REPORT ON FINDON'S COPPER SECTIONS, MOUNT DARWIN.

Zeehan, 10th October, 1903.

SIR,

Acting on your instructions, I left Zeehan on the 8th September last to visit and report upon some copper sections which have lately been taken up by Mr. J. Findon at Mount Darwin. The sections had been placed under offer to Mr. G. Orange, the representative of the Tasman Syndicate, of London, and this gentleman, together with Mr. T. A. Irvine, of Strahan, and Mr. J. Findon, the prospector of the section, were present at the mine at the time of my visit. Since then I understand that Mr. Orange has made arrangements with the holders of the section to carry out further prospecting operations, and has also taken up several other sections in the vicinity. The section to which my attention was principally directed, and, so far as I am aware, the only one on which any prospecting work has been done, appears on the latest Huxley and Jukes Mineral Chart as No. 265-M, 80 acres. It was previously held by C. Brumby, and was reported on by Mr. W. H. Twelvetrees, Government Geologist, in 1900. The section is situated to the north of Mount Darwin, on the western slope of the somewhat broad and high ridge connecting Mount Darwin with Mount Jukes. In a direct line it is a little more than 1½ miles west of the township of Darwin, which is situated on the North Lyell Railway, and distant about 13 miles from the port of Kelly Basin. The top of the ridge is about 1500 feet above the level of the railway, and there would be no difficulty in erecting a self-acting aërial ropeway, to deliver the ore on the eastern side of the ridge, which side I conceive to be the most suitable for the erection of machinery for the treatment of the ore.

Geological Features.—The country rock consists of a somewhat dense felsite, rendered partially schistose in many places. The planes of lamination strike about 30° west of north, and dip to the west at an angle of 60°. The copper-bearing formation, which has been exposed by trenches from about the centre of the section northwards, appears to conform in strike and dip with these planes of lamination. It consists of schistose felsite, more or less

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completely converted into chlorite rock, and impregnated with copper and iron pyrites. The pyrites is fine-grained and fairly evenly-distributed through the stone. The width of the formation cannot be accurately ascertained at the present time. It appears to vary from 20 to 60 feet, but sufficient work has not been done to enable the full width of the formation to be examined. For some feet from the surface the greater part of the copper has been leached out of the stone, leaving small iron-stained cavities, and it is only from those trenches which have got below this leached zone, which, naturally, is deeper in some places than in others, that the best copper-bearing stone has been obtained.

No. 1 Prospect Hole.—This is the most southerly opening which has been made on the formation, and is situated a little to the north of the centre of the section. It is 8 feet long, measured across the lode, and 3 or 4 feet deep. All the stone at grass carries nice copper pyrites distributed through it. A bulk sample taken by me and submitted to Mr. W. F. Ward, Government Geologist, yielded 2·9 per cent. of copper. It is probable that this result would have been somewhat higher had the sample been taken from the bottom of the trench, as, having been taken from the whole of the stone at grass, it included a good deal of surface stone from which the copper had been leached.

No. 2 Trench.—This trench is 1 chain north-west from No. 1 prospect hole. It is 60 feet in length, and has been put right across the formation. The western half of this trench is quite shallow, and has not got below the leached zone. The stone, however, looks as if it would make into copper at a short depth. A couple of shots put into the bottom of this portion of the trench revealed small quantities of copper pyrites in a favourable chlorite rock, with native copper in the joints. At about the centre of the trench a shaft 20 feet deep has been sunk. Unfortunately, owing to the heavy rain which fell on the day I arrived on the section, this shaft was full of water, and could not be examined. Mr. Findon tells me that a short distance from the surface the stone was very good. Then an "intrusion" of barren rock came in, but this was passed through, and there is good stone showing in the bottom of the shaft at the present time. I took a bulk sample of the copper-bearing stone in the tip from the shaft, and this yielded 3·0 per cent. of copper. Another sample from the shaft consisting of about 20 lbs. of large lumps of ore selected by Mr. Findon yielded 5·0 per cent. of copper.

To the east of the shaft the trench cuts into rising ground, and is 8 feet deep in the end. Only the first 7 feet, however, contain appreciable copper, and that only on the south side of the trench. A head appears to cross the formation at this point, and temporarily cuts off the good stone. For 3 feet to the east of the shaft I could not get at the side of the trench to sample it. It looks fair stone, and I should judge it to contain 3 per cent. of copper. The next 4 feet was bulked, and yielded 1·9 per cent. of copper, and a selected sample taken from the bottom of the trench yielded 4·1 per cent. of copper. The next 5½ feet bulked yielded only 0·5 per cent. copper. The remaining 6 feet to the end of the trench is also poor, and I did not think it worth sampling. It thus appears that the principal copper-bearing formation, where exposed in this trench, is 43 feet wide. Of this, 20 feet should bulk from 2 to 3 per cent. of copper. The remaining 23 feet is not exposed at a sufficient depth to warrant any estimate being formed as to its copper contents.

No. 3 Trench.—This is a shallow trench 45 feet to the north-west of No. 2, and, except in a sink at the west end, has not got below the leached zone. This sink was full of water, but in one place the copper-bearing stone was showing above water-level, and a sample from 18 inches of stone yielded 3·2 per cent. of copper.

No. 4 Trench.—This trench was put in at the time of my visit, under the direction of Mr. Orange. It is about 5 chains north-west of the workings already described, and is situated on the east side of a prominent knob in the north end of the section. The trench is in a favourable-looking chlorite rock, which, however, has been for the most part leached of its copper contents. In the deepest part of the trench, at the west end, some nice-looking copper is showing, and a bulk sample of 2 feet of stone yielded 2·5 per cent. copper. The width of the formation here is not determined. The trench is 14 feet long, and all of this will, I think, be copper-bearing at a short distance from the surface. After my sample was taken, another shot exposed 2 feet more of similar stone, and this still continues in the face.

Mr. Orange proposes to put in a prospecting tunnel below the formation at this point. From the level of the spot which has been chosen for the approach about 30 or 40 feet of backs will be obtained with 120 feet of driving. The backs will then be increased by driving southward on the formation. If the copper contents prove satisfactory at this level, then it is proposed to bring in a low-level tunnel from the other (west) side of the spur.

The Knob.—There appears to be some probability of a parallel formation being discovered a couple of chains to the west of the present workings. On the top of the knob mentioned above there is a good deal of iron-stained chloritic rock, which is in all probability the capping of a copper-bearing formation. Indeed, a few shots put in under Mr. Orange's direction revealed the presence of a little native copper in the joints of the stone, the whole of the pyrites having been leached away. This formation would be tested by the deep-level tunnel from the west side of the ridge, or by continuing the proposed prospecting tunnel from the east side.

Although there is not sufficient work done on this section to warrant any reliable estimate being made of the amount or value of the stone present, from the indications I have seen, and from the samples I have taken, which I believe fairly represent the bulk values of the stone exposed, there appears to me to be a reasonable prospect that further work at a moderate depth will succeed in disclosing large bodies of stone carrying from 2½ to 3½ per cent. of copper. I am inclined to think that as depth is gained the average stone will assay somewhat better than my samples, owing to the fact that the copper has been leached out near the surface, and it is probable that some of this leached stone was included in all my samples. Even allowing for this, however, the proposition must be regarded as a low-grade one, and can only be dealt with profitably if operations are carried out on a scale which will allow of the most economical methods of mining and handling the stone. I may here mention that the stone only carries small quantities of the precious metals. My samples were not assayed separately for gold and silver, but equal quantities of each of the eight samples were taken and assayed as one sample. This yielded: gold, trace; silver, 2 dwts. per ton.

The facilities for mining the deposit by means of tunnelling are good. On the west side of the knob there is a deep gorge, from which 700 or 800 feet of backs are obtainable. The slope of this hill is about 1 in 2, but no backs would be gained for the last 300 feet of tunnelling, as the deposit is on the east side of the knob, which is about 300 feet in width. The formation, however, probably dips westward at about 60°, so that for the deeper levels this will not make so much difference. The product from the mine would be brought to the surface on the west slope of the main ridge, and might, as stated above, be conveyed by means of a self-acting ropeway over the saddle into the valley on the east side, where I think it probable that water-power would be available. Certainly, abundant timber both for mining and steam-production is available in either valley.

As regards prospecting and development, I think the right thing is being done in putting in first of all a shallow level tunnel from the east side of the spur. This tunnel should be extended southwards as a drive along the lode, crosscuts being put in at short intervals. This will give a good idea of the value and width of the deposit, and enable further development work to be laid out to the greatest advantage. At the same time, surface prospecting along the course of the lode should not be neglected. There is at present no reason to believe that the deposit does not extend beyond the present workings, and it would be well to ascertain its extent in this direction as soon as possible. If this work gives satisfactory results, then development work should be laid out with a view to providing for a large output.

It is probable that for a certain depth mining operations can be carried on on the open-cut system. Very soon, however, underground mining will have to be resorted to; this will not be expensive, as the country rock is firm, and probably very little timber will be required, provided a good filling-up system is employed.

Treatment of the Ore.

Although this question cannot be fully dealt with in this report, it is of such importance, not only to the owners of the property under review, but to owners of similar properties on the West Coast, that I think some remarks on the subject may not be out of place. The ore consists essentially of a somewhat silicious rock, impregnated with copper and iron pyrites. The two latter minerals together would represent from 15 to 30 per cent. of the total weight of ore. With the addition of lime, there is no doubt that this ore could be smelted direct with the production of a high-grade matte, but in the absence of the precious metals it is very doubtful whether this method would leave any margin for profit.

There are several other methods of treatment for low-grade copper ores which have been practised with more or less success. These may be considered under two heads: I., lixiviation processes; II., mechanical concentration, followed by smelting of the concentrates.

I.—Lixiviation Processes.

I am unable at present to give details of cost of treatment of these processes. They have been used principally in the treatment of ores in which the copper is present in the form of carbonate or oxide. When the copper is present as sulphide, as is the case at Mount Darwin, it must be converted into oxide by roasting the ore prior to lixiviation. There are no minerals in the Mount Darwin ore which in any way interfere with lixiviation, so that the practicability of the processes is merely a question of cost and amount of copper recovered. Most of the following notes are taken from an article which appeared in the *Engineering and Mining Journal* of June 6th, 1903, by Dr. E. D. Peters, on the treatment of low-grade copper ores.

(1) "*Lixiviation of the ore direct, with a solution of Ferrous chloride and salt (old Hunt and Douglas method)*.—Considerable quantities of ore have been successfully worked by this process in the United States. The method depends upon the fact that oxide of copper is decomposed by ferrous-chloride solutions, forming insoluble ferric oxide, while the copper goes into solution as cuprous and cupric chlorides. It is precipitated in a very pure metallic form by iron, the ferrous chloride solution being thus also regenerated, and requiring only the addition of a little salt to fit it for further use. The consumption of metallic iron in this method is very small, since much of the copper is in solution as cuprous chloride."

(2) "*Lixiviation of the ore, with hydrochloric and sulphuric acids, which are regenerated in the solution by the precipitation of the copper from a chloride solution by means of sulphurous acid (new Hunt and Douglas method)*.—By this method the copper is precipitated from its chloride solution by means of sulphurous acid gas, which throws down the copper as a very heavy white cuprous chloride, that settles almost instantaneously. Sulphuric and hydrochloric acids are regenerated in the solution, which only requires the addition of salt to make it ready for further use.

"One great advantage of this method is the rapid dissolving of the oxidised copper present by the strongly acid solution, which even attacks sulphides with considerable energy. Any lead and silver present remain undissolved."

(3) *Lixiviation of the ore with sulphurous acid (Neill's process)*.—"The native oxides and carbonates of copper are readily soluble in sulphurous acid with the formation of cuprous sulphite. This salt is insoluble in water, but

soluble in water containing sulphurous acid, from which the copper can be precipitated by driving off the excess of sulphurous acid by heat. The precipitate is cupro-cupric sulphite, and contains 49·1 per cent. of copper. This salt is a heavy, crystalline compound, of a dark red colour, which settles readily from the solution, and can be washed by decantation, dried, and reduced to metallic copper by fusing on the hearth of a reverberatory furnace.

Sulphurous acid produced by roasting pyrite is the cheapest chemical procurable in the western country, and the plant is much simpler than that used in making sulphuric acid. A unit of copper converted into cuprous sulphite requires but half the sulphur that would be required to convert it into cupric sulphate. Cuprous sulphite is precipitated from the solution without the use of scrap-iron, which is a great advantage in remote districts. Sulphurous acid dissolves very small amounts of other metal that may be in the ore, and the precipitated cupro-cuprous sulphite is practically pure, and furnishes pure copper by a simple smelting operation."

(4) *Lixiviation of the ore with sulphuric acid and salt (Irvine process)*.—This process, which has been patented by Mr. T. A. Irvine, of Strahan, has been taken up by a London syndicate. Laboratory tests have been made on numerous samples of ore, including some from Mount Darwin, the results of which are said to be satisfactory. It is proposed to generate the sulphuric acid at the mine and precipitate the copper with pig-iron.

I think it is very possible that the solution of the problem of the successful treatment of our low-grade disseminated copper ores may be found in one or other of the lixiviation processes. They possess one great advantage over any process involving smelting operations, namely, they can be started on a comparatively small scale without very seriously affecting the cost of treatment.

II.—Mechanical Concentration, followed by smelting of the Concentrates.

The object of this process is to produce a comparatively high-grade pyritic concentrate by the cheap methods of mechanical concentration, and then to smelt the reduced tonnage in the usual way. The cost of smelting is thus reduced in proportion to the amount of concentration effected. The process is of course only suitable to ores in which the amount of concentrates obtained is small in comparison with the total quantity of crude ore treated, for, as a set-off against the saving in smelting cost, must be placed the additional cost of the mechanical concentration and the loss of metal which this process involves. In the treatment of copper ores this latter item is the most serious. Copper pyrites is a very brittle mineral, and when the ore is crushed a very large proportion becomes converted into an impalpable slime, which is impossible to save by the ordinary methods of wet concentration. This fact has already been demonstrated in the Lyell field in the case of the South Tharsis Mine, where an ordinary wet concentration plant, consisting of jigs, buddles, &c., was erected to treat a low-grade pyritic ore. The concentrates were found to contain an undue proportion of iron pyrites, the greater part of the copper passing away in the slimes. This trial may, I think, be regarded as conclusive evidence against the adoption of the ordinary process of wet concentration for the treatment of our low-grade copper ores.

The Elmore Process.—Of late years a new process of mechanical concentration, known as the Elmore process, has been brought out, which claims to deal effectively with many ores which cannot be satisfactorily treated by the old method, and among these copper ores are said to be specially amenable to the process. The principle of the process depends upon a curious property possessed by oil of adhering to the surface of certain minerals, especially to those of metallic lustre. If finely-crushed ore is agitated with water and any thick mineral oil it is found that the particles of the metallic minerals attach themselves to and penetrate into the oil globules. The non-metallic minerals, on the other hand, which form the greater part of the valueless gangue, are not affected by the oil, and remain suspended in the water. If the pulp be now allowed to stand, the oil, carrying with it the valuable minerals, will float to the surface, and the worthless gangue will sink to the bottom. The following account of the process as worked at the Glasdir Copper Mines at Dolgelly, North Wales, is taken from a pamphlet published by the owners of Elmore patents, which was kindly lent me by Mr. J. G. A. Stitt, of Zeehan:—

"The rock from the mine, after passing through the usual stone-breakers, is crushed in a pair of Cornish rolls, and run thence to two Huntington mills, wherein it is reduced to pass through a 30-hole screen, and issues therefrom with just sufficient oil to make it into a freely-flowing pulp. From the Huntington mills the pulp passes directly into the open end of a horizontal rotating drum, inside of which is fixed a helix, with crossblades or buckets, which lift up the pulp to a certain height and drop it again, at the same time propelling it forward to the opposite end of the drum, thus keeping the pulp in constant agitation for the few seconds which are occupied in its progress through the drum. With the pulp is also admitted a small quantity of a thick, sticky oil (the residue left in the stills in the refining of paraffin oil). This oil is of course subjected to the same agitation as the pulp, and is consequently tumbled about with it. . . . The oil and pulp automatically discharge from the opposite end of the drum into a pointed box or spitzkasten, in which the tailings or rock at once settle down and flow off with the water at the bottom, whilst the oil, by reason of its buoyancy, floats to the top, and carries up with it practically all the values which the ore contained. From the top of the pointed box the oil, with its load of mineral, flows off continuously to a specially-constructed centrifugal machine, where the oil is extracted from the mineral (which is left in the machine), the oil being at once ready for re-use. For close extraction three mixing cylinders are sometimes used, the pulp passing from one to the other, after floating off the oil and collected mineral, and receiving a fresh stream of oil in the next mixer. A second centrifugal machine is also found desirable below the first, to separate the last of the oil and water from the concentrates. The concentrates are left in the machine, practically dry and free from oil." In order to gain some idea of the applicability of this process to the Mount Darwin ores, I made several experiments with the bulk samples which I obtained from Findon's section, the assay values of which varied from 1·9 per cent. to 3 per cent. of copper. The ore, having been crushed to pass through a 60-mesh screen, was agitated in a suitable vessel with water and cylinder oil until most of the pyrites appeared to be taken up by the oil. The latter was then skimmed off, diluted with kerosene, and passed through a canvas filter. In this latter operation a good deal of fine copper pyrites passed through the filter and was lost, thus materially decreasing the value of the results. Still the amount of copper extracted from the crude ore should indicate roughly the amount which would be recoverable in practice, and this amount may be calculated from the assay values of the crude ore and the tailings. In my experiments the extraction varied from 83·2 per cent. to 93·6 per cent. of the total copper contained in the ore. The concentrates recovered represented from 17 per cent. to 20 per cent. of the total weight of ore taken, and the assay values ranged from 6·8 per cent. to 13·3 per cent. of copper. In the course of my experiments it was very noticeable that the finer particles of copper pyrites were more readily taken up by the oil than the coarser ones, and, further, that the copper pyrites was much more readily taken up than the iron pyrites. I am of opinion that most of the copper which remained in the tailings was present in comparatively large particles consisting of cupriferous iron pyrites. It was only after prolonged agitation that, in one case, I got most of these particles to pass into the oil. In this particular case I obtained an extraction of 93·6 per cent. This fact leads me to the conclusion that the most suitable treatment for the ore would be a combination of the ordinary methods of wet concentration with the Elmore process. This method was suggested to me by Mr. Luke Williams, F.G.S. The larger particles of ore, which cannot be readily saved by the oil process, can be saved by the ordinary wet method, while the slimes, which cannot be saved by the wet method, are best adapted to the Elmore process. In this connection the Elmore process appears to be capable of occupying a similar position with regard to wet concentration as does the cyanide process with regard to the amalgamation of gold ores.

I am indebted to Mr. Luke Williams for the following particulars as to cost and methods of treatment by the oil process obtained by him during his recent visit to England:—"Each unit of oil plant has three cylinders, and will treat 25 tons of ore in 24 hours. In London two boys are engaged at 18 shillings a week each to attend to the recovery plant only (crushing not included); the cost for wages, wear and tear, and oil, which is bought at 4½d. per gallon, is in London about 1s. per ton of crude ore for dressing only. The cost of a two-unit plant is approximately £1353, and a four-unit plant £2304." Mr. Williams has also supplied me with some interesting figures with regard to a plant which he saw treating a very low-grade copper ore from old dump-heaps in Cornwall. He says:—

"The crude ore treated assayed copper 0·6 per cent.
The concentrates obtained assayed copper 7·8 per cent.
The tailings discharged assayed copper 0·09 per cent.
Recovery of copper .... 85 per cent.

The working costs were very small, the wages of course being much lower than in Tasmania. At the mine on day shift four men and eight boys were employed to feed the rock-breakers and hand-pick the ore on the Robins' conveyor, and attend engine, battery, and oil plant. The wages account ran as follows:—

Day Shift.

	s.	d.
1 man feeding stone-breaker	3	0
6 boys hand-picking ore, at 1s. each	6	0
1 man attending to battery...	3	0
1 man attending to oil plant	3	0
2 boys attending to oil plant	3	0
1 enginedriver	3	4
	£1 1	4

In the afternoon and night shifts the rock-breaker and hand-picking belt were idle, this portion of the plant treating in one shift enough ore to keep the rest of the plant at work twenty-four hours.

Afternoon and Night Shifts.

1 man attending to battery	0	3	0
1 man attending to oil plant	0	3	0
2 boys attending to oil plant...	0	3	0
1 enginedriver	0	3	4
5 hands afternoon and night shifts (per shift)	£0	12	4

The total wage-cost of running the plant three shifts and treating 240 tons of ore per week was £13 16s., or 1·15s. per ton. Total power used for all purposes about 50 h.p.

Taking the above data as basis for calculation, an estimate may be formed of cost of copper-extraction by the process suggested above, namely, wet crushing and concentration, followed by oil-treatment of the slimes, and smelting of the concentrates from both processes. As the ore is a low-grade one, and involves smelting of the concentrates, it would be only possible to treat it on a large scale. The estimate will therefore be based on a plant treating not less than 200 tons per twenty-four hours, using, say, 50 head of stamps crushing to 10 mesh. It will be assumed that from these 200 tons of crude ore 25 per cent., or 50 tons, of concentrates are produced, and that 40 per cent. of the total pulp, or 80 tons, per day is slimed and treated by the Elmore process; further, that of the total copper contained in the

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crude ore, 85 per cent. is recovered in the blister copper.

The cost of crushing and wet concentration under local conditions may be taken at 3s. per ton of crude ore.

The cost of oil-treatment of slimes works out, according to the data available, on a 4-unit plant, as follows:—

2 men attending to oil plant, three shifts at 9s. per shift...	54 shillings.
4 boys attending to oil plant, three shifts, at 6s. per shift	72 ,,
Cost of oil, at 1s. per ton of slimes ...	80 ,,
Interest on and depreciation of plant, at 20 per cent. per annum on £6000	66 ,,
50 h.p., at 1s. 6d. per horse-power per day	75 ,,
Cost of treating 80 tons of slimes ...	347 ,,
Cost per ton of slimes	4·33 ,,

The estimate of cost of smelting and converting the concentrates may be based on the results obtained by the Mt. Lyell M. and R. Company's reduction work at Queenstown. According to the report of that company for the half-year ending March, 1903, the cost of smelting and converting has been reduced to 14s. 2·89d. per ton. The conditions are, however, not quite similar; the ore treated at the Lyell Reduction Works is a low-grade pyrites, and requires to be smelted twice in order to get a sufficiently high-grade matte for the converters. The concentrates from the Mt. Darwin ore should, according to my concentration tests, contain as much copper as the first-grade matte at Lyell, and consequently would only require to be smelted once. On the other hand, the ore would require briquetting before smelting, the converter charge would be higher than at Lyell owing to the fact that a larger proportion of matte would be produced per ton of concentrates, and lastly, the cost all round would be somewhat greater in the comparatively small works treating only 50 tons per day. I think that if we allow 18s. per ton for smelting and converting the concentrates, the estimate will not be far out.

Freight and realisation charges on blister copper amount to about £10 per ton. In estimating the value of blister copper, therefore, £10 per ton must be deducted from the market price of copper. On the above data cost of treatment works out as follows:—

Crushing and concentrating 200 tons crude ore, at 3s. per ton	600 shillings.

Oil-treatment of 80 tons slimes	347 ,,
Smelting and converting 50 tons concentrates, at 18s.	900 ,,
Total cost of treatment of 200 tons ...	1847 shillings.
Total cost of treatment per ton of crude ore	9·23 ,,

With copper at £35 per ton, Which I think may be taken as a safe average, and allowing £10 realisation charges on blister copper, and assuming that 85 per cent. of the copper is recovered, an ore containing 1·20 per cent. of copper would pay the cost of treatment on the copper contents alone. If mining and other charges may be put down at 8s. per ton, then a gross content of 2·25 per cent. copper would pay all expenses.

The above estimate is, I believe, a safe one, and one which might, under able management, be considerably reduced. I think it is quite possible that I have under-estimated the copper-recovery which may be effected by a combination of the ordinary method of wet concentration and the Elmore process. It is also probable that my estimate of the cost of the Elmore process is too great, as it was based on the working costs of a very much smaller plant. However this may be, the figures given appear to me to be sufficiently encouraging to warrant a careful enquiring into the possibilities of that process.

I regret that the data at present at my disposal do not enable me to give estimates for comparison of the probable cost of some of the lixiviation processes to which I have alluded above. These processes require the most careful consideration. It is quite possible that some of them may be cheaper than the process I have outlined. Neill's process especially would appear to be an economical one, as sulphurous acid, the only re-agent used, can be produced by simply bringing the fumes from the roasting-furnace into contact with water. I was fortunate in being able to secure some information as to actual costs in the case of the oil process from Mr. Luke Williams, who, I understand, has shipped to England a ton of ore from the Colebrook Mine for trial. As far as I can see, however, the process seems well suited to the low-grade deposits of disseminated copper ores, of which there are many in the Island, and I therefore thought it desirable to examine the problem generally, and determine, approximately at least, if the method gave any promise of dealing with these propositions. I may mention, among deposits that seem likely to be amenable to the

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treatment I have outlined, the copper formation met with in the No. 5 tunnel of the Hercules Mine, Mt. Read, the low-grade cupriferous schists of the Western slopes of Mt. Lyell, and many others at Mt. Darwin and Mt. Jukes; of the grade of many of these deposits I cannot speak, but from my estimate of probable cost of treatment it seems likely that at least 2 per cent. of copper must be present to bear the costs of mining and treatment, and that deposits carrying larger values than this are worthy of consideration.

From the highly successful operations which are being conducted at Mt. Lyell, the value of large pyritic deposits even of low grade are fully recognised; but hitherto there has been a great doubt as to the value of the low-grade disseminated pyritic deposits of the class which has been dealt with in this report. I think, therefore, that this tentative discussion of the limitations of value necessary to make a payable proposition of this class may be of interest.

In conclusion, I desire, again, to gratefully acknowledge my indebtedness to Mr. Luke Williams, for supplying me with much valuable information; also to thank Mr. Adam G. S. Morton, Assayer, Zeehan, for making several assays of the products from the concentration tests, and Messrs. Sumpter, Bennett, and others for kind assistance and hospitality during my visit to Mt. Darwin.

I have the honour to be,
Sir,
Your obedient Servant,

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Assistant Government Geologist.

W. H. WALLACE, *Esq.*,
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JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.