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OPERATIONS OF THE MOUNT LYELL
MINING AND RAILWAY COMPANY,
LIMITED, FOR THE YEAR 1901-2.

By MEMBERS OF THE COMPANY'S STAFF.

The Mines.

Mt. Lyell Mine.—During the year under review in this Report, operations at the "Big Mine" have been characterised by the usual activity, the ore output being maintained the same as before, *i.e.*, approximately 1000 tons per working day. However, partly on account of the heavy fall in the price of copper, and partly in consequence of the lowering of the average assay value of the ore since the open-cut has advanced into the heart of the ore-body, the excavation of ore is at present restricted practically to the south-eastern half of the body.

The open-cut is now laid out in nine terraces or benches, numbered downward, as follows:—Nos. 0, 0a, 1, 2, 2a, 3, 3a, 3b, and 4, the numbers 1, 2, 3, and 4 corresponding to the original tunnels or levels. The vertical distance between Nos. 0 and 4 is 266 feet. Of these benches, the first three are now only in overburden; Nos. 2 and 2a are partly in ore and partly in overburden; all the others are in ore. The depth from the top surface of the knoll on which the mine is situated, and back of the ore-body, *i.e.*, in the hanging-wall, to the bottom of the open-cut, is about 320 feet. The surface opening of the excavation is oval in shape, and measures at the present 800 feet by 630 feet. Of the former underground mine levels, Nos. 1 and 2 levels are now completely obliterated by the open-cut; while of No. 3 level workings, a small portion still remains on the hanging-wall side; No. 4 level has only latterly been attacked by open-cutting, and the contour drives are still in existence.

Thirty-seven rock-drilling machines are made use of for the winning of ore in the open-cut and underground, and the removal of overburden. They are mostly of Rand Drill Company's make. The air-compressor is a fine piece of Australian designed and made machinery, and was supplied several years ago by Messrs. Thompson and Company, of Castlemaine, Victoria. It is duplex compound, fitted with inter-cooler and surface condenser; steam cylinders, 14½ inches and 24½ inches; air cylinders, 15 inches and 24 inches; stroke, 36 inches; delivery, 1000 cubic feet per minute free air at 60 revolutions; working pressure, 80 to 90 lbs. at compressor. Blasting is done in the open-cut twice a day—at noon and at 5 p.m.—the daily number of shots varying from 180 to 280, and the depth of holes from 22 feet to mere pops for breaking boulders of ore. The chief explosives used are gelignite, black powder, and chlorate and nitro-benzol compounds (rack-a-rock), of which the total annual consumption is 60 tons, divided about equally among the three kinds. Blasting by electricity is largely practised, principally in the overburden benches, on deep holes, up to a dozen being fired together, and

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dislodging 1000 to 1500 tons at a time. A travelling revolving steam-crane handles the larger pieces of overburden rock. The ore excavated is lowered from the upper benches by means of two self-acting gravity-inclines, in five-ton trucks, to the mine storage-bins. These are situated a little below No. 4 level, and have a total capacity of 6000 tons, and feed both the haulage-line, *i.e.*, surface tram connecting the mine with the Smelting Works, and the aerial ropeway serving the same purpose.

In the company's report for the half-year ended the 31st of March, 1901, a re-estimate of the ore reserves above No. 4 level is given, and the ore-body divided into five equal sections, running transversely across the mass. As before, the estimate is restricted to the ore available above No. 4 level. This was the original main working level for underground exploration purposes in the past, and is regarded as the provisional bottom level of the open-cut. In other words, the horizontal section of the ore-body at No. 4 level being taken as a basis, the extent of overburden to be shifted in the course of time for the purpose of freeing the entire mass of ore above this level was marked off by prolonging proper batter-lines from the periphery of the body at that level to the surface of the ground, and it is towards this ultimate circumferential limit of the open-cast that the excavation of the overlying rocks is being systematically conducted. This programme involves very extensive works, not alone for the removal of ore, but still more for the removal of the overburden. The original mass of the former was estimated at 693,045 cubic yards, and of the latter at 1,500,000 cubic yards. The official estimate above referred to states that there were then left for removal above No. 4 level, over the entire five sections referred to, 1,626,665 tons of ore, and of this quantity 978,337 tons were available in the south-east sections Nos. 1, 2, and 3, of an average assay of—Copper, 2.35 per cent.; silver, 2 ozs.; and gold, 0.0725 oz. No estimate made at any time for the purpose of guidance in open-cut operations has paid any attention to the extraction, by this means, of ore below No. 4 level, since it was considered that, for practical purposes, the latter was a sufficient limit *pro tem*. Since the payable ore, however, extends below No. 4 level, and in places has been found to reach as low as No. 5 level, 150 feet lower down, the above programme of operations will have to be amplified by carrying open-cutting operations below No. 4 level until the apex formed by the junction of the batter lines is reached. It may be stated that the management already has the necessary provisions for this lower work in hand.

It is to be regretted that the continued low price of copper has a manifest influence on the payableness of the ore, and that, in consequence, certain grades are now being avoided and left standing which might with profit be included in the treatment in more prosperous times. However, as is apparent from the regularity of the assays published in the monthly returns, the management is endeavouring—and has succeeded with exceptional success—to maintain the average copper assay of 2.35 per cent., which last year's estimate affirmed. For this purpose an elaborate system of sampling is in vogue, as a check on the values won and despatched, and both the open-cut and underground surveys are kept strictly up to date. In both respects the supervision is of an exemplary character, as indeed is required in all departments, considering the fact that the mine is what is called "a low-grade proposition."

Below No. 4 level the usual development work, by way of exploration drives and crosscuts in advance of stoping, has been going on, hand-in-hand, during the year with the stoping operations themselves. The latter are carried out on local enrichments of more or less size, chiefly on the south-eastern hanging-wall end of the main mass, although the footwall is also in places characterised by occurrences of richer ore, and in fact the famous rich pocket which gave the impetus to developing the property on a large scale was so located. This Bonanza returned £105,000 net by sale in London, out of 850 tons of ore. These old workings were again entered this year, but examination revealed that in the first extraction, in 1894, the rich ore was very thoroughly removed.

Below the horizon of the above-mentioned workings, which are intermediate between Nos. 4 and 5 levels, the body has been contoured completely in No. 5 level, and proved to be somewhat smaller in extent than at No. 4 level. At No. 6 level, however, 100 feet below No. 5 level, the body experiences an increase in width, as has been established by the driving on footwall and hanging-wall. The latter work has recently rounded both the north-eastern and north-western corner of the ore-body, and will be brought to a closure in the course of a few months. Sixty feet below No. 6 level there is No. 7 level, in which the usual contour exploration work has also been started, but it was only carried for a short distance on each wall, on account of the preferableness of contouring at No. 8 level. This last level has been opened up from a vertical three-compartment shaft sunk in recent times from No. 5 level down through the hanging-wall schists, thus bringing its bottom close to the contact of conglomerate and schist, between which two rocks, it may be said, the ore-body as a whole is enclosed at its southern end. The shaft itself is so situated as to admit of rising to the surface at a point most suitably located for future hoisting and surface transportation. In No. 8 level, 100 feet below No. 7 level, corresponding to 410 feet below No. 4 level, or 730 feet from the surface, crosscut drives to the main ore-body have been driven, and the search for the pyritic main mass has recently been attended with success. Considerable driving has also been done on the contact of schist and conglomerate in Nos. 4, 5, and 8 levels, in a direction south from the main body, for the purpose of investigating the presence of continuations or repetitions of the latter, but so far without result.

Simultaneously with defining the contour of the main mass underground in the levels named, its assay value has also been determined at all points, and this has proved the bulk of the underground ore to be of a similar grade to that in the now untouched portions of the open-cut. Occasional richer patches have been met with, and the downward extent of the larger enrichments in the south-eastern portion of the main mass has been traced as far as No. 8 level, thus showing them to characterise, in a more or less connected manner, the entire depth of the ore-body from the surface down. These richer shoots seem to be of a subsidiary nature, standing in some geological relation to the main mass, but not always by way of direct alteration of same. Especially in the greater depths of the mine, the character of the enrichments mineralogically, on the whole, may be said to be quite distinct from the main body, inasmuch as the ore is an occurrence of bornite, and occasionally chalcopyrite, or both together,



MOUNT LYELL MINING AND RAILWAY COMPANY'S MINE.

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in a quartz matrix, making the whole not very dissimilar from the ore occurring in the northern portion of the field, one mile and more away. The main mass, on the other hand, is emphatically only cupriferous iron pyrites, with rarely over 10 per cent. of impurities, *i.e.*, silica, heavy spar, alumina, &c. The enrichments referred to are undoubtedly offshoots from the pyritic body, most likely of subsequent origin to same.

The following are data relating to the size, &c., of the ore-body :—

At No. 4 Level—total length 660 feet; greatest width 270 feet.

At No. 5 Level—total length 510 feet; greatest width 210 feet.

At No. 6 Level—total length 510 feet; greatest width 270 feet.

Strike of major axis of deposit at No. 4 Level—N.W. to S.E.

Strike of major axis of deposit at No. 5 & 6 Levels—N.N.W. to

S.S.E.,

with a dip constantly to the south-west into the hill; on the whole, rather steeper nearer the surface than at a depth. The footwall extends very steeply from No. 3, past Nos. 4, 5, and 6 down to No. 7 level. The same is also true of the south-east corner of the ore-body, but at the north-west corner the underlie goes flatly to the south-east. The hanging-wall is very steep from Nos. 3 and 4 levels to No. 5, but flattens out between Nos. 5 and 6 levels in the middle of the body, there being a considerable bulge-out at No. 6 level.

The typical chemical composition of the pyritic ore may at present be taken as follows, the figures representing the last half-yearly average analysis :—

	Per cent.
Iron... ..	40·30
Silica	4·42
Barium Sulphate	2·50
Copper	2·35
Alumina	2·04
Sulphur	46·50

The average composition of the underground ore for the same period was :—

	Per cent.
Iron	24·75
Silica	30·69
Barium Sulphate	1·48
Copper	5·33
Alumina	6·30
Sulphur	30·0

In consequence of the mining operations being confined chiefly to the simple method of surface extraction by means of open-cutting or quarrying, with the attendant removal of overburden, while the underground driving has been restricted to the determination of the size, direction, and value of the ore-body, the summary of underground distances traversed is not very large for a mine of this prominence, although the figures total up a tolerable amount. The following is a *résumé* of the exploration

and other work done since the inception of mining operations up to 30th June this year :—

Mount Lyell Mine—	Feet.
Driving	12,092
Crosscutting	2,962
Winzes and rises	1,571
Shafts	703
Total... ..	17,328
Other mines acquired by the company.	6,220
Grand total	<u>23,548 ft., or 4.46m.</u>

It may be stated that latterly operations with the diamond-drill have been inaugurated in the "Big Mine," starting in No. 6 level. Several holes have here been drilled horizontally through the ore-body, in order to test the assay value, and no doubt the same means will be used to explore other portions of the main mass. The convenience of this method of prospecting is reported to be fully realised, very prominent being the speed of penetration into new ground, notwithstanding the hardness of the pyrites, its occasional laminated and even shattered condition, and the inclusion of layers of excessively hard chert and jasper-like rock near the footwall.

The underground workings are lighted by electricity, and they are also connected with the company's main telephone system. Hoisting underground is done by small winding-engines, of which there are six on the ground, with compressed air as motive power, average pressure 80 lbs. per square inch. The well-known square-set system of underground timbering is in use in the stopes, and filling is done where necessary or convenient for stowage of mullock.

The mine has a well-appointed machine shop of its own, for current repairs, &c., but relies on the Reduction Works for larger work of this kind.

Considering the well-known heavy rainfall of the district, it may seem strange that one of the greatest difficulties to contend with at the mine is a rather irregular water supply. During the last seven years the annual average number of rainy days was 221, and the rainfall 116.77 inches, yet water is occasionally scarce. The company has not felt justified to impound on a very large scale above the level of the mine (at an elevation of 1500 feet), owing to the extreme costliness of the necessary work in consequence of the peculiar much-cut-up topographical features of the locality, which make extensive water-storage impossible anywhere except at the bottom of the valley, some 500 feet below the top of the open-cut. The supply is derived from Conglomerate Creek, $1\frac{1}{4}$ miles distant, a small tributary of the Queen River, at an elevation of 1750 feet on the western fall of Mt. Owen, and is led to the workings by race, flume, and piping (involving a syphon across a valley 400 feet deep), to a service-reservoir of 150,000 gallons capacity. An average of 170,000 gallons is delivered daily, of which 50,000 gallons are used on surface and underground mining, the remainder being consumed by machinery, &c. The quantity of water making in the underground workings is very slight, and varies with the surface de-

position. The mine is, from the miner's point of view, practically absolutely dry. The quantity of mine water being small, it is fairly acid in character in consequence, and both expensive and difficult to handle. The corrosive qualities have been constantly on the increase since the growth of the underground workings (and the open-cut) has opened new surfaces of the pyrites to contact with the atmosphere. Iron pipes would be completely ruined in less than three weeks, and within a fortnight a single drop, constantly falling from the roof of a drive will eat a hole through a half-inch plate of iron. The water leaving the lowest adit, No. 5 tunnel, carries up to 23 grains of copper and 200 grains of sulphuric acid per gallon, and is treated for recovery of the copper by precipitation with scrap-iron. A suitable system of mud-settling tanks, precipitating-boxes, launders, copper-collecting boxes, &c., is in use, and will shortly be enlarged. The precipitate carries about 50 per cent. copper, and is sent to the converter plant.

Auxiliary Mines.—The "other mines" referred to in the above table are the Royal Tharsis, South Tharsis, King Lyell, Glen Lyell, and the Mt. Lyell Reserve leases, all of which have been acquired by the company of late as additions to its metal-bearing flux resources, and swell the total acreage of the company's mine and smelter leases to 2697.

At the Royal Tharsis Mine, which is about three-quarters of a mile north of the "Big Mine," considerable underground exploration has been carried out, and a couple of thousand tons of silicious copper-bearing flux have been forwarded to the smelters. Steps are now in progress to start open-cut operations as well.

The South Tharsis deposit is in immediate proximity to the Royal Tharsis one, and is being worked by means of open-cut. The South Tharsis and Royal Tharsis mineral shoots, though close to each other, do not appear to be connected. Both are simply locally-intensified occurrences of the general mineralisation characterising certain schists of the district, and are wholly different in character from either the "Big Mine" or the northern ores of the field. A total of 33,024 tons of these mineral-bearing fluxes has been delivered to the smelters since the company acquired the two properties, the average assay value of the flux being—Copper, 1.64 per cent., with small amounts of silver and gold. Delivery of these fluxes to the smelters is effected over the gravity-incline built by the former South Tharsis Company from mine to concentrators, and from this point by 60 chains of 2½ feet wooden-rail tram, on steep descending gradients, to bins on the "through tram," i.e., the 2-foot steam-tram running from the foot of the haulage-line to the smelters. This system fully answers all requirements, including cheapness of working, and has been retained as most suitable after thorough investigation of all alternatives.

The further underground exploration of these deposits has so far been held in abeyance, but it is stated that the diamond-drill will shortly be made use of for underground prospecting. An interesting property recommending itself for exploration by this method is the King Lyell, which lies at the foot of the "Big Mine," and in which, report has it, there are deposits of cupriferosus clayey gossan, similar in character to that of the Mt. Lyell Blocks Mine, but lower in grade, although the mediocre results of the sluicing and puddling operations carried out by the previous owners do not encourage high expectations.

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On the Lyell Reserve Block 4691 an interesting pyrites deposit carrying fahl-ore, opened up by the former owners, has been further explored by the company, but its small size precludes extensive operations. The value goes up to 6 per cent. copper.

The average chemical composition of the metal-bearing fluxes for the last half-year was as follows:—

	Silica. Per cent.	Iron. Per cent.	Alumina. Per cent.
South Tharsis flux ...	62·67	8·05	12·17
Royal Tharsis flux ...	61·17	9·94	10·44

This composition does not differ essentially from that of the purchase-ores derived from the northern portion of the field, but the fluxes are somewhat denser in character than the latter, and require more careful treatment in smelting.

The concentrating works erected by the old South Tharsis Company have not been made use of. The machinery has partly been removed elsewhere; the boiler, for instance, having been taken to the company's haulage-line and the steam-engine to No. 2 smelting plant; and some portions have been sold. The experience of the former owners in the concentration of these difficult ores was disappointing. Although the detailed results are not available, and in any case extended over too limited a period of time to be final, the fact is established that there was a remarkably heavy copper loss. The iron pyrites by itself was saved fairly easily, but it did not contain the copper expected, and which was apparently associated with it in the ore. The copper went its own way, remaining with the tailings of the jigs, and enriching them beyond the copper contents of even the cleanest pyrites headings. On the slime-tables the concentration of the copper was much better, yet all through it seemed as if the copper slimed considerably, and occurred in the ore quite distinct from the iron pyrites, much in the manner of a mere cover on the particles of the latter, with a strong tendency to float off instead of settling. This experience does not augur well for the easy concentration by water of the low-grade ores of the district.

The Reduction Works.

Smelting Plants.—At the company's Smelting Works the usual energetic operations were continued during the year. Since the beginning of 1902, however, a smaller number of furnaces has been made use of for the same ore-consumption. At the present it may be said that there are five furnaces in continuous operation, whereas the number formerly used to be seven and eight. The total number possessed by the company is eleven blast-furnaces, arranged in two smelting plants, the older or No. 1 plant containing six blast-furnaces, and the newer plant, No. 2, five. The latter furnaces were built according to experience gained in the operation of the former, and were made considerably larger, the respective sizes in the plane of tuyeres being as follows:—No. 1 plant, 40 inches by 168 inches (except No. 3, which is 36 inches by 126 inches); No. 2 plant, 42 inches by 210 inches; the height in each case, from the tapping to charge floor, is 20 feet overall; the height of ore-column above tuyeres is 9½ feet; the number of tuyeres (3 inches throughout) is 32 in No. 1 plant (24 in No. 3 furnace), and 40 in No. 2 plant. The

furnaces are water-jacketted high up, the jackets all being cast-iron, with the exception of the small steel-plate tympan-jacket. At the present time it may be said that three of the large furnaces of No. 2 plant practically smelt into first matte all the ore that is delivered, while two furnaces of No. 1 plant are devoted to the concentration of the first matte into converter matte, and only occasionally treat ore alone. Under these circumstances, each furnace of No. 2 plant sometimes smelts up to 350 tons of Mt. Lyell pyrites per diem, and the average, as calculated from the four weekly returns, is about 270 tons of pyrites daily. Phenomenal tonnages are occasionally reached; thus, No. 6 furnace recently treated a total of 724 tons of material (matte, silica, limestone, and slag) in a single day. This vigorous work is due to the fact that the amount of air formerly distributed to the large number of furnaces is now supplied to the smaller number. Simultaneously, the blast pressure also has risen, until it is now on a level with the pressure made use of in the progressive matte-smelting establishments of the United States and British Columbia, and ranges from 36 to 40 ozs. at the blowers, and from 30 to 34 ozs. at the furnaces, the difference at the two points being loss by friction in hot blast-stoves, blast-mains, and furnace-connections. To meet this higher pressure no alteration was made to the furnaces, except the raising of the sump, *i. e.*, the elevating of the overflow-level of the furnaces by several inches for the proper trapping of the blast, the same as before.

At the same time, important improvements were also made in the motive-power department by the installation, in each smelting plant, of steam-saving appliances, consisting of Green's economisers, with induced draught-fans and a system of steam superheaters. The economy effected by the economisers is determined as 15 per cent., and by the superheaters as 16 per cent., total saving 31 per cent. The waste heat of the fireboxes of the hot-blast stoves, in addition to that of the boilers, contributes to this high result. The steam plant of the Smelting Works is, therefore, entirely up to date, and the various improvements have succeeded in lowering the cost of power to what must be regarded as the local minimum. The fuel employed is still chiefly firewood, the use of coal being merely auxiliary. The respective consumptions under the boilers were, for the year, 36,443 tons of wood and 1794 tons of coal.

The work done in this department for the year was the highest yet performed. There are six 124-h.p. Babcock and Wilcox boilers available in each smelting plant, two in each case now being in reserve. The average indicated horse-power was 1905; total engine revolutions, 310 millions; air delivered to furnaces, 31 billions cubic feet, weighing 1,054,000 tons. This air was heated to an average temperature of 580° Fahr., thus absorbing 291½ billions British Thermal units out of the combustion of 49,000 tons of firewood in the hot-blast stoves. The latter have continued to give every satisfaction. In point of repairs the eight stoves (four in No. 1 plant, with 56 castiron U tubes each, at 16 cwts., and four in No. 2, with 70 U tubes each) have given practically no trouble, there having been only about a dozen tubes completely replaced since the beginning, on account of burning out. The number of hands employed in the smelter motive-power departments is 80, comprising engine-drivers, firemen, cleaners, wood-handlers, &c. It may be mentioned that,

for the production of the blast, there are in use nine vertical compound condensing-engines, 12 inches and 22 inches by 18 inches, set up in marine style, and direct coupled, by means of a flexible coupling, to a No. 8 Root's blower, each of 116 cubic feet displacement; also one reserve No. 7 Root's blower with vertical engine attached, ordinary style, and two reserve No. 7 Root's blowers, belt driven from a horizontal tandem compound-engine, 12 inches and 20 inches by 30 inches. The power-plant thus follows the unit system, i.e., each furnace has a blower driven by an individual engine, although the blast is not conducted to each furnace separately, but directed into a common blast-main. The condensers are of the surface type (1000 square feet), also with vertical compound-engines, 6 inches and 12 inches by 6 inches, and air-pumps to suit—the latest with Edwardes' pump.

The following are the statistical figures of ore treated, rendered by the company for each quarter of the past year:—

Treated	Quarter ending Sept. 30th, 1901.	Quarter ending Dec. 31st, 1901.	Quarter ending Mar. 31st, 1901.	Quarter ending June 30th, 1902.	Total for year 1901-02.
	Tons.	tons.	Tons.	Tons.	Tons.
Mt. Lyell ore ...	69,289	65,688	71,111	79,969	286,057
Purchase-ores ...	21,257	20,731	11,680	4,841	58,509
Metal-bearing fluxes	5,726	6,480	7,702	8,139	28,047
Total	<u>96,272</u>	<u>92,899</u>	<u>90,493</u>	<u>92,949</u>	<u>372,613</u>

It is thus apparent that the average per day was the treatment of over 1000 tons of raw mineral-bearing substances, besides which the company has treated in its blast-furnaces all the first matte, converter slags and linings, flue-dust, and similar middle-products formed in the process.

It may be remarked that the grade of the first matte at present does not exceed 15 per cent. copper, being a concentration of from 6 to 7, and more, from the original ore into first matte, all of which work is practically performed, as remarked, by the furnaces of No. 2 plant. The re-treatment of this first matte, or concentration of same, by the furnaces of No. 1 plant, raises its grade to 45 per cent. and 50 per cent. copper, which is the standard required for proper economical bessemerising into blister copper.

The output of the furnaces in copper, silver, and gold, for the year under review, is as follows:—

Output.	Quarter ending Sept. 30th, 1901.	Quarter ending Dec. 31st, 1901.	Quarter ending Mar. 31st, 1901.	Quarter ending June 30th, 1902.	Total for year 1901-02.
Fine copper in blister (tons)	2,630	2,579	2,520	1,870	9,608
Silver, fine (ozs.)	164,932	160,102	182,487	171,133	678,654
Gold, fine (ozs.)	5,224	5,002	5,650	5,555	21,451

The total money-value of this year's output, calculated upon the changing quotations for the copper and silver, is given as £765,584.

The grand total of ore treated since the beginning of smelting operations on 25th June, 1896, up to the 31st of March, 1902, as

given in the company's last report, together with average assays, is as follows :—

	Total tons.	AVERAGE ASSAY.		
		Copper. per cent.	Silver. ozs.	Gold. oz.
Mt. Lyell Mine	1,160,684	3·00	2·81	0·101
Purchase-ores	154,923			
Total ores	1,315,607			
Total metal-bearing fluxes	33,023	1·64	0·21	0·020
Grand total ores and metal-bearing fluxes . .	<u>1,348,630</u>			

The principal consignor of outside purchase-ores was the North Mt. Lyell Company, which has supplied half the total. Then, in order, follow the Lyell Tharsis, Mt. Lyell Blocks, and the old South Tharsis Company, while small lots have been received from the King Lyell, Duke Lyell, and Prince Lyell companies. The North Mt. Lyell Company completed its contract shortly after the end of the year. It is interesting to state that the average assay of all of the purchase-ores, representing, as it does (with the exception of a quantity of rich ore shipped to England by the North Mt. Lyell Company), an approximation to the average value of the silicious bornite ores of the district, is—Copper, 6·70 per cent.; silver, 1·93 oz.; gold, 0·002 oz. The Mt. Lyell pyrites, therefore, though lower in copper, are relatively higher in silver and gold than the average bornite ore of the district. The aggregate average assay of all ores treated by the company in the course of time is—Copper, 3·44 per cent.; silver, 2·70 ozs.; and gold, 0·090 oz.

The following last half-yearly average analyses may be of interest :—

	Silica. per cent.	Iron. per cent.	Alumina. per cent.
North Mt. Lyell... ..	63·70	6·22	10·10
Lyell Tharsis... ..	64·00	5·08	17·25
Mt. Lyell Blocks	60·91	7·91	10·60

If the returns for the quarter from the end of the company's half-year to that of the statistical year are added to the above, the results are as follow :—

	Tons.
Mt. Lyell ore treated	1,240,653
Purchase-ores	159,764
Metal-bearing fluxes	41,162

Grand total 1,441,579 tons of
local ores furnished by the company from the beginning to 30th
June, 1902.

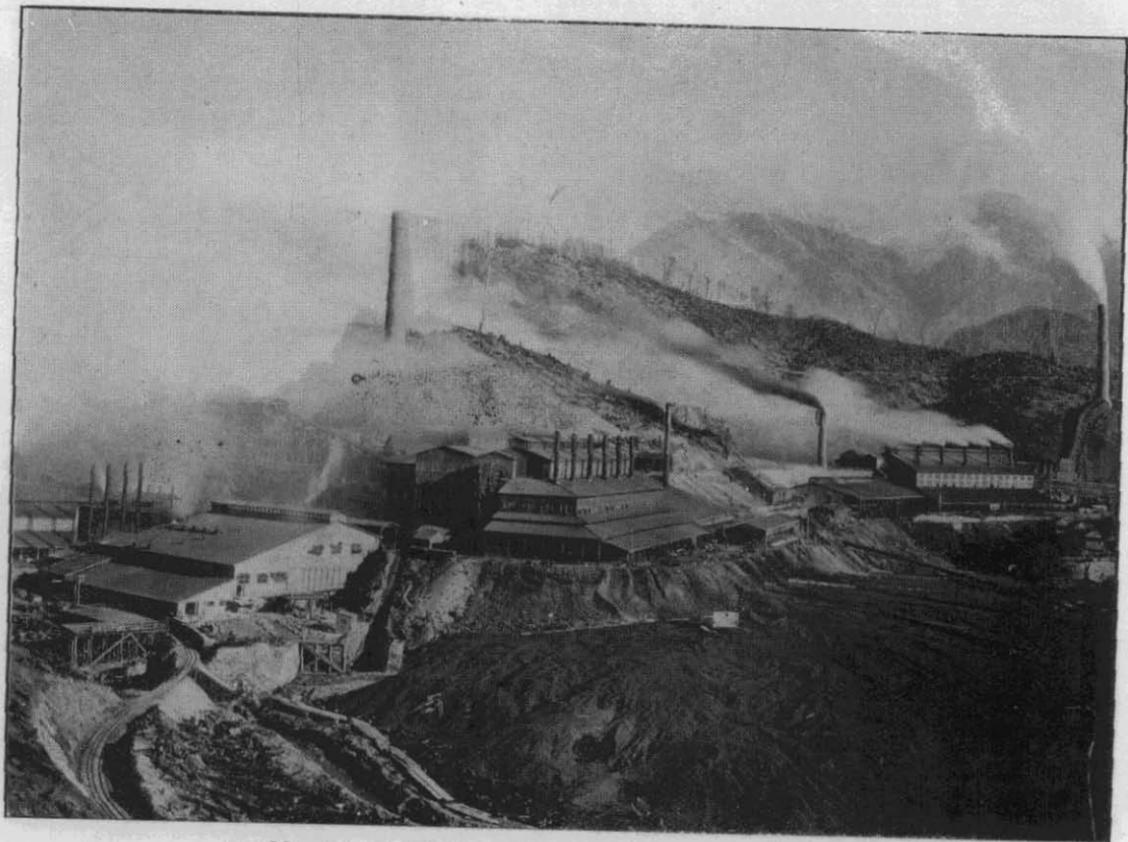
Besides the above-mentioned, there have also been smelted the following quantities of other materials from commencement up to the end of the company's last half-year (31st March last) :—

	Tons.
First matte	271,913
Silica flux	327,183
Limestone flux	182,202
Flux slag	281,134
Coke used at blast-furnaces	81,044
Flue-dust re-treated	24,022
Converter slags	45,223
Converter linings	7,276
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Add ores and metal-bearing fluxes...	1,219,99
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Total materials furnaced	1,348,631
	<hr/>
	2,568,628

The above figures apply to the twofold smelting, but do not include the bessemerising of the product, *i.e.*, converter matte.

The method of metallurgical treatment has remained the same as at the start, *i.e.*, direct pyritic smelting, with the use of only a very small percentage of carbonaceous fuel and with a heated blast, and subsequent bessemerising after Manhés. The type and details of the blast-furnaces have required no alteration from the original design. The use of a hot blast for the furnace treatment has been proved by experience to be obligatory and not to be circumvented, as indeed is demonstrated by a careful investigation of the thermo-chemistry of the method. The process, as a whole, is divided into three stages, *i.e.*, two smeltings into matte, and the converting of the enriched matte into blister copper.

The quantity of coke used in the blast-furnace smelting, when calculated on the ore, is about 5 per cent. in current work for the twofold furnacing, and 6 per cent. on the ore including all incidental coke for glowing-in purposes and similar occasional use, while, on all the material fed into the furnaces (less coke itself), the percentage is only $3\frac{1}{4}$ per cent. for the double smelting. It can hardly be maintained that so small an addition of coke has any vital bearing on the furnace reactions, from a heat point of view, and it is commonly remarked that the coke simply serves to keep the tuyeres from becoming too hard. It is fed along the long walls of the furnaces with this special object in view. Such low percentages of coke are only possible owing to the application of the oxygen of the atmosphere to the ore mixture under conditions which make the oxygen perform a function somewhat different in its effect from that which it exercises in ordinary blast-furnace smelting, where a larger percentage of carbonaceous fuel is necessary. In all three stages of the process the material (ore or matte) is constantly subjected to an oxidising action, and not a reducing one. The process, therefore, in this respect is the direct inverse of ordinary smelting operations in blast-furnaces. A potent factor establishing the feasibility of the furnace-smelting is the presence of a heavy percentage of iron and sulphur in the Mt. Lyell pyrites, which elements yield a sufficient quantity of heat, during their com-



MOUNT LYELL MINING AND RAILWAY COMPANY'S SMELTERS.

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MOUNT LYELL MINING AND RAILWAY COMPANY'S HAULAGE LINE.

bustion, or union with the oxygen of the atmosphere, to allow the solid products of combustion to remain in a superheated molten condition. This peculiarity also distinguishes the bessemerising operation. In fact, it may be said that the Mt. Lyell ore-smelting is nothing more than a bessemerising of ores, or matte therefrom, direct in blast-furnaces, but so managed as to be continuous, and not intermittent, as is the bessemerising operation, and also under perfect control, both as to the composition of slags and mattes and the proper mechanical separation of these two products. The company remains to this day the only instance of this idea being utilised on a large scale as the exclusive method of treatment. The entire length of time occupied by the transition of the copper in the ore from the latter into blister copper, *i.e.*, from the moment the ore enters the first furnace until the blister copper issues from the converters, is only from five to six hours, if the time lost through cooling and transportation between apparatus is disregarded. An essential condition of success is rapidity of treatment, for it is only by this means that the necessary heat is concentrated to the required pitch.

The blast-furnaces were blown in successively on the following dates:—No. 1, 25th June, 1896; No. 2, 6th October, 1896; No. 3, 24th June, 1897; No. 4, 13th September, 1897; No. 5, 13th September, 1897; No. 6, 26th May, 1898; No. 7, 3rd October, 1898; No. 8, 18th October, 1898; No. 9, 26th January, 1899; No. 10, 8th May, 1899; and No. 11, 29th June, 1899.

The blast-furnace slags vary between the following limits of composition, the furnace-charges for ore-smelting and matte-concentration differing somewhat from each other. Limestone is used only in the latter operation, and not on the ore. The first matte is re-smelted by itself, as a rule, *i.e.*, very exceptionally only has pyritic ore been used with it:—

	Per cent.	Per cent.
Silica	36·66	to 41·70
Iron protoxide	50·67	to 43·14
Calcium oxide	1·20	to 8·16
Barium oxide	1·90	to 0·16
Alumina	7·47	to 5·46
Copper	0·25	to 0·35

The flue-dust is ground up and mixed in a steam-driven mill with about 4 per cent. of common clay and the addition of a little water, and no lime is used for binding. The briquettes are of the size of ordinary bricks, are made by hand in preference to presses, and weigh about 14 lbs. each. They are laid on shelves in a large drying-room, and rough-dried by the heat of pots of slag ranged alongside. The quantity of flue-dust so handled was 4666 tons for the year. Its average assay was—Copper, 3·5 per cent.; silver, 2·5 ozs.; gold, 0·07 oz. It contains about one-third silica, which comes from the dust and sand accompanying the quartz flux. More elaborate means of preparing the flue-dust, like fusion in a reverberatory furnace, moulding and burning in closed kilns, as well as a briquetting machine of good repute, have been given lengthy trials, but have all been discarded on account of being too expensive, and preference was finally given to the present means, which is primitive in character, but more satisfactory in regard to cost and

efficiency. The flue-dust is partly oxidised, but there are not sufficient sulphates in it to act as binding-material for machine briquetting, and the cost of the obligatory lime has decided against the method.

The system of getting rid of the slag by granulation has been in use since the start, but of late years it has become necessary to resort to mechanically raising the accumulating dump of each smelting plant to a higher level, to keep the talus of the dump within bounds. This is effected by centrifugal pumps of a special construction—the outcome of the simplification of prevalent types and adaptation to the special work to be performed. The pumps are at present steam-driven, but will shortly be run by electricity. The slag-pumps are of small diameter, 10-inch suction by 9-inch discharge, with 18-inch beaters or vanes, and are run at from 540 to 600 revolutions per minute. The quantity of slag elevated during the year was 170,000 tons at No. 2 plant and 40,000 tons at No. 1 plant, together with all the water entering the two smelting plants, with the exception of that used for steam-generation, sprinkling, &c. The respective lifts are 15 and 11 feet at present.

The new sampling works, which were erected in place of the original mill which was destroyed by fire a couple of years ago, treats the samples of all ores and mineral fluxes, also purchase-ores used, and prepares them for the Assay Office. The proportions taken in transit and delivered to the sampling works are—every 25th ropeway bucket of open-cut pyrites, every 16th truck of underground ore, every 18th truck of mineral flux, while the proportion on purchase-ores varies from all to $\frac{1}{4}$ to 1-8th. The balance of lots goes direct to the furnaces; none of the ores, &c., are specially crushed, but are smelted in the size as broken at the mines.

Converter Plant.—The converting operations were conducted in conformity with the amount of matte produced by the blast-furnaces. The bessemerising plant is a double one, *i.e.*, consists of two independent equal-sized departments, each with facilities for turning out from 25 to 40 tons of copper a day. The total number of vessels is 14 (12 in use), vessel-stands 6; and there are two re-melting-furnaces with a No. 5 rotary blower each, with vertical engine attached; two high-class Fraser and Chalmers' horizontal compound condensing blowing-engines, 16 inch and 24 inch by 30 inches, with air-cylinders 30 inches by 30 inches, delivering 3000 cubic feet of free air at 60 revolutions; a 14 inch by 3 $\frac{1}{4}$ inch by 10 inch duplex Worthington high-pressure pump; an accumulator; and all other necessary paraphernalia for the handling and tilting of the vessels, including hydraulic cars for shifting same, travelling crane, &c., together with the necessary machinery, grinding-pans, &c., for the preparation of the vessel linings; also drilling-machines for drilling the blister copper for sample. Steam is supplied by four 70 h.p. multitubular boilers. In the motive-power department the average indicated horsepower developed for the year was 300, and the amount of wood fuel consumed 13,043 tons. The average blast-pressure is 8 lbs. per square inch at the vessels.

This portion of the reduction works is also unique, for it is the only case of bessemer works for copper in Australasia. The first converter was started on continuous work on 14th January, 1897. The style of vessel is that known as the Stalman type, which has proved eminently satisfactory, and slight in repairs.

to which latter fact the square shape of the vessels has essentially contributed. The tilting-gear is extremely simple and effective, the rack being on the cylinder itself, which travels horizontally on the hollowed piston-rod, through which the pressure-water enters and leaves.

The clay for the vessel linings is a fine white variety of refractory nature, won in the immediate vicinity of the converter plant, and the silica is supplied by the screened fines or refuse from the quartz-crushing plant at the quarries. In these important respects the company is therefore fortunately situated. The composition of the clay is the following:—

	Per cent.
Silica	62.52
Alumina	23.89
Iron oxide	0.26
Calcium oxide	0.25
Magnesium oxide	0.40
Water and undetermined	12.68
	100.00

The number of "blows" which a lining will stand until corroded so thin that the vessel has to be removed is from five to seven.

The production of the bessemerising plant for the four quarters of the year is given above, under the output of the furnaces in metals. Since the beginning of operations to the end of the company's last half-year (31st March) the total results are as follow:—

Blister copper, 40,168 tons, of an average assay per ton of—Copper, 98.83 per cent.; silver, 81.36 ozs.; gold, 3.124 ozs.; containing—Copper, 39,698 tons; silver, 3,268,016 ozs.; gold, 125,498 ozs.

Adding on the production for the last quarter, the figures become the following, from the commencement of work to 1st July, 1902:—

Blister copper, 42,060 tons; containing—Copper, 41,568 tons; silver, 3,439,149 ozs.; gold, 131,053 ozs.

The quantity of converter matte treated by the converters from the beginning to the 31st March is 87,229 tons, of an average assay of—Copper, 49.48 per cent.; silver, 39.34 ozs.; and gold, 1.480 ozs.

The blister copper is now poured into plates, or cakes, measuring 16 inches by 24 inches and 2¼ inches thick, the former bars or pigs having been abandoned. Five hundred plates constitute a lot or parcel of 50 tons, the sample of which is kept distinct. Sampling is done by drilling two ¾-inch holes through each plate, with power-driven drill-presses. The blister copper is all shipped to the United States, *via* London, and is refined by the Baltimore Copper Smelting and Rolling Company in Maryland, on a toll arrangement, the products being turned over to the company. The products, *i.e.*, electrolytic copper, as ingots, wire bars, &c., on the one hand, and fine silver and fine gold on the other, are sold by the company, the two precious metals being disposed of at the United States Mints, and the copper in the open market. It is chiefly exported to Europe, its identity being merged in that of the well-known brand "B.E.R."

Subsidiary Plants, &c.—An important adjunct to the company's reduction works is the coking plant it possesses at Port Kembla, near Wollongong, New South Wales. This consists of 62 ovens of longitudinal horizontal type, 24 feet long by 3 feet 6 inches wide by 5 feet 4 inches high, with circulating gas-flues, and a capacity each of about ten tons of coke per week. The works are supplied with complete grinding and elevating machinery, hydraulic handling apparatus, including coke-pushing machine, and all other necessary paraphernalia, bringing the installation up to date. The small coal used is from the Mt. Kembla Mine, and prior to grinding for coking is dressed by washing-machinery to remove the slate. The coking plant supplies the entire requirements of the reduction works, which, in view of the small consumption of coke due to the peculiar smelting method, are comparatively light, and fall below 350 tons per week for the treatment of 7000 tons of metal-bearing material. An excess of output is disposed of by sale.

In addition to using the South Tharsis and Royal Tharsis metal-bearing fluxes, the company has latterly reverted to the more extensive use of barren quartz-flux, chiefly on account of the slackening of deliveries of silicious ores by the neighbouring mines. The supply of natural silica is inexhaustible, for one of the principal rocks of the district, which occurs in very massive deposits right on the spot, is quartzite, and, failing this, an equally inexhaustible supply of conglomerate would have been available. The silica quarry is now opened up on a large scale, and, as formerly, quarrying is restricted to the crest of the hill, 500 feet above the river flat, where the material is harder than in the valley, where it was first attacked. This quarry is worked in three benches, and covers an area of 10 by 20 chains, involving about $3\frac{1}{4}$ miles of trams. The stone is sent by a self-acting three-rope Otto ropeway, of the same type as the larger one between the mine and smelters, down to a special crushing plant, situated in the flat about 1200 feet distant, and connected with the reduction works by a regular $3\frac{1}{2}$ and 2 feet tram service. The capacity of this ropeway is 30 tons an hour, and it is run by seven men, including loaders and dischargers. The crushing plant consists of two of the largest-sized "Comet" rotary crushers, driven by a 25-h.p. engine and multitubular boiler, and is situated on top of a set of stout storage-bins of 1000 cubic yards total capacity. The stone is broken to 3-inch size, and is screened free of sand and fine stone by perforated percussion tables. A drawback of the silica quarry is the occasional softness of the stone and the occurrence of sandy streaks, which have to be shifted separate from the hard quartz. This removal is effected by two self-acting rope inclines, of the double fixed and single-moving rope, alternate-motion type, with stop-blocks on the carrying-ropes and automatic tripping-gear on the conveyors. The two latter are connected by a $\frac{1}{2}$ -inch rope, while the fixed cables are discarded $1\frac{1}{4}$ -inch haulage-line ropes; clear spans 1000 feet; height above ground, 90 feet in centre of lines. The sand is thus dumped into an out-of-the-way flat, and 150,000 cubic yards have been tipped in the last three years. The nominal capacity of each sand-tip is 50 cubic yards an hour, and the attendants are a man to work the brake and a boy to tend the loading-bin doors.

The quartzite directly overlies a limestone bank, the strike and dip of which are practically parallel to those of the quartzite, the

dip in both cases being almost vertical. The limestone, however, is worked in a gully at the foot of the silica hill, and is directly accessible to the railway. The exposed width of the limestone bank is 7 chains, and length of stripping 10 chains from entrance to head of gully, where the overburden is too heavy to remove. The quarrying is done in five benches, over a vertical height of 130 feet. The stone is lowered from the three upper levels, in wooden, steel-lined shutes, to the storage-bins, a means of conveyance which has given every satisfaction, and shown surprisingly little wear, both with limestone and quartzite. The longest shute now used is about 150 feet, with a uniform slope of about 28° , but formerly one of 300 feet length and $1\frac{1}{2}$ foot square section, with an inclination of 32° , was successfully negotiated on quartzite. The limestone is napped to a coarse size only.

The quantity of stone supplied by the silica quarry from 1st January, 1898, to 30th June, 1902, is 316,563 cubic yards of crushed, for furnaces, and 12,930 cubic yards of fine, for converters. The output of the limestone quarry for the same period was 155,451 cubic yards of broken rock. Number of men employed at present, on silica 100, and on limestone 65. Explosives used on silica, chiefly black powder; on limestone, chlorate-nitrobenzol compounds.

Typical analyses of these two barren fluxes are the following:—

	Silica. Per cent.	Iron Oxide. Per cent.	Alumina. Per cent.	Carb. of Mag.	Carb. of Lime. Per cent.
Quartz-flux, white	91.44	1.54	3.09	....	....
Quartz-flux, dark	88.72	3.60	7.03	....	....
Limestone, grey... ..	10.92	.57	2.88	3.00	83.40
Limestone, black	3.26	.85	.86	trace	95.10

The limestone, though not very pure, serves all purposes for copper-smelting, and also makes a good burnt lime. For the latter there are two kilns at the quarry, 18 feet high by $6\frac{1}{2}$ feet diameter.

Both quarries continue to constitute the lucky factors, by way of fluxes, which made their presence, in such close proximity to the smelting works (60 chains), so valuable to the company. The same is also true of the clay deposits in the immediate vicinity of the smelting works which have supplied all the bricks used in the construction of the works (4,000,000), and which the company utilises for the manufacture both of ordinary bricks and firebricks. The brick plant was, a couple of years ago, shifted from its original site at Queen's Crossing to Ragged Creek, close to the township. This year's output was 533,000 red bricks, 128,000 firebricks, and a quantity of piping. The quality of the firebricks is quite equal to ordinary Australian makes, and the price of production considerably cheaper than the local cost of the imported varieties, so that the company has given up the use of the latter.

The means of ore-transit at the reduction works are, as before, between the mine and the smelting plants, on the one hand, the old haulage-line, which now chiefly carries the underground ore, and takes back supplies for the mine, and, on the other hand, the large aerial ropeway, over which the bulk of the Mt. Lyell open-cut ore is carried. These two lines run practically parallel to

each other, and, as the ropeway is subject to occasional shut-downs for repairs, the retention of the haulage-line has been of the utmost value for the purpose of continuous traffic, for the line is quite equal, temporarily and in three shifts, to take the place of the ropeway. During the year the haulage-line carried 114,857 tons wet weight of ore, in 55,518 full trucks, divided as follows:—Open-cut ore, 22,904 trucks, or 57,260 tons; underground ore, 7,794 trucks, or 41,865 tons. Besides this, it carried all the mine supplies (coal, wood, explosives, and general) on the return trip. The number of men employed on the line, and at the bins for loading trucks, is 13.

The aerial ropeway is a further unique feature of the plant. It is an exceptionally difficult line from an engineering point of view, but has splendidly established the suitability of such methods of transport in rough country like the mining fields of the West Coast. The following are the chief particulars of the line:—

Main Line from ore-bins at mine to central station, near No. 1 plant, horizontal length 6750 feet.

Vertical rise on mine side to top of mountain saddle, 430 feet.

Vertical fall on reduction works side from top of mountain saddle, 920 feet.

Mean gradient, mine side, 1 in 2·9.

Mean gradient, smelter side, 1 in 6·3.

Maximum gradient on mine side, 1 in 2·5.

Mean gradient, mine to smelters, 1 in 14·7.

Number of standards, 13; also 1 "viaduct" (double standard), 1 tension-gear (intermediate station joining ropes), and a rail-passage, five chains long, on top of saddle.

Height of standards—Lowest, 8 feet; highest, 51 feet.

Tension weights—On large carrying-rope, 15 tons; on small carrying-rope, 8 tons; on traction-rope, 1 ton.

Longest spans between standards, 1155 feet, 1188 feet, and 1320 feet.

Greatest height of rope above ground, 220 feet.

Distance of carrying-ropes apart, $6\frac{1}{2}$ feet.

Length of branch from central station to No. 2 plant, nearly at right angles to main line, 890 feet.

Length of branch from central station to No. 1 plant, in straight continuation of alignment, 300 feet.

Capacity of carriers or buckets, 11 cwts. of Mt. Lyell pyrites.

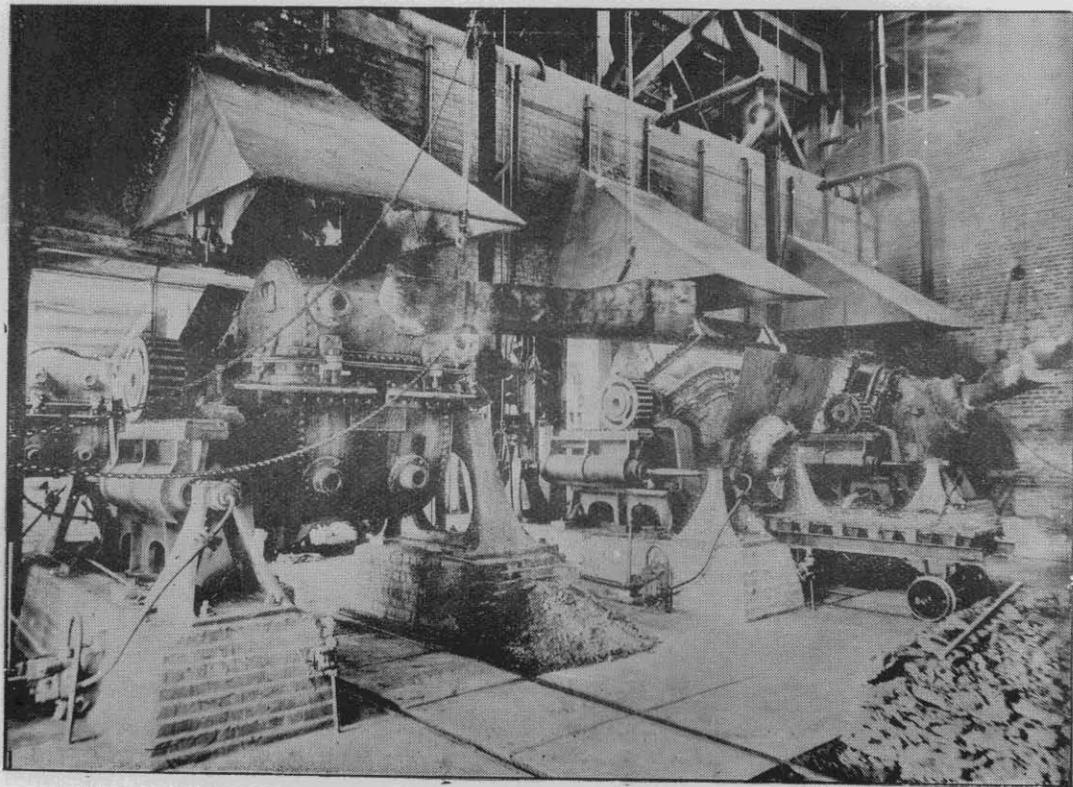
Speed of travel of buckets, 6 feet per minute.

Rate of delivery, one ton per minute, *i.e.*, one bucket, or carrier, arrives each half-minute.

Number of buckets on line at one time, 70.

Cost of delivery from mine bins to smelter floors, including all labour, supplies, maintenance, new ropes, breakdowns, supervision, light, &c., also including loading, shunting, and discharging buckets at stations, per dry ton of ore carried, varies from 6*d.* to 7*d.*

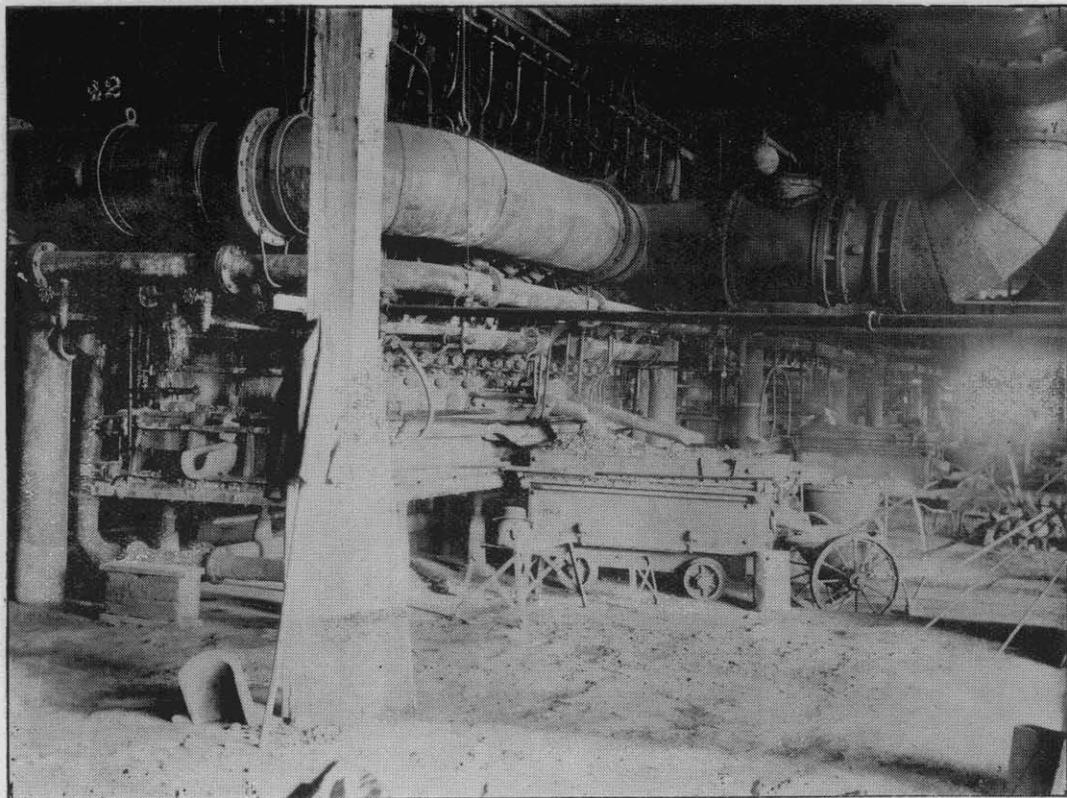
The entire quantity of ore is deliverable, as desired, to either smelting plant, *via* the central station. The main line, as well as both branches, is self-acting, there being no power used, except at the starting of the empty line, when it is necessary to get the buckets from the mine terminus over the top of the hill. When the line is fully loaded, it is entirely self-acting. The



MOUNT LYELL MINING AND RAILWAY COMPANY'S CONVERTERS.

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MOUNT LYELL MINING AND RAILWAY COMPANY'S WATER JACKET FURNACES.

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carrying-ropes are of the "locked section" type, with perfectly round and smooth periphery, the diameters being 35m.m. on the loaded and 25m.m. on the empty route. They are coupled together, in lengths exceeding 500 feet, by means of a special coupling in halves joined by a right and left-hand union piece. These ropes act as flying rails, over which the buckets pass, the hanger carrying each bucket having at the top two grooved pulleys, placed together tandem fashion. The traction is done by means of an endless running rope, $\frac{3}{4}$ -inch diameter, 16,000 feet long, of flexible construction. To this the buckets are attached by means of an ingenious special grip, suitable for the steepest gradients. The traction-rope is kept in motion by the descending loaded buckets, the speed being under the control of a brake at the upper or mine end of the line. The carrying-ropes are not continuous from the mine to the reduction works, but the total distance is divided into three sections—one from the mine to the top of the saddle, and two from there to the central station. A novel feature is the substitution, on top of the hill, for the carrying-ropes, of a fixed line of rails about 300 feet long, sweeping over the narrow ridge on top of the saddle. This is the point at which the carrying-ropes would be exposed to most wear, and their replacement by a fixed rail at this point has proved faultless. The number of full buckets carried by the line during the year was 396,944, delivering 220,304 tons wet weight of open-cut ore. The ton-miles amounted to 330,456. The total number of hands employed in connection with the work, the chief portion of which is engaged in the filling and emptying of the buckets, is 48. The cost of delivery appears lower than that of similar lines of the same size, and is about equal to the cost of carriage over the haulage-line from mine-bins to foot of smelters side of that line. From this point the haulage-line still necessitates three-quarters of a mile of carriage to smelters on the 2-foot "through tram," while the ropeway delivers direct to furnaces.

As already mentioned, there is a similar ropeway at the silica quarry, and there is a third of the same style connecting the Lyell Tharsis Mine with the "through tram." This is about one mile long, and of the same capacity as the silica line.

Besides the above means of transportation for ore, an extensive system of 2 feet steam-trams is in use, of a total length of 12 $\frac{1}{2}$ miles, with five Krauss locomotives, for the delivery of supplies like silica, limestone, timber, and firewood from the respective local sources. Four and a half miles of this is combined with the 3 feet 6 inch system, as a three-rail track. In addition there are in use, for firewood and timber getting, about 18 $\frac{1}{2}$ miles of 2 feet 6 inch wooden bush-trams. The materials received over sea, such as coal, coke, and machinery, are, of course, brought over the company's own 3 feet 6 inch railway line from Regatta Point to Queenstown and the reduction works. Such goods arrive at Regatta Point, on Macquarie Harbour, either direct by boat, or overland by the Emu Bay and Government Railways, *via* Burnie, a portion of the coke and coal being diverted over the last-named routes. As connection is now made at Strahan with the general railway system of the State, it is possible for blister copper to be shipped direct by rail to Hobart, were this necessary. The coal carried is still Newcastle or southern coal from New South Wales, Tasmanian coals being

placed at a disadvantage, partly because of inferior quality and partly on account of high transportation rates.

The company's repair shops have attained considerable magnitude in course of time, and the works are now practically wholly self-contained and self-reliant, except for the supply of raw materials like pig and wrought iron, steel, &c. The machine shops contain seven forges, five lathes, locomotive wheel lathe, pipe and bolt screwing machines, planing, drilling, and shaping machines, power-driven punching and shearing machine, boiler-maker's rolls, 7 inch by 20 inch steam-hammer, &c., and can cope with any variety and size of job likely to occur, in turning, fitting, blacksmithing, boilermaking, tinsmithing, plumbing, wood-turning, &c. The number of mechanics employed is 39. The foundry has proved a most useful addition, and now has sufficient capacity to supply all the castings necessary in the company's operations, both of greater quality and greater durability, as well as considerably cheaper, than outside sources.

The foundry is fitted with two cupolas, drying-stove, three-ton travelling-crane, &c., and a large stock of patterns. Moulding-sand is found locally, and very good. The chief articles turned out are a great variety of water-jackets, slag and matte pots, fore-hearths, spouts, and other furnace-parts, rolls, pulleys, brake-blocks, firebars, &c. The number of foundry hands is 24. It may be of interest to mention that the blast for cupolas and forges is supplied by a compound portable engine and a No. 4½ Baker rotary blower, which latter, about ten years ago, was secured from the defunct lead-smelter at Argenton, near Zeehan, by the then manager of the mine, and laboriously conveyed to the "Blow" for the purpose of experimenting on pyritic smelting, but never used.

The carpenters' shop also plays an important rôle towards the supply of various articles of current use, like truck-parts, rope-way bucket-linings, wheelbarrows, tuyere chips and plugs, cabinet and joiners' work, &c., to which must be added all pattern-making for the foundry.

Apart from the above shops, 92 hands are engaged in floating gangs in the construction, erection, and maintenance of the various paraphernalia used in smelting, steam-generation, engine-driving, building-maintenance, electric machinery, &c. They comprise fitters, blacksmiths, strikers, pipe-fitters, plumbers, bricklayers, carpenters, electricians, and labourers.

The electric light installation is complete in each plant and department.

The water-supply is derived from the middle and west branches of the Queen River by pumping, and from Conglomerate Creek and the east branch of the Queen River by gravitation, the respective deliveries being 529,000,000 and 931,000,000 gallons for the year; total, 1,460,000,000 gallons. The pumps employed are two sets of duplex double-acting power-driven plunger-pumps, 10 inches by 36 inches, with a large Worthington duplex compound steam-pump as a stand-by. Power is supplied by two 12 inch by 24 inch horizontal engines and two multitubular 70 h.p. boilers.

Every precaution has been taken, by means of an elaborate reticulation and the installation of alternative pumping facilities, to protect the various buildings against serious danger from fire. At an elevation of 180 feet above the slag-dump level there is a reservoir of 300,000 gallons capacity, fed by race from Con-

glomerate Creek, which supplies pressure-water for fire, slag-granulation, and hydraulic furnace-lifts, &c.

The company's telephone system is extensive, ramifying to all points of importance, and reaching from the depths of the mine to Regatta Point. It has 66 instruments and 109½ miles of wire, aside from 60 miles of wire belonging to the Government, but on the company's posts, and maintained by the company's railway department.

Finally, the company's sawmill, working on local timber, need only be named, while the same is true of the lubricating-oil refinery, a small establishment which has the merit of saving at least one-half of the oil consumption.

Financial, &c.—The following table shows the cost of treatment of ore, as collected from the company's half-yearly reports :—

Half-year ended	Mining.		Overburden removal.		Smelting.		Converting.		Total.	
	s.	d.	s.	d.	s.	d.	s.	d.	£	s. d.
31st Mar. '97	1	8·27	2	0	18	1·64	3	10·39	1	5 8·30
30th Sept. '97	1	4·88	2	0	16	2·44	3	7·78	1	3 3·10
31st Mar. '98	2	4·64	2	0	17	9·87	2	9·18	1	4 11·69
30th Sept. '98	2	5·83	2	0	16	5·31	2	5·33	1	3 4·47
31st Mar. '99	2	3·56	2	0	16	3·61	1	11·19	1	2 6·36
30th Sept. '99	2	5·31	2	0	17	10·45	2	2·15	1	4 5·91
31st Mar. '00	2	11·76	2	0	15	10·70	2	2·30	1	3 0·76
30th Sept. '00	3	5·00	2	0	14	11·89	2	0·29	1	2 5·18
31st Mar. '01	3	1·40	2	0	15	9·65	2	1·16	1	3 0·21
30th Sept. '01	2	6·86	2	1	14	8·04	2	0·45	1	1 4·35
31st Mar. '02	2	3·89	2	1	14	8·17	2	2·15	1	1 3·21

It has to be remarked that the overburden charge is a nominal one, debited against the winning of ore, irrespective of the actual cost. This charge was determined once for all, when the programme for open-cutting was made out, in such a manner as to even up the average of the cost over the total quantity of ore to be extracted; otherwise, the later days of the open-cut, when the amount of overburden to be removed per ton of ore would be considerably in excess of what it was at the initial stages of the work, would then oblige the ore to suffer an extreme charge in this respect.

The item of mining comprehends the usual complete working expenses, including supervision and management, also the delivery of ore from the open-cut benches to the mine ore-bins and similar expenses attendant on or subsequent to excavation, until the smelting department receives the ore. The figures are, therefore, swelled by expenses not necessarily of a mining nature.

The item of smelting similarly comprises the usual essential costs attaching to the operation itself, such as labour, coke, supplies, stores, hot-blast, supervision, electric light, &c., beginning with the sampling of the ore, and concluding with the second smelting to converter matte; but it also includes the carriage of the ore from mine-bins to smelter storage-bins over ropeway or haulage-line; the cost of winning and delivering all barren and mineral-bearing fluxes; the maintenance of plant and buildings; the pumping of water-supply; all motive-power costs; collection and re-treatment of flue-dust and other middle products, both from the furnaces and the converters; all cost of transportation

of raw and middle products between the furnace plants and the converters; and, in fact, all incidentals of an operating nature, to which are added cost of laboratory work, telephones and signals, stationery and general office expenses. Converting is treated with similar fulness. The only items not included in the above figures are London and Melbourne head-office expenses, which are slight compared with the rest of the outlay, as well as depreciation of plant. All three departments, moreover, pay the company's railway the usual rates above actual cost of transportation, thus leaving that branch of the company's enterprise a profit. It is, therefore, apparent that the actual mining and smelting costs, *i.e.*, the winning and treatment, as such, are lower than these more comprehensive figures indicate. The cost of shipping and realising on blister copper, of course, is not included, this not being a local cost.

The mine, smelter, and railway departments deal with each other financially as entirely independent concerns, and account separately to the Melbourne head office for all transactions. The mine, however, is not treated as selling to the reduction works the ore which it supplies, *i.e.*, the monetary value of the ore is disregarded. This would, under the circumstances, only be a very unnecessary complication.

The company, in its last report, publishes a summary of dividends, to which we have added the one paid since the issue of the last report, being that of 1st July.

Dividends Paid.

No.	Date when paid.	Amount of Dividend per Share.		Amount of Bonus per Share.		Total.		
		s.	d.	s.	d.	£	s.	d.
1	1st July, 1897	4	0	...	...	44,220	0	0
2	1st October, 1897... ..	4	0	...	...	50,000	0	0
3	1st January, 1898	4	0	...	...	50,000	0	0
4	1st April, 1898	4	0	...	...	50,000	0	0
5	1st July, 1898	4	0	...	...	50,000	0	0
6	1st October, 1898... ..	2	0	...	...	27,114	18	10
7	3rd January, 1899	2	6	...	...	34,375	0	0
8	5th April, 1899	2	6	...	...	41,250	0	0
9	1st July, 1899... ..	3	0	...	...	55,000	0	0
10	2nd October, 1899	4	0	...	...	68,750	0	0
11	2nd January, 1900	4	0	1	0	68,750	0	0
12	2nd April, 1900	4	0	1	0	68,750	0	0
13	2nd July, 1900... ..	4	0	1	0	68,750	0	0
14	1st October, 1900... ..	2	0	...	...	27,500	0	0
15	3rd January, 1901	2	0	...	...	27,500	0	0
16	1st April, 1901	2	0	...	...	27,500	0	0
17	1st July, 1901... ..	2	6	...	...	34,375	0	0
18	1st October, 1901... ..	2	6	...	...	34,375	0	0
19	3rd January, 1902	2	6	1	6	55,000	0	0
20	3rd April, 1902	1	6	...	...	20,625	0	0
21	1st July, 1902... ..	1	6	...	...	20,625	0	0
		<u>£3 2 6</u>		<u>4 6</u>		<u>£890,011 19 8</u>		

The wages paid by the company during the last three years, in the whole of the departments, *i.e.*, mine, reduction works, railway, and coke works, have averaged £263,326 per annum.

The number of men employed during the four quarters of the year is reported as follows:—

	Quarter ending 30.3.'01.	Quarter ending 31.12.'01.	Quarter ending 31.3.'02.	Quarter ending 30.6.'02.	Aver- age.
At the Mt. Lyell Mine ...	419	426	344	326	379
At the other mines	46	42	52	50	47
At the reduction works ...	1221	1300	1300	1288	1277
At the railway	235	225	220	207	222
Total... ..	<u>1921</u>	<u>1993</u>	<u>1916</u>	<u>1871</u>	<u>1925</u>

In conclusion, it is hoped that the above somewhat rambling notes may serve to give those interested a fair idea of the complexity and magnitude of the company's operations, and the up-to-date, progressive character of its operative policy.