules eastern adit and the Hercules No. 4 tunnel. It is this upward portion of the field which brings the ore up to the level of the Hercules Mine workings.

Returning now to the folds of the Alpha series, the interesting and important fact deduced is this: that the ore-bodies on the Hercules known as the "South," "A," "B," "C," "D," "F," and the footwall portion of that known as the "E," are all on the descending limb of the same fold (Alpha series) as the easternmost portion of the Mt. Read ore-body as proved in the present workings. Just at this portion of the ore-body on the Hercules the horizon of the limestone beds consisted of several smaller beds separated by other sediments. This accounts for the occurrence of what have been erroneously taken as completely separate ore-bodies.

Of course the reader will have realised by now that the Mt. Read ore-body and those on the Hercules are really portions of the same mass, the northern continuation of the Mt. Read portion, which should occur to the west of the Hercules workings, having been removed by denudation.

We now come to the behaviour of the ore-bodies in the Hercules Mine. Concisely it is this: the "B," "C," "D" ore-bodies are known with certainty to continue downwards from the 3A to the 4 level, a depth of roughly 100 feet. The problem for solution, however, has always been—What becomes of them below No. 4 level? My conclusions are that they continue downwards with a constantly flattening dip until they reach a point below No. 5B level, where they have all junctioned with each other, and with the downward continuation of that portion of the "E" ore-body between the footwall and the "E" main north drive.

This point of junction is approximately the trough of a fold of the Alpha series. From this point the combined ore-body rises to the crest of an anticlinal fold of the same series, situated on the meridian of the "E" main north rise (Woodard's rise). From this anticlinal crest the ore-body plunges downwards to the east.

The main portion of the ore-body therefore lies to the east, below No. 4 level. This downward plunge eastwards is the furthest portion in that direction of the ore-bodies which has been investigated by bores or workings, but the conclusion I have arrived at is that it continues downwards to the trough of another syncline of the Alpha series, to rise yet once again to the crest of an anticline. This succession of folds is continued to the eastward, but I am unable to state their exact number until the investigation has been completed to the northern end of the whole

belt. Suffice it to say, that their existence has been proved.

The "F" ore-body behaves in exactly the same manner. The portion known as the footwall branch dips eastward down to the third stope above No. 4 level, where it takes a sudden rise upwards, to roll over and again plunge downwards to the east. The open stopes in the southern workings on this (Dawson's) ore-body present an excellent illustration on a small scale, of these Alpha folds. The back of the fourth stope here shows the wall of the ore-body rolling over like a dome. The synclinal trough is seen in the footwall stopes here at the second and third stope level.

The "A" lode begins to split at the 5B level where there is a portion characterised by pyritic copper deposits and another portion of high-grade zinc-lead ore. This zinc-lead portion, I conclude, diminishes in quantity as the ore-body approaches the No. 5 level, where it has practically all disappeared, and the ore-body becomes a true pyritic copper deposit. This character is due to the nature of the bed the solutions have replaced along the planes of schistosity. The dip to this level has taken this lode to a location directly below the "B" lode in No. 4 level. At the No. 5 level the dip of the replaced bed has become very flat (corresponding to the flattening in the "B," "C," and "D," ore-bodies above), approaching the height of a synclinal fold. This trough occurs at a point east of the 650′ S. drive, from which, corresponding to the folds described above for the zinc-lead sulphide ore-bodies, the replaced bed rises to an anticlinal arch situated to the west of the winze at 700 feet. From this arch the ore-body plunges downwards to the east, but beyond this point no work has been done on it. It must, however, be subject to the same folds as affect the zinc-lead sulphide bodies. Thus it is seen that the No. 5 tunnel gave an exaggerated idea of the thickness of this copper ore-body.

So much for the effect of the Alpha folds. A consideration of the effect of the Beta folds is, however, essential before the real trend of the ore-bodies can be realised. As stated above, there is a rise towards an anticlinal arch northwards from the trough of a fold of the Beta series situated between the Hercules No. 4 tunnel and the South Hercules eastern adit. The crest of this anticline is situated somewhere between the No. 4 and No. 3 tunnels. A plunge there occurs downwards to the north to a synclinal trough situated between the No. 8 and No. 4 bore-

holes. Another rise northwards occurs from here to the crest of an anticline at Dawson's Rise, whence there is a plunge northwards on a synclinal fold of relatively great extent, the trough of which is somewhere south of the Ring Prospecting Association's workings. From this point the horizon of the ore-bearing beds rises to the Ring Prospecting Association, and continues rising and falling to the northern boundary of the area examined.

The zinc-lead sulphides located on the Ring P.A. occur on the eastern descending limb of the same synclinal Alpha fold which is described above as forming the western portion of the Mt. Read ore-body. From this point (Ring P.A.) the axes of the Alpha folds swing from west of north to nearly due north. The Jupiter zinc-lead ore-body apparently occurs on the same descending easterly limb of the same fold. These two mines therefore (Ring P.A. and Jupiter) both have the whole series of folds occurring in the Mt. Read and Hercules mines to the eastward of them.

Now we can understand why so many tunnels and bores failed to locate the zinc-lead ore-bodies.

(1) The No. 2 or western adit on the Mt. Read Company's property failed to pass through the ore-bodies simply because the bottom of the troughs of the folded ore-body did not reach that level (300 feet below the No. 1 or main adit). Its eastern extension from below the open-cut workings did not penetrate ore because the folds are continued eastwards (these folds, in fact, being the southern continuation of the Alpha folds in the Hercules), thus preventing the ore-body from descending downwards to this level.

(2) The South Hercules eastern adit did not pass through the zinc-lead sulphides because it was driven over the top of the ore-bearing horizon, approximately along the axis of a Beta synclinal trough.

(3) The Barlen tunnels did not prove ore because the off-shoots from the main body, viz., the "A," "B," "C," and "D" ore-bodies, pinch out northwards at the level of the these tunnels, but continue northwards beneath the level of the tunnels, the big Beta synclinal trough plunging downwards in a northerly direction from Dawson's Rise being responsible for this.

(4) The No. 4 tunnel (Hercules) did not penetrate the "B" and "E" ore-bodies for the reason that it passed over the horizon in which they occur.

(5) The No. 2 tunnel (Hercules) failed to locate the "E" ore-body for the same reason.

(6) The No. 5 tunnel at the Hercules did not cut the zinc-lead sulphides because the united ore-body sank below No. 4 level, but rose again from the trough of the fold before it reached the level of No. 5 main crosscut.

(7) The 550-feet north drive at No. 5 level did not prove ore because it was driven west of the footwall of the united ore-body, the dip of which flattened sufficiently to take it over the top of this drive.

(8) The 700-feet north drive at No. 5 level did not cut the sulphides because it was driven under a portion of the ore-body which was rising from a synclinal trough to an anticlinal crest of the Alpha series.

(9) The No. 5 bore did not cut the ore-body because it passes directly underneath an Alpha synclinal trough.

(10) The No. 4 bore failed to prove ore because it was put in along the direction of the axis of a Beta fold which carried the ore above it coming northwards from a synclinal trough on its rise to the anticlinal crest. The eastern portion of it did not penetrate ore because folds of the Alpha series kept the footwall of the ore-body constantly above it, although there will probably be ore ahead of it.

(11) The No. 6 tunnel did not cut the ore-body because the Alpha folds again kept the footwall above this level.

The following existing practices, conceptions, and opinions concerning occurrences on this field must be corrected:—

(1) Attempts have been and are still being made to obtain correct figures for the dip and northerly pitch of the ore-bodies. From the fact that the ore-body is folded, as described above, these attempts are useless, and should be at once discontinued. The impossibility of giving figures for the northerly pitch is exemplified by the

consideration that in places the ore-body actually has a decided southerly pitch.

(2) The practice has been adopted of dividing the mineral belt into two portions—a zinc-lead sulphide belt and a cupriferous belt situated to the west thereof. This division is artificial, and therefore misleading, and should be discontinued.

(3) The designation of certain rocks separating masses of ore as "intrusive schists" is wrong, as none of these schists is intrusive, and the practice is not in accordance with the origin of the ore-bodies. This usage should cease.

(4) The designation of the main adit at the Mt. Read Mine as the 300-feet level is misleading to the public. As this level is nowhere 300 feet below the uppermost portion of the ore-body, and is in fact very much less, it gives a wrong impression to call it the 300-feet level. It will in future be called the No. 1 or main adit.

(5) It has been stated in reports that the No. 1 or main adit on the Mt. Read Mine was in the ore-body for at least 770 feet. This is an exaggeration, as the adit, which runs for 210 feet before striking ore, passes through a length of 377 feet of ore, after which it traverses barren country for 224 feet, when ore was passed through for 100 feet. The remainder of the adit is in practically barren country. Thus the total length of ore proved in the adit is 477 feet.

(6) The deduction, resulting from the occurrence of copper deposits in No. 5 level (Hercules), beneath the "B" and "E" ore-bodies, and non-occurrence of the zinc-lead ore-bodies there, that the latter class of deposits changed in depth to copper is absolutely wrong. This opinion was held by earlier observers, and adopted by Blakemore on insufficient investigation, and has done the field much harm. It was assumed that the zinc-lead sulphides were the result of secondary enrichment, and would therefore be a shallow superficial feature. This is quite an erroneous conclusion, and it can be stated definitely that the zinc-lead sulphides are not the result of secondary enrichment, but are still in the original condition in which

they were formed. Their continuation, with their present composition, in depth, therefore, is assured to an extent compared with which the deepest present mine workings are quite insignificant. The vertical range of these deposits at any point depends on the depth to which the folds in the replaceable beds will allow them to go.

IV.—THE MINES.

The Hercules Gold and Silver Mining Company.

This mine was discovered in 1894 by Mr. J. Will. Development and exploration work continued up to 1901, when the first important sales of ore began. This continued, with certain interruptions, of which that caused by the strike in 1905 was the longest, up to September last, when ore-production ceased, and has not been renewed up to date.

The total capital subscribed up to the present date is £39,050. The total receipts from ore sales has been £263,696 17s. 11d. The total dividends paid have absorbed £36,323 9s. 3d. This leaves a sum of £266,425 8s. 8d. which has been spent by the company.

The total output has been 181,426 tons, constituted as follows:—

	Tons.
Gossan	15,376
Sulphide (lead ore)	134,051
Zinc blende	31,343
Copper ore	345

The approximate assay values of these outputs have been:—

	Gold.	Silver.	Lead.	Zinc.	Copper.
	oz.	oz.	Per cent.	Per cent.	Per cent.
Gossan	·45	23·6	12·12	...	...
Sulphide (lead ore) ...	·297	18·14	10·30	28·5	...
Zinc blende	·178	10·51	7 0	42·49	...
Copper ore	...	2·0	...	...	4·4

Such being the past achievements of this mine, it is now necessary to see what are its future prospects. My deduction as to the behaviour of the ore-bodies below No. 4 level are all-important in this connection. Mr. G. H. Blakemore in January, 1913, made an estimate of the amount of ore available, and his calculation was that there were 156,000 tons available from the 3A level down to 47 feet below No. 4 level. At the same time the mine manager (Mr. Moxon) made an estimate of 322,000 tons to the same point. Critically examining both these estimates, I find that Blakemore allowed practically no ore for those portions of "A," "B," "C," and "D"

bodies affected by the falls or subsidences which have occurred therein. His estimate was further affected by the assumption that the value of the ore depended wholly on the lead, silver, and gold contents. In considering this question of quantity of ore, I have adopted the practice of regarding all ore as good grade if the total metal contents (gold, silver, lead, and zinc) approach the average of the ore sold up to the present time, irrespective of how the value is distributed among those four metals. Mr. Moxon's estimate is based on the same principle. Taking into consideration the known dimensions of the ore-bodies and their general behaviour, and making due allowance for the amount already stoped, and including those portions of the workings not examined or taken into consideration by Blakemore, I find that the latter gentleman's estimate was most decidedly less than what may reasonably be calculated on.

Mr. Moxon has recently made revised estimates of ore-reserves, and I will now proceed to explain my opinion as to their reliability in the light of my conclusions as to the general behaviour and trend of the ore-bodies.

Ore Above No. 4 Level.—The amount of ore available above No. 4 level in all the ore-bodies known to exist is given as 145,000 tons. This is regarded as "blocked ore." I can endorse this estimate as being a reliable indication of the amount of ore which can be extracted from this portion of the mine, but it must be remembered that portion of this, occurring as it does in the mine workings affected by the rather extensive subsidences, will be more costly to mine than it otherwise would be, although it most certainly cannot be regarded as unrecoverable.

Ore Below No. 4 Level.—In making the estimate for this portion of the mine the results of the diamond-drill bores obtained during the last 12 months have been taken into consideration, and were, of course, essential.

What the several bores proved was this:—

(1) No. 2 bore proved the footwall of the united ore-body, described previously, to be 70 feet below the No. 4 level at No. 2 crosscut, and about 50 feet west of the hanging-wall as seen at No. 4 level. The ore to this point was high-grade.

(2) No. 7 bore proved the same footwall to be 128 feet below No. 4 level at a point 50 feet east and 67 feet north of its position proved by

No. 2 bore. The ore passed through was here also high-grade, the whole bore assaying:—

Gold.	Silver.	Lead.	Zinc.	Copper.
oz.	oz.	Per cent.	Per cent.	Per cent.
·138	5·3	4·0	23·6	0·33

(3) No. 8 bore showed that the footwall was at some unknown distance beneath a point 230 feet below No. 4 level, *i.e.*, 87 feet vertically below No. 5 level, since the bore ended in as high-grade ore as has ever been found in the mine, and did not penetrate the footwall. This bore is situated 42 feet north of No. 7 bore. The average assay of the whole length of this bore is:—

Gold.	Silver.	Lead.	Zinc.	Copper.
oz.	oz.	Per cent.	Per cent.	Per cent.
·138	5·9	7·2	28·8	·38

The explanation of these three results is, of course, that the ore-body is here pitching northwards down the descending limb of a fold of the Beta series, as previously explained.

Mr. Moxon has calculated on the results of these bores that there are 118,500 tons of high-grade ore available blocked out on three sides. I can again endorse this estimate, with the reservation that my deductions as to the variations of the position of the footwall alter the method of calculation. The figures, however, can be relied on.

As regards the "A," "B," "C," "D," and "F" ore-bodies, Mr. Moxon calculates that, down to a depth of 70 feet below No. 4 level, there are roughly 165,000 tons of "probable ore." On the understanding that this estimate is so designated, and not taken as "blocked ore," this is a reliable figure.

In the case of the "E" ore-body, he calculates the "probable ore" down to 230 feet below No. 4 level (assuming the length and width known on No. 4 level) as 477,000 odd tons. This, of course, is in addition to the ore calculated above as ore "blocked out." As the result of my conclusions concerning the behaviour of the ore-body below No. 4 level I cannot endorse the basis of this calculation. I feel perfectly justified, however, in stating that subsequent development work by diamond-drill or otherwise will prove this quantity to be available. I would base this prediction on the ore in the portion of

the fold to the east of the No. 8 bore rather than on that in the whole block taken by Mr. Moxon, as continuing on his assumed regular line of dip down to the vertical extension proved by that bore.

Finally, therefore, I can state that there are 263,000 tons of ore which may be regarded as "blocked out," and that there are 165,000 tons of "probable ore," without counting, say, 450,000 tons of "probable ore" in the united ore-body, which in my opinion ultimate development work will prove to be a conservative estimate.

The Mt. Read Mining Company.

This mine was discovered in 1891 by A. E. Conliffe. The first work done on it was in sluicing the gold shed from the gossan. Exploratory and development work continued more or less regularly up to 1900, when the first ore was sent out. The output of ore continued until 1901, when production ceased, and a new company was formed. This company has continued operations on a generally limited scale since that date, and since the completion of the No. 2 or western adit, in 1907, only two men have been employed. During the last few months exemption from the labour covenants has been granted, and at present the mine is absolutely idle.

The total capital subscribed by the present company is £141,944 6s. No dividends have been paid. According to the last balance-sheet published by the present company, £115,945 has been paid for the purchase of the property and £20,874 has been spent in conducting the affairs of the company.

I have found it impossible up to the present to obtain exact information as to the total expenditure on the property since its first discovery. The nearest figure I can give is £100,000, and this will probably be found to be near the mark.

The total output of ore has been 8059 tons, the receipts from which totalled approximately £8000.

In discussing the future prospects of this mine, I must state at once that, in spite of the very large sum of money which the several companies have expended, development work has not been carried to that stage which would allow estimates to be made of any appreciable quantity of "blocked out ore." Practically all estimates of quantities, therefore, must necessarily be in connection with "probable ore," although a certain amount of ore is certainly "blocked out."

The only estimate of ore-reserves of which I could obtain the exact figures is that made by Mr. P. Ledoux in 1903. The details of this calculation I cannot obtain. The estimate was this:—

> "The probable quantity of profitable ore existing in the main ore-body between the surface and a depth of 50 feet below the upper tunnel amounts to 122,000 tons. This may be taken to have an average of 4 dwt. gold, 14 oz. silver, 8 per cent. lead, 22½ per cent. zinc, and 0·33 per cent. copper—on the assumption that the undeveloped portion has the same average metal contents as the ore already broken and that visible in the mine."

Taking into consideration the behaviour of the ore-body, I find that the present workings may be taken as indicating the existence of this amount, and perhaps more, of "probable ore." The estimate below No. 1 adit was based on two winzes sunk on the ore, one 50 feet deep and the other 39 feet. Even so, I think that 122,000 tons may be taken as probable ore. As regards the assay value of this ore, I may say that I doubt whether the figures given above are justified. Development work is necessary before such assay figures can be given. I must here state my opinion that the ore-body on the Mt. Read Mine, as showing in the present workings, is distinctly lower in grade than that in the Hercules Mine. This may not apply to ore which is likely to be subsequently proved, as discussed in a subsequent chapter of this report.

The Jupiter Mine.

This originally consisted of two mines—the Jupiter and the North Jupiter. Both of these were forfeited in 1905, and the present owners acquired a consolidated lease which includes both mines.

The existence of zinc-lead sulphides on this property was only established in 1905, the previous mine workings having disclosed only copper ore.

Since that date development work has proved the existence of a high-grade zinc-lead ore-body 240 feet in length, extending over a vertical depth of almost 100 feet down to the No. 3 tunnel, and varying in width from 20 feet down to 1 foot, but averaging about 6 or 7 feet. It has not been proved below No. 3 tunnel level, although there is no doubt that it extends beneath that level.

The total amount expended on the property has been roughly £7000. The total output has been:—

	Tons.
Sulphide (lead ore)	6400
Zince blende	600
Copper ore	22

The assays of the sulphide are not obtainable, but it was certainly good grade ore. The zinc blende assayed 42 per cent. zinc, the copper ore assayed 8 per cent. copper.

No estimate of ore-reserves in this mine is justifiable, although there certainly remains some ore above No. 3 level, less in quantity, however, than that extracted.

As will be pointed out in a subsequent chapter, I am of the opinion that development work below No. 3 level will disclose considerable quantities of ore existing to the east of that showing in the No. 3 level.

The Ring P.A. Mine.

This was originally opened up in about 1896 to investigate an ore-body seen outcropping on what is called the "copper knob." This proved to be a copper ore-body with practically no zinc or lead. Subsequently the Tasmanian Copper Company purchased the property with the object of using the clean copper ore to mix with the zinc-lead ore from their Rosebery Mine for smelting purposes. Later on they sold it, and the mine workings are now included in a section charted in the name of J. H. S. Munro. A working option was given to a Launceston syndicate last year, and the work carried out towards the close of 1913 proved that the zinc-lead sulphide ore-body occurred on this property to the east of the copper workings.

The total output of copper ore has been 2340 tons, valued at about £6000. The Tasmanian Copper Company spent about £7300 on the property. I cannot obtain figures as to the previous expenditure, but the present optionees have spent about £250.

As regards the future of this property, it may be stated that no estimate whatsoever can be made as to the quantity of zinc-lead sulphide ore available. The work done on this ore-deposit has only been sufficient to prove the fact that ore of this character does exist here. The zinc-lead sulphides were first seen in a trench below the track to Mt. Read. A tunnel put in lower down the hill cut a

seam of high-grade zinc ore, which was driven on for some distance. I am doubtful, however, whether this seam is the same as that seen in the trench; a definite statement on this point must be withheld until the survey is plotted.

As stated below, however, it is my opinion that, owing to the fact of this ore-body occurring here on the most westerly of the Alpha folds of the united ore-body, there exists the possibility that considerable quantities of zinc-lead sulphide ore will be found to the east of and below the portion at present known.

The South Hercules Mine.

This mine was started shortly after the Hercules. The only ore proved was in a shaft sunk near the southern boundary.

No ore has been sold from this mine, and the expenditure is unknown, but probably exceeded £5000. The original company forfeited the sections about three years ago, and they are now chartered in the name of Corrigan and Maddox.

No estimate of ore-reserves can be made. In this case it may be stated that the ore-bearing horizon exists below the eastern adit, and boring will prove whether the Hercules ore-bodies are continuous, through this property, with the eastern folds predicted by me on the Mt. Read Company's lease. The probability of this is, in my opinion, encouraging.

V.—THE POTENTIALITIES OF THE FIELD.

A consideration of the field as a whole is essential to convey to the general public some idea of what may be expected from it in the future. I will here use my deductions as to general behaviour of the ore-bodies in making a definite statement of my opinion in this connection.

Amount and Value of Output.

Total output of the field (approx.)	200,000 tons
Total receipts from sale of ore (approx.) ...	£280,000
Average value per ton (approx.)	£1 8s.
Average assay value per ton (approx.)	Bet. £9 & £10

It is thus incidentally seen that the amount received in payment for the output has been ridiculously below its true value.

Ore-reserves.	Tons.
Total blocked ore	263,000
Total probable ore	737,000
Grand total	1,000,000

Considering now my previous statements as to the effect of the Alpha and Beta folds on the portions of the horizon of the replaceable limestone bed in the different parts of the field, we realise the possibility of the occurrence of ore in amounts far in excess of the above estimate. It will be remembered that the folds of the Alpha series place the horizon of the replaceable bed to the east of the Mt. Read open-cuts below the surface, but above the No. 2 or western adit. A continuation of these folds occurs east of the No. 8 bore on the Hercules. The same folds, combined with the effects of a Beta fold, place the same horizon below the level of the South Hercules eastern adit. Similarly a fold of the Beta series takes the ore-bearing horizon down to the Ring P.A., where ore is known to occur on one of the westernmost folds of the Alpha series; the same applies to the Jupiter. In all the country between the Hercules and the Ring P.A., and onwards to the Jupiter, the ore-bearing horizon exists beneath the surface, rolling up and down to the eastwards.

It must not be rashly assumed, however, that the replaceable bed exists throughout the whole of this horizon. Breaks in its continuity are likely to occur. When, however, we take into consideration the fact that the ore is known to recur persistently throughout the whole length of 7 miles of the Mt. Read-Rosebery mineral belt, confidence is engendered that a considerable portion of this horizon must contain zinc-lead sulphide deposits. The effect of depth on the value of these deposits can be ignored. It is my opinion that exploratory work on the lines indicated in a later part of this report will prove ore to exist to an extent compared with which the estimate given above will be very small indeed.

In addition to the good grade ore considered in all calculations and predictions made up to this point, however, there undoubtedly exist throughout the field immense quantities of low-grade ore, *i.e.*, ore containing up to, say, 10 per cent. zinc and 1 or 2 per cent. lead, which are destined to be a source of profit after the rich sulphide ore is depleted and the inevitable progressive improvements in metallurgical methods have taken place.

VI.—THE CAUSES OF THE PRESENT DEADLOCK.

The total amount spent by the companies which have carried on operations in the field since its first discovery is approximately £400,000, but probably exceeds this figure. It must not be assumed, however, that the whole of this sum has been expended on the mines themselves. Expenses outside of the field have absorbed quite an appreciable proportion of this, but the exact amount would be impossible of estimation. One fact, however, should be recorded. Since the inception of the present Mt. Read Mining Company the total sum expended in the State of Tasmania has been £12,278, while the expenses in London (none of which was for metallurgical research) was £8596.

The reasons, apart from this, why the expenditure of £400,000 has not succeeded in establishing the field as an active producer of profitable ore, seem to me to be the following:—

The policy which seems to have influenced those directing the operations on the field has been characterised by the desire to obtain profit quickly and at once, and at the expenditure of very little capital. This was the policy directing the work at the Hercules Mine up to quite recently. Thus is explained the feverish pig-rooting for gossan at the sacrifice of valuable sulphides, followed, with the advance in metallurgical treatment by the Tasmanian Smelting Company and others, by the tearing out of the high-grade sulphide with no thought as to what would become of the lower-grade material. This shortsighted method of mining, together with the neglect to fill stopes, in ground which at the best requires much care in mining, resulted in making it difficult to obtain that lower-grade ore in future mining operations. The same policy of endeavouring to obtain much for very little has characterised the directors' attitude towards the metallurgical question, which they were soon forced to realise was vital to the mines. Their investigations into the question, as described in the half-yearly reports from 1897 onwards, consisted in sitting down and waiting for a process to come along and be presented to them. It has been realised for years that the ore on this field differed in some marked way from the Broken Hill ore, yet no attempt whatsoever

has been made by any of the companies concerned in this portion of the field to carry out an investigation which is the first and essential step in the attempt at an evolution of a process to economically extract the values from the ore. I refer to the question of the existence of the mineral huascolite which has been positively asserted by certain authorities to be present, thus explaining why Hercules ore has not proved to be susceptible to the same treatment as has been successful on Broken Hill ore of similar composition. Huascolite is a chemical compound of zinc sulphide and lead sulphide. Consequently if it exists to any extent in the ore, a mechanical process designed to separate zinc blende from galena will be useless in its treatment. It is certainly not to the credit of the companies concerned that they have not made it their business to have this vital point decided. It is surprising, also, that those officials of the companies whose daily occupation brought them into a constant realisation of the peculiar properties of the ore did not take advantage of their opportunities to investigate the question. There has been a woeful lack of self-help in the history of this field.

In the failure of the evolution by outsiders of a process suitable to these ores, the Hercules Company, instead of subscribing sufficient capital and systematically developing its mine, and at the same time employing a competent metallurgist to properly investigate the treatment of the ore, made a succession of contracts for the sale of ore, of two kinds. In the first of these the zinc was wholly lost; in the second the lead contents were lost. In this way some 39,000 tons of zinc have been given away, and 2200 tons of lead have been hopelessly lost.

The last contract with the Tasmanian Smelting Company, which was practically forced upon the Hercules Company, was unjustifiable, as it benefited neither the latter company nor the Smelting Company, which it was meant to assist. It is a terrible thing to see ore worth on its assay from £9 to £10 being sold for £1 8s., and towards the last for 16s., per ton.

The above remarks apply more particularly to the Hercules Company. As regards the Mt. Read Company, I must state my opinion that the money expended has not been put to the best use. Particularly in the last few years there is very little to show for an expenditure of nearly £21,000. Part of this was spent in driving the western adit, which was justifiable, although now proved to have been based on wrong assumptions. The work at

the main adit-level, however, has been wasted, as it should, before anything else, have been spent on crosscutting the ore-body to properly develop it.

Practically, therefore, the one mine has had the money to spend, but has not made the best use of it, while the other company would not supply the capital, but sacrificed some of the resources of its mine to maintain a precarious existence.

Summarising, therefore, the cause of the present deadlock is the absence of a suitable process to treat the ore. The failure of the companies to do their proper share in the practical investigation of this question has brought about the result which should have been foreseen years ago. The effect of the unjustified statements made by many of those reporting on the field, that the zinc-lead sulphides would not live down, has accentuated the deadlock thus reached.

VII.—THE PRESENT POSITION IN REGARD TO THE TREATMENT OF THE ORE.

The processes which may be taken into consideration as likely to enter into this question of treatment may be divided into the following classes:—

(1) Mechanical Processes.—These include the "flotation processes," such as the "minerals separation process," De Bavay's process, Horwood's process, &c.

(2) Chemical Processes.—This group includes the process of the Tasmanian Metals Extraction Company. It also includes the direct smelting process practised by the defunct Tasmanian Smelting Company, which, however, to recover the zinc must be followed by a slag dezincing process.

(3) Electrical Process.—This group includes the Gillies process.

At the outset it must be stated that the huascolite question has not been solved as yet to my knowledge. If the presence of this mineral in appreciable quantities in the ore is proved, then all the processes under "mechanical processes," including the flotation processes, are foredoomed to failure, and only the chemical or electrical processes need be investigated. In the absence of definite knowledge on this point I will point out what is being done now in each type of process.

(1) *Flotation Processes.*—There are two distinct types of operations affected by these processes. The first is the separation of sulphide mineral from a valueless gangue. The second is the separation of two sulphide minerals from each other.

The most successful application of flotation has been in the first type of operation. On the ores of good grade on this field, *i.e.*, those to which attention is now being paid, this operation would be superfluous, as there is practically no gangue.

It is the "selective flotation" processes which must be looked to for the solution of the separation of zinc-blende from the other sulphides. The success of this method on Broken Hill ores is far from being perfect, and extensive research and experimentation are going on to enable better recoveries to be made. Still greater have been the difficulties experienced with regard to these Tasmanian ores,

and the imperfect results on Broken Hill ores are much less perfect on the more refractory zinc-lead sulphides of the Mt. Read-Rosebery district.

Experimental trials and investigations as to the applicability of this "selective flotation" on the ores of the Mt. Read Field have been for some time, and are still being, carried out by the Mineral Separation and De Bavay's Processes Australian Proprietary Limited, which controls and works all those patents which represent the last word in those flotation processes which do not involve a preliminary roast.

After an examination of the results of laboratory tests by these people, I find that the results obtained still leave very much to be desired. A bulk test (2 tons basis) gave the following results:—

	Wt.	Assay.		Recoveries.						
	%	Gold. oz	Ag. oz.	Pb. %	Zn. %	Fe. %	Ag. %	Pb. %	Zn. %
Original Ore	100	·120	5·7	8·0	32·4	13·2	...	...	...
Zinc Concentrates	47	·100	2·0	4·3	50·4	7·7	16·5	25·3	73·1
Lead Concentrates	10·2	·145	41·8	41·1	21·1	8·2	74·8	52·4	6·6
Middlings	42·8	·135	1·0	3·9	15·3	20·4	9·0	21·0	20·3

The zinc concentrates and the lead concentrates are by no means near perfection, but it is the middlings product, representing nearly half of the original weight of ore, which is the real stumbling-block. This is worse material to treat than the original ore.

The particular modifications of the "selective processes" which involve a preliminary roast, such as Horwood's process, likewise give imperfect results. They have yet to prove that they can satisfactorily deal with this ore on a commercial scale.

(2) *Chemical Processes.*—(*a*) Tasmanian Metals Extraction Company Limited: This company was formed about six years ago to erect works at Rosebery, wherein to treat these ores by the "bisulphite process." The works were not started to be erected until about two years afterwards, but eventually, early in 1913, treatment was commenced. Much secrecy was observed in all the work, and admission to the works was refused everyone. It was obvious that difficulties were encountered from the start, and subsequently work was suspended and most of the hands discharged. The present manager, Mr. Frank Rowley, was good enough to show me through the works, and stated that considerable difficulty had been encountered in the mechanism of operation, as is usual with all new metallurgical processes, and this has consequently hindered progress. Metallurgically, however, the process had been successfully proved by a shipment of high-quality dense zinc oxide, containing no trace of lead. This, however, was produced under mechanical difficulties, and treatment was therefore suspended in order to render the working conditions more satisfactory. The process consisted essentially of first crushing and roasting the complex zinc-lead ore in order to decompose the sulphides and oxidise the contained metals, the roasted ore being then mixed with water and exposed under special conditions to the action of sulphur dioxide gas (produced during the roasting of a subsequent lot of ore), which extracts the zinc in the form of soluble zinc bisulphite, leaving the iron, lead, silver, and gold in the residue in a form suitable for direct smelting. The soluble zinc bisulphite is then converted in the insoluble zinc monosulphite by heat, and this, when separated, dried, and calcined, produces a particularly dense zinc oxide, not in any way resembling the usual light and flocculent zinc oxide produced as "fume," which latter is unsuitable for reduction to metal. Besides being dense and suitable for zinc-smelting, the oxide is entirely

free from lead, and thus produces a spelter of very high grade. Mr. Rowley also stated that he would shortly be restarting treatment of ore.

(*b*) *Direct Smelting Processes.*—The operations carried on by the Tasmanian Smelting Company constituted the first portion of the treatment of zinc-lead sulphides by direct smelting, namely, the production of bullion carrying the lead, silver, and gold values. The second part of this process consists in the extraction of the zinc from the slags resulting from the first operation. It is this second portion of the process which is at present the stumbling-block to the application of this smelting process to the treatment of the zinc-lead sulphide ores of this field. Mr. P. S. Morse, of the Sulphide Corporation, reported on the methods employed in Europe in dezincing the zinciferous slags. He stated that the Oker process (on which great hopes had been built), although an undoubted technical success, had no possible chance of proving economically successful under the conditions existing in Tasmania as to the cost of labour and coke. He, however, recommended that experiments be carried out to find how far another process (the Schmidt and De Graz) would prove successful under local conditions. He could not say whether success was probable. These experiments have not been undertaken.

(3) *Electrical Processes.*—Gillies' Process: I am unaware of the details of this process, and have no information as to the technical success of the laboratory tests.

However successful the process may ultimately prove, one fact is abundantly evident, and this is that the erection of works at North-West Bay, near Hobart, to treat the ore by this process is economically unsound. To deliver the ore at the works at North-West Bay the cost of the following handling and haulages will be added to the treatment costs:—

(1) Haulage from Williamsford to Zeehan on narrow-gauge line.
(2) Handling from narrow-gauge trucks to those of the Government line.
(3) Haulage to Strahan.
(4) Loading into boat at Strahan.
(5) Sea-carriage from Strahan to North-West Bay.
(6) Unloading at North-West Bay.

It is quite clear, therefore, that if the Gillies process is to be applied to the treatment of these ores it must be right adjacent to the locality of production.

Summing up in regard to this treatment question, therefore, I state my conclusions as follow:—Assuming the non-existence of the chemical compound huascolite (for I have no reason yet to disregard this possibility), there is no more likelihood on present showings that flotation (selective) will prove successful, than that the Tasmanian Metals Extraction Company will solve the problem. These are the two processes from which most is expected. If the zinc sulphide-lead sulphide compound (huascolite) does exist, then selective flotation must surely fail. This must be at once investigated and settled.

VIII.—THE PROCEDURE ESSENTIAL TO THE SUCCESSFUL DEVELOPMENT OF THE FIELD.

The conclusion which must inevitably result from a consideration of all the facts briefly delineated in the preceding chapters is this:

The only hope of efficiently developing and working these immense deposits of zinc-lead sulphides is by an amalgamation of the whole of the interests in the field. This includes also the northern portion of the belt, which is not included in this report, but which forms one unit of what commercially must be regarded as a huge industrial concern.

The future of the whole field, therefore, depends on the combination of all the mining companies, together with the lessees of all sections on the mineral-bearing zone, with the formation of an industrial organisation controlling the whole zinc-lead sulphide belt.

When such an amalgamated company is formed, its activities must be directed towards the following:—

(*a*) The appointment of a metallurgist of ability and experience to investigate the treatment of the ores in a scientific but practical manner. It would be better if he were not wedded to any particular process. In addition to his own investigations, which must be initiated by a complete study of the nature of the zinc-lead sulphide ore, he must necessarily examine critically results of those who are attempting to apply particular processes to the ore.

(*b*) The carrying out of a complete scheme of development and exploratory work, both on the mines themselves and on those portions of the field in which, as indicated above, the ore-bearing horizon occurs. This calls for a huge diamond-drilling scheme, which cannot be indicated here, but which will be completely delineated in the bulletin. In addition to this the company will be called upon to open up both the Hercules and Mt. Read Mines, as well as the, at present, less important properties, ready for ore-extraction on a large scale.

The general objectives of this diamond-drilling and developmental campaign will be these, taking the occurrences from south to north:—

(1) The search for ore in the folds of the ore-bearing horizon to the east of Dunne's shaft.
(2) The location of the eastern continuation of the folds of the ore-body to the east of the Mt. Read open-cuts.
(3) The proving of the ore-bearing horizon on the South Hercules section below the eastern adit-level.
(4) The investigation of the continuation of the folded ore-body to the east and north of No. 8 bore, below No. 4 level, on the Hercules. Also the search for the ore-body below No. 4 level both north and south of the No. 4 tunnel.
(5) The similar exploration by diamond-drilling of the country to the east of and below the known occurrences of zinc-lead sulphide on both the Ring P.A. and Jupiter Mines.
(6) The investigation of the intervening sections by diamond-drilling, which preferably should be located at the crests of the anticlinal folds.

As mentioned above, this scheme will be elaborated in detail in the complete bulletin on the field.

A vital factor entering into the operations of this amalgamated company will be the question of cheap power, which must be available before the field can progress at all. Such power at a low cost must be obtained by the utilisation of the waterpower awaiting development in Tasmania. There are three possible sources whence this electrical energy can be brought to the field:—

(1) The Great Lake power scheme, which is now being purchased by the State; provided, of course, that it is considered desirable or practicable to bring a transmission-line over 70 miles of very rugged and heavily-timbered country.
(2) The Lake Rolleston power scheme, which it is calculated will produce 12,000 horsepower, and which will involve the erection of about 6 miles of transmission-line.
(3) Failing both of these sources of supply, there exists the Mt. Lyell Company's Lake Margaret hydro-electric power scheme, now approaching completion, which can be made capable of pro-

ducing more than their own present requirements. Lake Margaret is about 12 miles from the centre of this field.

Returning to the question of treatment, it is essential to the best interests of the field that the amalgamated companies should own and control the plant for such treatment, whether that is the outcome of their own metallurgist's work or that of other experimenters. The working of the mines and the complete treatment operations should form two units of an harmonious whole.

Such an amalgamated company must be provided with large capital. It must be regarded as a huge business concern, and should be financed on those lines. It can in no sense be regarded as a "get rich quick" medium. It is wholly and solely of the nature of a solid business.

IX.—CONCLUSION.

In view of all the considerations enumerated in this report, I am justified in stating that the potentialities of the field and the prospects of evolving a suitable process for treating the ores are such as to present more than sufficient inducement to inaugurate such a commercial organisation. The field would then possess all the factors essential to the existence of a sound business. If worked as such, it should prove a profitable investment.

LOFTUS HILLS, M.Sc.,

Assistant Government Geologist.

Launceston, 1st August, 1914.