THE TASMANIAN NON-FERROUS MINERAL INDUSTRY

Thesis

presented by

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PREFACE.

The following is an attempted economic study of Tasmania's principal non-ferrous mineral industries comprising copper, tin, silver-lead and zinc, which are surveyed separately and prefaced by an historical outline of the chief mining fields relating to each.

The historical outlines have been included because they indicate the economic problems awaiting solution, and in addition they testify to the wisdom or otherwise of certain policies, and the applicability of specific principles.

The economic survey here undertaken was prompted by a spirit of enquiry arising out of a three years' close association with Tasmania's West Coast mining fields. The instability of mining, with its derelict capital, annihilation of whole towns and impermanence in community life generally, first aroused this enquiry.

The method adopted has been to collect as many facts as possible pertaining to the subject, and from these data make a study of the structure and problems of each industry separately. In the final analysis, the thesis is permitted to emphasise its most obvious conclusions, and provide a brief practical proposition as an answer to them.

The prohibition on the release or publication of non-ferrous mineral statistics because of National Security Regulations, and the general shortage of man-power on office staffs have made the collection of statistical data a very difficult task. The order prohibiting the release of non-ferrous statistics has generally been interpreted to apply to both the pre-war and the war period and the Mines Department therefore refused to provide any statistics relating to any period, or to give any assistance at all for the purpose of this study. This attitude has necessitated a personal canvass of all the principal mining fields and the majority of the small ones, and

arrangement of interviews with managers and high-ranking officers of the various companies. The project has forced me to adopt the policy of beg or steal so far as statistical information has been concerned, and consequently there are many gaps that might have been filled in a more opportune time.

It must be emphasised here that there is nothing significant in the choice of base years in the following analysis of costs and trends. They have been adopted by reason of expediency and convenience. The lack of uniform statistical trends is to be regretted, but the present difficulties confronting the layman make the most desirable impossible.

The base year taken for copper is 1933, and although this was a very unfavourable year for most industries, no serious objection can be taken to it here, for the copper industry was a steadily expanding one. Where obtainable, I have tried to make 1928 the base year on which to plot graphs, because this year was generally recognised as a most favourable one.

All statistics are authentic, except where marked "Approximate", and there they are provided only on the most reliable evidence. Companies facing the biggest problems, such as the Mt. Lyell Mining and Railway Company Limited, proved the most fruitful in my canvass for information, while those whose problems were relatively small were the least willing and the most suspicious.

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I N D E X

(N.B. It is regretted that, owing to a typist's error, Pages numbered 105 to 128 in Section II (Tin), have been duplicated in Section III (Silver-lead) To obviate confusion, the second set of these numbers have been marked "A", viz. Chapter II in Section III commences on Page 109A.)

I N D E X (Continued)

S E C T I O N I

COPPER

Introductory

The Commonwealth's chief source of copper is Tasmania. Approximately seven-tenths of all Australian produced copper comes from this State. Queensland is the only other Australian producer of importance, where Mt. Isa has recently contributed to the wartime drive for more home-produced copper by switching from zinc-lead to copper production under orders from the Commonwealth Government.

War demands have called for a speeding-up in copper production. The duration of this increased demand will depend upon the structure of our war machine. If this structure changes, we can expect changes in the demand for copper.

The geographical location of the copper-bearing country for the State under review is principally the West Coast Range. Incidentally, this range, which commences with Mt. Farrell and terminates with Mounts Huxley, Darwin and Jukes, has proved the main source of the State's richest and most profitable mining properties. The Mt. Lyell Mining and Railway Company Limited at Queenstown operates the State's largest copper deposits at Mt. Lyell in the above-mentioned Range, from which electrolytic copper is produced. The only other producer is the Electrolytic Zinc Company at Rosebery, which treats complex ores containing a small percentage of copper.

Other fields where copper is known to exist are the Mounts Darwin, Jukes, Mt. Balfour, Heazlewood, Scamander, Mt. Farrell and the copper and nickel deposits of the Five-mile, Zeehan. The Mt. Lyell Company has spent large sums in prospecting at Mt. Balfour and the Darwin Jukes without success. Of these fields, it

might fairly be stated, that those which have swallowed up much capital in prospecting have given no promise, while the others have not been sufficiently tested to allow any definite estimate of copper deposits present.

Outside of the Mt. Lyell field and what the Read-Rosebery mines are capable of producing, the possibilities of extension are therefore limited. From all reports on these other fields, the only one that might add to the drive for copper is the low-grade Scamander deposits. The field would require a good deal more prospecting and development to give any satisfactory estimate.

Australia's annual production is between eighteen thousand and twenty thousand tons, of which Mt. Lyell produces approximately 12,500 tons. Prior to the war, Australia produced sufficient copper for her own needs and had an exportable surplus. Soon after the outbreak of war in September, 1939, the British Ministry of Supply expressed its willingness to purchase, under contract, any surplus electrolytic copper up to 7,000 tons, but because of expansion in the armament industry in this country, no quantity became available for export. Since then, the consumption of copper has so increased within the Commonwealth, that the demand is outstripping supply by approximately 20,000 tons annually; thus the Commonwealth is only able to produce 50% of its war-time needs.

The Rhodesian mines are able to supply Australia's demands at a figure below home-produced copper, but under the stress of war, the anxiety to become self-sufficient has led to efforts to step up production in Australia. A committee known as the

Copper and Bauxite Committee has been formed and commissioned by the Federal Government to make a thorough investigation and report on the industry. It is the endeavour of this Committee to have production increased by 50% during 1942 and still further during the subsequent years of the war. Mt. Isa (Qld.) is the most important new producer. At Rosebery (Tas.) every effort is being made to increase copper production at the expense of milling zinc, although the latter is more profitable to the Company.

The quantity of copper raised in Australia is sensitive to price movements, and consequently the Prices Commissioner from time to time has greatly enhanced the price for copper to give the necessary stimulus to increased output. "At the outbreak of war in September, 1939, the price of copper in London was fixed at £51 sterling per ton. This was subsequently increased to £62 sterling per ton on the 18th December, 1939. On the following day, the price in Australia was fixed at £A63/17/6 per ton and on 16th February, 1940 was further increased to £A76 per ton. This latter increase was made partly to stimulate production in Australia. Owing to expansion of defence measures, local production was insufficient for local needs, and to avoid the necessity of imports, the price was raised to include the sum of £4 per ton which was to be devoted to exploration and new development by the major copper mining companies" (Commonwealth Year Book, 1940.) The price of copper has steadily increased until it is now (May 20th, 1942) x £100 per ton plus a £5 bonus

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x - Note This price has continued through 1942 - 1943.

on all copper produced above the base tonnage set by the Commonwealth Controller of Minerals for each particular Company. For Tasmania, this action has stimulated activity, but for reasons analysed later, production is not likely to increase. The higher price is having this effect - whereas production was likely to have fallen, it is now being maintained at the high level of about 12,500 tons.

As the Read-Rosebery mines are not primarily copper-producing, and the complex ore has only about .5% copper, we cannot expect any large increase in copper production from the Rosebery mill, which is working to capacity. Owing to Lyell's diminishing assay returns, that industry's problem is to maintain present output. The only source of increased production for this State appears to be in the location of new mines, which chances are very slender, or from a more intensified scale of operations on the present producing fields.

It has been stated through the press that for Australia it would be impossible to obtain by re-opening of old mines sufficient copper to warrant the suspension of importing. This is particularly the case for Tasmania as a source of increased production.

During the years of peace, the price of copper was so fluctuating in nature that it did not stimulate prospecting and development, and consequently the first great problem is the location of copper deposits whose nature and extent warrants exploitation. At a time like the present, when the most pressing economic feature is the shortage of man-power and capital equipment, the problem is intensified. It is obvious that the Federal Government is not prepared to go to any extremes to find copper. There will be a

limit to what the Government is prepared to spend to locate and develop deposits, and this limit will be decided by the manpower and capital resources which can be released for this purpose. The question then becomes - is it better to apply this can-be-spared amount of labour and capital to the present producing mines or in an endeavour to exploit new possibilities? A compromise may provide the answer. That question must be decided by the Commonwealth Controller of Minerals, who is in possession of more facts that can be summoned by the writer. But it is worthy perhaps to mention here that Mt. Lyell has room for three hundred more men, principally miners, tradesmen and labourers, and Rosebery is also experiencing an acute shortage of labour to operate at capacity the existing plant.

For any material increase in production at the fields of Lyell and Read-Rosebery much more capital would have to be made available in the form of plant and mining equipment and also more manpower would be necessary. It is doubtful whether the present copper-producing Companies in this State would be prepared to increase their plant and so make available from their own capital resources accommodation to allow any big increase in output, firstly because their reserves only promise about ten years of life for their already heavily capitalized mining plant, which is not likely to realize very much when reserves are worked out, and secondly for the reason that the demand is only a wartime one, and might change suddenly and leave their greatly increased output at the mercy of a declining market. Also, in the face of high taxation, they have what Mr. Keynes terms

"User Cost" to consider. There is the choice of exploiting their deposits today, and being heavily taxed, or producing more steadily over a greater number of years, when probably bigger profit margins can be retained.

These questions are not likely to be wholly decided by the private enterprises concerned. If the Government wants the copper and the reserves are known to exist on these fields, then pressure might be brought to bear to exact the highest output, on the condition that manpower and capital equipment are made available. But in conclusion of the point raised, it can be definitely stated that there is a shortage of manpower on these two fields which, if amended, could help production.

For Tasmania it does seem that the most profitable avenue to follow is to release more labour to Lyell and Rosebery first, and if there is any surplus then to prospect new fields. It is hardly to be expected that Tasmania will be able to contribute above 14,000 tons to the requirements of the Commonwealth even if manpower is augmented.

CHAPTER 2

Historical

The history of the copper industry in this State is the history of the Mt. Lyell Mining and Railway Company Limited. The Mt. Lyell deposits have been continuously worked since 1885 on a large scale. The proposition is a low grade one, but its extensive nature has enabled the industry to become highly mechanised.

Early Problems :- After the Company had been floated and operations commenced in 1885, it was confronted with the problem of providing its own transport accommodation to the Port of Strahan,

which was thirty miles away over some of Tasmania's most difficult terrain. The construction of the Company's railroad cost over £300,000, which could not have been undertaken but for the discovery of a very rich lode of ore which synchronised with this critical period. Total expenditure amounted to over £400,000 before the first dividend was paid.

The Company amalgamated with the North Mt. Lyell Mining Company in 1903 to make the working of its own poorer deposits more economical to exploit. From then on, it gradually acquired the principal mining properties in the vicinity of its own leases, and the exploitation of the field by the one Company has been a very large factor contributing to its success.

Amalgamation was dependent upon the solution of technical obstacles - economic reduction; and these difficulties were liquidated only after experience and skill were imported from America. The technical advice obtained was from very highly paid sources, and the cost to the Company was very considerable, but it brought success when failure was imminent.

A further problem that faced the Company in its early years was that of cheap power, which was needed for the mines and smelters. As the nearby forests became demolished, wood fuel for the steam boilers became more costly. For a time uncertainty of the mine deterred from venturing on a water scheme which had been investigated years before, but in 1911 a start was made, and by 1914 the waters of Lake Margaret were harnessed with a head of 1,100 feet to provide hydro electric power. The scheme was most successful, and brought down the cost per horse power

per annum from £30 to £3. With the economies secured by the above mentioned factors, the success of Lyell seemed assured for many years.

However, in 1922, when pyritic smelting was discontinued at Lyell, the Company was facing adversity. The working costs per ton of Copper, which are decided partly by the quantity of ore won, and partly by the process and management applied, rose considerably between 1916 and 1921 with the general rise in the price level of wages and materials, and the desirability of economy had become an urgency. Mining costs increased by 114%, but owing to a decrease of one third in the amount of ore required per ton of copper, the actual increase in operating costs was only 40%. The tonnage of ore mined per ton of copper produced in 1916, on the average in the period 1916-1921, and in 1921 was 51, 43 and 34 tons respectively, and the costs per ton of ore treated for the same periods were :- Mining, 9/-, 14/4 and 19/3, Reduction 10/9, 16/4 and 22/- and for both 19/9, £1/10/8 and £2/1/3.

But for the decrease in the tonnage of ore required, due to the adoption of floatation - a new metallurgical process, which was destined to revolutionize the copper industry the world over, operating costs in 1921 would have been £105 instead of £70 and total costs £136 against £69 net return for a ton of copper. Lyell would have closed down.

Whereas in 1921, the six months from 1st October to 1st March smelting took 30,320 tons of Mt. Lyell pyrites under the old dystem of treatment, the six months from April to September 19 1922 took only 6,500 tons of pyrites. This factor materially helped to reduce costs at a most critical time in the history of Lyell.

It is also interesting to note from the Director's Report to the shareholders at the annual meeting of the Company in 1922 that Lyell set a production aim of 12,000 tons per annum, when the output was just above the 6,000 tons, and the price of copper was £62/3/6 in London, a reduction of over £7 per ton from 1920 and £35 a ton from 1916 when mining costs were less than half. The directors of Lyell at that early period and when Lyell was suffering heavy losses, were keenly aware of the principle of increasing returns or decreading costs through increasing output that appliesso particularly to the copper industry. IN order to survive, they launched out on a bigger scale of operations. The Arbitration Count in June, 1921 increased engineering hours from 44 to 48 and reduced the wage of miners per shift from 13/- to 11/6½d. The engineers refused to work, and came out on strike for 35 days and then returned to work on the terms of the

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Costs to Produce and Market Copper £ per ton
(vide published statements of accounts.)

	1916	Average 1916-1921	1921
Mining	23	29	32½
Treatment	27½	33½	37½
Freight and Charges	10	12	13½
Management	2½	3	3½
TOTAL PRIME COSTS	- 63	-77½	- 87
Maintenance of mine	7	5	3
Depreciation of plant	3½	4½	4
Interest (see below)	6	7	7
TOTAL OVERHEAD COSTS	- 16½	-16½	- 14
ALL COSTS	79½	94	101
PRICE OF STANDARD COPPER, London.	116	102	69

Note - Interest on the Lyell share of the Subscribed Capital during the period is added to the working costs as a mimimum charge.

Figures From Economics of Lyell - 1922 - By T.B. Brigden.

new award. The company was not seriously affected by the absence of the engineers and as the number of employees of the company was over 1,000 at that period, the wage reduction per shift meant much to the Company in its great effort to decrease working costs.

During the same period, the company was faced with a heavy burden from the increased price of shipping charges and also the enhanced prices of coal and coke. The Directors further stated in their Report that the outlook of the Company was uncertain, and that even if the price of Copper increased to that of earlier years, the industry could not continue unless all costs were reduced further, including wages. In 1923 the price of copper recovered somewhat, the average London price being £66/7/4, a rise of over £4 a ton on 1922, but the Arbitration Court increased the basic wage to 69/3d. per week. This brought additional expense to Lyell and the cost of shipping, coal and coke increased still further, so these increases in costs offset the benefit of the improved price of copper. Lyell's interest in other companies was very substantial and the return from these investments aided the Company over these lean years.

During 1923 the Company entered into contract to supply pyrites for the manufacture of sulphuric acid for super-phosphate production at Yarraville (Vic.) The pyrites could be recovered as a by-product for a very low additional expense. It was found that they could not compete against pure sulphur from Europe for the manufacture of a pure acid, but for a crude acid as used in phosphate manures, pyrites was ideal, and themining of this was a profitable venture for the Company when copper returns were unsatisfactory. During the same period, a further rise in wages from 69/3d. to

75/6. and the persistent rise in the cost of coal, coke and freight further deprived the Company of any reduction in costs.

In 1925, the Commonwealth Arbitration Court again raised the award and the basic wage was increased to 79/- an increase of 3/6 per week. The Company, finding that wages, which are an important item of mining costs, were not likely to be reduced, then gave serious attention to better and cheaper treatment methods and especially to recoveries of metal from ore treated.

A small percentage of blister copper had been absorbed by the local market in Australasia, but by 1926 the Commonwealth was able to absorb half of Mt. Lyell's copper production which had increased during the years mentioned by nearly 1,000 tons and was at that time 6,922 tons per annum. This meant decreased marketing costs and helped to shape confidence in the industry's future.

The Lyell Company had since 1899 manufactured its own coke at a plant at Port Kembla (N.S.W.) which was capable of producing 25,000 tons annually. This plant had been able to supply all coke requirements to the smelters at Lyell at a figure which was materially below the market price until 1926, after which coke requirements through improved smelting methods were so reduced that it was found unprofitable to continue with this Port Kembla plant. It was dismantled and Lyell then purchased their coke from the open market, which could now supply their needs cheaper than they could produce it themselves.

The year 1927 showed a decline in output of blister copper. This was due partly to a strike of the engineers and partly to alterations effected to the milling plant. The average assay had declined to 5.85% As a result of altered treatment, pyrites

was no longer required for smelting and this meant a saving in mining and treatment costs. No longer was it necessary to mine ore at less than 1% assay. The cost of producing a ton of copper increased with lower output due to the strike and the lower grade of ore being treated. The tonnage of copper sold locally in this year equalled the output of copper produced. The price of copper had declined to £58/5/8 London, and as there was a real danger of cessation of all copper production at Lyell, the Directors approached the Commonwealth Government for a bounty to survive the crisis.

1928 saw better times for the industry. The price of copper rose substantially (by £13 per ton London). The Company was successful in increasing its recovery from 92.5 to 93% which on the tonnage of ore then treated, 123,444 tons, materially increased the return of copper, and the output in that year reached 7,000 tons. The directors were able to report at the Company's annual meeting of shareholders a material reduction in costs through a better and more economical smelting process, and a larger output of ore milled.

The copper from the furnaces had up to thistime been sent to Port Kembla to be purified by electrolytic methods and also to effect a recovery ofthe gold and silver in the ore. With cheap power now obtainable from their own Hydro plant at Lake Margaret, the Company decided to erect its own electrolytic refinery at Queenstown, and 1928 this was successfully done. This plant has since justified its establishment. Some & £70,000 worth of capital was used in this venture.

In the same year, a huge tunnel was constructed to effect economies and to increase the tonnage handled of the ores from North Lyell and neighbouring mines. The cost of this tunnel was approximately £60,000, but this large initial expenditure made possible a substantial reduction in transport and handling charges between the mines and reduction works.

In 1929, the Company entered into agreement with the Tasmanian Government to supply 3,000 horse power of electricity to the Electrolytic Zinc Company's reduction plant at Rosebery, and in order to comply with the obligations of this covenant, an additional power station was erected in 1931 at Lake Margaret, and the capacity of the plant there increased from 8,000 horse power to 10,000 continuous, with a peak load of 12,500 h.p.

The local consumption of copper had declined in 1930 and this necessitated exportation of a large surplus tonnage. Although the average price of copper for the year was lower than the previous year by more than £21 per ton, a very serious decline, the industry was helped by the exchange premium. For the previous thirty years the average price of copper had been £79/4/9 and now the London quote was £54/3/7 sterling.

The subscribed capital of the Company was increased in this year from £1,289,195 to £1,550,000 by the issue of 260,805 £1 shares. All shares were taken up, and Lyell embarked on a plan of increased production, to meet the crisis. The same year showed a reduction in mining costs due to improved mining facilities with the purchase of more modern equipment and metal recovery was higher for the same period. The blister copper output had reached the highest in the history of the Company, and was nearly 10,000 tons

for the 12 months. Once more, the directors decided that the plant must be further extended to reduce costs in order to meet a diminishing price. They placed 13,000 tons as their aim and made immediate arrangements to increase the capacity of extraction, reduction smelting and refining by increased mechanization.

The year 1931 saw an increase in tonnage treated (as shown by Graph, Page 30A.) and the output of blister copper exceeded the 10,000 ton mark by more than 1,000 tons. This programme had reduced the costs of production, but a further fall to £38/3/9 sterling in the price of copper had brought an urgency to produce more cheaply than ever. This was a hard question in the face of decreasing ore assays.

Again Lyell launched out, and increased its plant to treat 1,000 more tons per day than it had done in its best year. In the September of this year copper prices deteriorated still further and were as low as £32/1/- (Australian currency). After Great Britain left the gold standard in 1931, the return from exports improved, but as the world's unsold stocks were very high, there was little prospect of an improved price. Lyell faced another crisis.

In December, 1930, the Commonwealth Arbitration Court's decision to reduce all wages by 10% was applied to the Company's employees on May 7, 1931. This decision was most effectual in helping the Company to meet fixed costs in the face of a falling price for copper.

The average price for copper in 1932 was £38/3/1 and it fell as low as £20/7/- in July, but because of the advantageous exchange rate and increased tonnage handled, the Company was able to carry forward despite the low price. The tonnage treated in this same year was the biggest handled in the history of

Lyell. The directors prepared for even a larger scale of operations and felt sure that the price of copper must rise, as it was known that nowhere in the world could they produce copper at £20/7/- per ton.

During the following year 56,069 more tons of ore than the previous twelve months were treated and extensive preparations were made to work the Royal Tharsis mine on a very large scale. Minute attention was given to every phase of the mining, reduction, smelting and refining. It was found possible to recover the pyrite with a 50% sulphur content from the ore treated for copper. Arrangements were made with Commonwealth Fertilizers and Chemicals Ltd. (a company in which Lyell is a large shareholder) to purchase this by-product for the manufacture of sulphuric acid. It had previously been demonstrated that pyrite was admirably suited to the manufacture of a crude acid, and could compete favourably with pure sulphur from overseas for this purpose. Some years before, it had paid Lyell to mine pyrite from the Blow for this purpose alone, but now it could be recovered from the ores being treated for copper, and this proved to be a valuable by-product. In the same period, there were signs of an increased local demand for copper, and Lyell prepared for a greater output than ever before.

1934 was a hard year, a year of battling with costs. There was a serious shortage of water, with consequent reduced output and increased cost of production. Assays, too, showed a decline. The return of blister copper was 3,000 tons behind that of the previous year, for nearly the same amount of ore treated.

A further fall in the price of copper caused anxiety to the industry. Copper was the lowest price for 150 years. In Rhodesia it was then being produced and delivered to London at less than £21 per ton. Lyell's

cost of production per ton for that year was £53.

Despite this unfavourable figure as against Rhodesian copper, Lyell had reduced costs from 27.6 shillings in 1929 to 16.7 shillings per ton of crude ore handled. The net profit from all sources was only £6,374, the lowest in the history of the Company after allowing £32,480 for prospecting, development and depreciation, and £1,489 for taxation, compared with 1929 which showed a net profit of £324,128 after allowing £111,734 for prospecting, development and depreciation, and £34,120 for taxation.

For the same period, dividends received from investments in other industries were £54,834, which meant that operations at Lyell had been carried on at a loss of £48,460, or by making no provision for depreciation, prospecting or development, £15,980. The directors stated at the meeting of shareholders held in Melbourne in December of 1934 - "If it is likely to cost £53 to produce copper, there is no justification to carry on, but it is expected we can reduce the costs to the 1933 figure of £46/3/4. No dividend was declared, which was the first withheld since 1921. During that unfavourable year of operations and faced with an exhaustion of profitable ore, geophysical prospecting was given attention to, in the hope of finding further deposits. Some £25,806 was spent on prospecting and development, with the result that the siliceious ores of West Lyell, which assayed only 2½% copper and ½ dwt of gold and 2 dwts. of silver were prospected and developed. These ores showed reserves of some 5,347,000 tons of ore at 2.41% assay of copper. West Lyell was discovered over forty years previously, but regarded as uneconomic because the floatation method was then unknown , and it was then thought commercially impossible to treat ores of such a low grade. The chief factor in favour of the exploitation of this low-grade

ore was cheap mining by open-cut methods, allowing increased mechanization, and the extensive ore body awaiting exploitation. Ore reserves had now increased from 1,013,000 in 1929 to 5,347,000 tons. A new era for Lyell commenced.

Again the directors decided to embark on a project demanding larger scale operations. It was carefully calculated that by a reversion to open cutting with modern electric shovels, and other capitalistic methods of extraction and handling, this ore could be worked profitably and costs could be substantially reduced.

Despite the cloud which then hung over the industry and a big loss sustained from the past year's operations, Lyell allowed to lapse the contract (which expired in March, 1935) to supply to the Government 3,000 horse power of electricity. For ten years, the Company had supplied power to the Read-Rosebery field, but now this power was required to meet the extended programme of industrial development. The Government power scheme at Tarraleah was now in operation, and from this source the Read-Rosebery field could be supplied. Not satisfied to see 3,000 horse power in reserve for their policy of extension, Lyell arranged with the Government to bring the Rosebery power line close to the sub-station at Queenstown so as to secure extra power if needed.

The sale of pyrite recovered from floatation of copper continued. About 9,000 tons were being supplied annually, and were giving satisfactory results.

The following year saw larger scale operations as planned put into effect. The output of copper jumped from 7,000 tons to 13,000. Over half a million tons of ore were treated, assaying 2.37%. Production of copper had increased by nearly 100% and as the greater part of the ore for that year was obtained from West Lyell by

open-cutting, the cost of mining was reduced. The average price for copper had declined, and had it not been that Lyell had operated on the scale it did, a loss would have been sustained. As it was, the Company carried on at a loss over the greater part of the year, but on the whole year's operations, a small profit was earned.

The special basic wage rate was fixed by the Commonwealth Arbitration Court on the 22nd April, 1934 on the evidence of the unprofitable nature of copper production during that period, and this remained in force during 1935. The Company agreed to restore to £3/2/6 when the price of copper reached £40 sterling. At the same time, the Company expressed the hope of being able to restore to £3/6/0 when copper reached the figure quoted.

The average price of copper reached the £40 sterling mark during 1936, and the Company restored the rates of pay to the normal basic wage to all employees and gave increased margins to artisans and a special margin to underground workers as awarded by the Commonwealth Arbitration Court.

The year 1936 was characterised by intensive working of the low-grade ores by open cut methods. Over 60% of all ore mined came from the West Lyell open cuts, and mining cost revealed a pronounced reduction. In 1934 it cost £30/8/0 per ton of copper produced for mining and in 1935 £26/3/0, and in the year under review only £23/2/0, which was a reduction of over 23% since 1934. During the whole year, an average of 1,500 tons was treated daily from West Lyell, thus reaching a new record for treatment tonnage. Operations in the underground workings at the Royal Tharsis and the Crown Lyell mines were suspended, and efforts were made to prepare for ever greater tonnage to be treated from the low-grade West Lyell ore body. From the profits of that year an

increased sum was set aside for prospecting and development to develop the open-cut mines.

The output and sale of pyrites increased by more than 15% on the previous year. Lyell's cost sheets now revealed a profit of £8.2 Australian currency per ton of copper produced, as against a loss for the three previous years, 1933, 1934 and 1935 of £0.2, £7.4 and £1.4 per ton respectively. During the depressed years the Company was able to show a small profit by reason of its investments in other companies, and but for those outside investments, they would no doubt have suspended operations.

In all except 1934 years (See Table Page 46) Lyell had shown a surplus on primary operating costs. So long as these were being met, it was better for Lyell to proceed than face the initial expense of starting at a latter period. In 1934 the average primary operating cost to produce copper was £A48.5 and the price of copper averaged only £A45.5. The Directors felt that copper prices must improve and by their policy of larger scale production, they thought the industry would again prove economic. World stocks of copper had begun to subside. In 1935 they were 520,000 tons, and by October 1936 they were only 320,000 tons. There was also increased evidence that consumption was outstripping current production. The race for armaments was reckoned to be largely responsible for this increased demand. Lyell prepared to meet the issue. 1937 was the best year on record. The average daily tonnage treated had increased to 2,300 tons. Production of copper stood near the figure anticipated a decade earlier, 13,000 tons, although assay returns had deteriorated to 1.75%. Prior to floatation, this would have been thought impossible. Recoveries were 90%, a fall of nearly 5%, which on the tonnage of 850,000 tons

treated meant a loss of over 700 tons of copper per annum. The price of copper had risen appreciably to the new high average of £A75.5 in London. Operating costs had increased by the introduction of shorter hours and higher rates of wages. The increased treatment of still greater tonnages of low-grade ore increased treatment costs for that year. All costs had risen by more than £5 per ton of copper, but with the new market price Lyell could show a profit of £28 per ton. On an output of 13,000 tons, this gave the Company a record return. After allowing £27,869 for prospecting and development, over £48,600 for depreciation and approximately £74,600 for taxation, the net return from all sources was £343,850. £71,600 of which came from investments elsewhere. Lyell's copper operations showed a net profit of nearly £350,000, excluding taxation, which is a charge against income, and not a cost against production. Because of the increased price of copper, the Company agreed with the Union representatives, whose members are employees of the Company to add to the basic wage 3/- per week to each employee while the London price of electrolytic copper stood at £56 sterling or higher.

The year 1938 revealed still greater expansion in mining and milling of ore. By this year, North Lyell was nearly exhausted. For over 35 years it had produced continuously the highest grade ores ever extracted from the field, much of which assayed over 12% copper. This field had produced to date 4,204,526 tons of ore, which gave 9,000 tons of copper, plus 155,835 tons extracted by the original owners. Open-cut operations at West Lyell became more important, yielding 75% of total ore mined, and underground extraction declined. The average treatment of ore per day reached the record figure of 2,300 tons. Assay returns were now only 1.48%,

but copper production stood constant at nearly 13,000 tons.

There was a substantial increase in operating costs, which increased from £47.7 in 1937 to £53.7 and total costs from £47.5 to £52.1 while the price of copper had dropped from the high figure of £75.5 to £56. The profit per ton of copper was reduced from £28 to £3.9. The price for that year fluctuated widely. The London Metal Exchange opened with copper at £55 sterling and during the year it dropped to £37.5 sterling, but by September was back to £48 sterling.

In 1938 Lyell had to treat 79 tons of ore for 1 ton of copper as against 66 tons in 1937 and 53 and 46 tons in 1936 and 1935 respectively. This meant an increase of 72% in ore tonnage treated for the same return as in 1935. In this year, the world's capacity to produce copper was stated to be very large, and copper prices appeared to be very sensitive to world stocks. In the beginning of 1937 world stocks were 495,000 tons and copper was at £37.5 sterling, while in September 1938 stocks had decreased to 480,000 tons, and the price moved to £48 sterling.

The last three years of the Company's operations have shown a sharp increase in tonnage treated, until at the present time, Lyell is milling 5,000 tons of ore per day. The total tonnage of crude ore for 1941 was more than a million and a quarter. Open-cutting at West Lyell continues on a bigger scale, while the ore assay has fallen below 1%. Mining costs are increasing as overburden at West Lyell increases and this means that for every ton of ore extracted at less than 1% for treatment one ton has to be removed as worthless, so that although the plant has now reached a treatment capacity of 360,000 tons per quarter, the mining section has to break 720,000 tons.

Costs. Mining costs decreased in 1939 with increased tonnage from the open cut mines, but total costs of production had increased by £1 per ton. After 1939, mining costs began to increase because of increases in wages and prices of materials, reduced assay values of ore treated and consequent lower metal recoveries. But milling costs have remained fairly constant. There was a slight rise in 1941 occasioned by shortage of labour and this necessitated overtime rates to the limited labour available. Realization costs have increased with increased shipping and insurance prices. All costs entering into production have shown a steady but not a sharp rise. Lyell's copper production has been closely held to the 13,000 ton output, but during 1941 this tonnage declined somewhat owing to the lower grades of ore treated.

Supply Difficulties

During 1940, in order to maintain output, large orders were placed by the Company for mining supplies and equipment. In their 1941 Annual Report the Directors stated that "owing to war conditions, serious delay has been experienced in obtaining delivery of the mining and treatment plant on order at the close of the previous year, so that the anticipated benefit to copper production from this source was not realised. Most of this plant had been received by the close of the year 1941, and the advantage of it will be felt during the current year."

The same year brought shipping delays because of New South Wales coal strikes and the wreck of a vessel engaged in the Company's business. It appears that these difficulties have continued to the present. The Company has large stocks of pyrites awaiting shipment to Yarraville the annual output of which has increased by some several thousand tons. There have also been delays in coke

deliveries to the smelters.

Wartime Price Control.

As from the 31st August, 1939, the London Metal Exchange was closed by order of the British Government and subsequently the British Minister of Supply announced maximum prices of non-ferrous metals, that of electrolytic copper being £51 sterling. The sterling price for electrolytic copper, of £62 per ton delivered buyer's premises, as fixed by the British Minister of Supply, remained unchanged throughout the year 1940. On the 19th December, the Commonwealth Prices Commission fixed the price of copper as that ruling on December 15th, which was £A63/17/6, and on February 16, 1940, the Commission again fixed the price at £76. During his investigation, the Commissioner conferred with the officers of the Company, and Mr. Lyell gave an assurance that it would utilize the difference between £72 and the fixed price for further prospecting, development and extension of its copper industry.

In Australia, the price of £76 per ton as fixed by the Commonwealth Prices Commission continued in force until 5th February, when from that time until 6th May the price to consumers was £2/10/- higher, but this alteration did not affect the price received by the Company for its product. After a further investigation of the copper position in Australia, the Commission fixed the price at £86/10/- per ton operative on 6th May, 1941. Of this price, the Commission provided that 30/- per ton would be placed to the credit of a pool under the supervision of the Prices Branch, out of which a bonus of £5 per ton would be paid on increased output by established companies, for whom base tonnages were fixed, and on all copper from other Australian sources. The price of £86/10/- was still operative at the end of the year. During 1942 it has been further increased, and

is now £105 non-selling, as the Government requires all copper. Lyell's base tonnage cannot be disclosed, but it is reasonable to suppose that it is around 12,000 tons. The Company has not yet reaped the benefit of the bonus.

Marketing Contracts

In 1939, with the approval of the Commonwealth Government, the Company entered into agreement with the British Government to sell to them all the exportable surplus of copper up to a maximum of 7,000 tons per annum at £48/10/- sterling f.o.b. Sydney. But so far no copper has been available for delivery under the above agreement. All production has been absorbed in the Commonwealth.

Industrial On March 31st, 1940 at a conference between the management and the representatives of the Unions, a new agreement was made and the old one expired. The main variation was the "price of copper allowance", which was put on a sliding scale of 1/- per week for each employee for every £2 a ton rise or fall in the price of copper instead of a fixed rise as previously agreed.

The following year, increases in the basic wage for Queenstown by adjustments in accordance with variations in the cost of living index figures amounted to 5/-. Under the terms of the Company's agreement with the Unions, the wage of all employees was further raised by 4/- per week on the 5th June in conformity with the increas in the price of copper. These alterations brought the basic rate to £4/13/- per week compared with £4/4/- at the close of the previous year.

Innovations. If the local innovation of filling the stopes with tailings from the reduction plant had not been adopted, the cost of mullocking by the former method with quarried material would have pushed the underground workings at North Lyell into the extra-marginal category.

MT LYELL PRODUCTION OF BLISTER COPPER AGAINST CRUDE ORE TREATED.

ar	Tons of Crude Ore Treated		Relative 1933 Base	Relative 1933 Base	Blister Copper Output in Tons	
22	89,443		22	57	6,066	
23	103,439		25	52	5,478	
24	125,613	M	31	67	7,097	
25	112,503		27	62	6,542	
26	115,695		28	66	6,925	
27	104,772	M	25	53	5,684	
28	123,444		30	68	7,126	
29	168,334		41	73	7,868	
30	236,134		58	94	9,898	
31	283,262		70	99	10,115	
32	348,903		86	105	11,059	
33	403,160		100	100	10,531	
34	378,908		94	69	7,217	
35	564,241		115	124	13,078	
36	665,400		165	124	13,040	X
37	841,427		208	122	12,883	
38	1,032,128		256	121	12,766	
39	1,085,933		267	127	13,392	
40	1,250,000	X	313	114	12,000	X
41	1,290,199		320	104	11,000	X
42	1,500,000	X	374	119	12,500	X

M - Ore Mined, which is not necessarily the same but generally fairly close to that treated

X - Estimated Tonnage

e compiled from data and information supplied by courtesy of the Mt. Lyell Mining and Railway Company

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Some Additional Facts

proximate Total ore tonnage treated to 1941 by Mt. Lyell 16,971,098 tons

proximate total tonnage Blister copper to 1941 by Mt. Lyell 365,441 tons

tal of silver in Blister Copper to 1939 15,131,432 ozs.

tal of gold in Blister Copper to 1939 450,938 ozs.

tal Dividends of Old Company £996,574

tal Dividends of New Company (Mt.Lyell Railway Co. Ltd.) to 1939 £4,952,495

CHAPTER III

COST ECONOMICS IN COPPER (MT. LYELL)

Extraction or Mining Costs.

Year	Table A: Cost to break the crude ore per ton in shillings		Table B: Costs allocated to mining to produce a ton of copper in £A	
	Actual	Relative	Actual	Relative
1916	16.0			
1921	19.8			
1933	7.7	100	100	£24.8
1934	11.6	150	123	30.5
1935	12.4	161	106	26.3
1936	8.82	114	94	23.2
1937	7.81	101	105	25.9
1938	7.47	97	119	29.5
1939	6.85	89	116	28.8
1940)	Not available but increasing			Increasing due to diminishing returns per unit tonnage of ore.
1941)				
1942)				

(Compiled from information supplied by the Mt. Lyell Co.)

The first and largest cost factor is that of mining, sometimes referred to as extraction. This cost is dependent upon the nature of the mineral lode. The two principal methods employed in extraction of copper-bearing ores are open cutting and underground mining. The nature of the lode to be mined determines the most economical method.

Open cut methods are cheaper for the reason that no timber is required, and also it lends itself to a more mechanized scale of operations, with many ensuing economies.

Three phases have marked the progress of mining at Mt. Lyell. In the early years of the mine up to 1909, the huge body of the Mt. Lyell mine, 650 feet long by 250 feet wide was well suited to open-cut mining, and 4,000,000 tons of pyritic ore and

4,500,000 tons of overburden were removed to a depth of 450 feet. Increasing depth in the parent mine and the acquisition of adjacent properties, notably the rich North Lyell Mine (containing large bodies of silicious ore which made an excellent smelting combination with the heavy pyritic ore) naturally led to a change of method, and from the time when the economic limit to open-cutting was reached on the large pyritic lode, underground mining methods of ore extraction were practised to an increasing extent and finally almost exclusively followed for many years.

The last decade has seen a reversion to open-cut mining, operations being directed to the low grade silicious ores instead of the massive pyrites as in the first phase. Costs have varied during these various phases. A detailed statement of costs during all these stages is not available. But from tonnage of ore treated, blister copper output and cost of producing a ton of ore in 1921, one is able to calculate fairly accurately the cost of extracting a ton of crude ore. This was approximately 19/- and in comparison with recent years was very high (c.f. with 1939, 6.85/-, when open cuts were being operated). Prior to 1909 when open cutting was employed to break the ore, costs were probably less that 19/-, but mechanisation had not gone nearly so far as it had at this stage.

A statement of mining costs for the late twenties is not available, but from the table A on Page 26, showing breaking costs, it is interesting to note that they had been substantially reduced by 1933. The year 1934 reveals a sharp increase. This was probably due to the final stages of working in the underground mines, together with the fact that this was the dry year for Lyell, when production fell very seriously. By 1936, 50% of the ore was coming from

West Lyell, and mining costs were reduced in that year by 3.58/- per ton of ore broken, which meant a total saving of approximately £69,106 to the industry. By 1939, when 90% was coming from the open cuts, mining costs showed a further decline of 1.97/- per ton, which on the new high level treated would mean a total saving of approximately £108,500. It is not hard to see economies to be gained by open cutting, and why Lyell reverted to this method of mining as soon as the nature of the country was suitable. The cost allocated to mining to produce a ton of copper has risen since 1939, because of the increase in cost of labour and equipment, and also because of the increased tonnage of over-burden to be removed, but the chief increase in costs is occasioned by the diminishing return of copper per unit tonnage treated.

Lyell's present phase of mining by open-cutting has shown the importance of capitalistic methods (mechanisation). It is not necessary to go into details, but this third phase of working is characterised by a tremendous increase in equipment and plant. A greater application of capital to this part of copper production has given astonishing results. Lyell is breaking about five times as much ore with the same number of men. The economies in cost are shown on Table A, Page 26.

Electric shovels to fill trucks carrying 16 to 20 tons of ore, bulldozer caterpillar tractors to clean up scattered rock on the floor of the workings, specially staffed machine and repair shops on the field to deal with all breakages and to prevent unnecessary duplication of plant and delay to a large fleet of petrol and diesel driven trucks for ore transport and removal of overburden, and electric locos for transport of the ore to the mill, are among the modern innovations made at Lyell.

Any factor affecting wages, mining equipment,

fuel and power means a corresponding influence upon mining costs. Wages are still the most important of all. Mining plant installations and equipment are now so highly capitalized that price increases here are also influential. Fuel such as petrol and crude oil for the trucks and coal for the steam locos have a considerable bearing, and finally electric power, which is increasingly employed, are all-important factors. The above are the principal items entering into mining costs in the industry.

It is because of increases in all of these, including power, portion of which has now to be drawn from the State Hydro-Electric Commission's scheme, that mining costs in Tasmania's copper industry are rising, and because mining accounts for approximately 50% of all costs in producing copper, increases must be carefully watched. With assay returns falling, and overburden increasing, mining costs are of vital concern. Today they are rising, and must be expected to increase further. But for the fact that the Federal Government has set the price of copper at such a remunerative figure of £100 per ton, and requires from Lyell the greatest physical output possible, irrespective of cost increases, Lyell's mining costs at this time might have brought grave concern to the Company.

When we speak of mining costs here, we are referring to the cost to produce a ton of copper, and not the cost to break a ton of crude ore. As the ore becomes poorer, it is necessary to reduce breaking costs proportionally if the industry is to retain a fixed mining cost per ton of electrolytic copper produced. During this war, the item must increase, assuming that technical methods of mining remain the same, and it is expected that they will. Any great change in technical methods is extremely unlikely during the war at any rate.

Looking at Table B, Page 26, extraction costs

to produce a ton of copper have shown an increase; but from Table A on the same page, we see a reduction in breaking costs. The two are reconciled by the fact that assays and recoveries have been declining. That is to say whereas in 1936 1,000 tons of crude ore yielded 18.32 tons of electrolytic copper, in 1939 the same tonnage gave only 10.125 tons.

This ability to reduce breaking costs as returns of copper are diminishing, is the major problem in the mining section of the industry. Lyell's pre-war period showed that ability, and thus the Company was able to survive. Its war period is not likely to show such a virtue, but for the present at least, such is not imperative to survival.

The industry's post-war problems are likely to be acute in this direction, as Lyell's reserves of ore are believed to continue to be growing poorer. It does not seem likely that mechanization will go very much further in the extraction of ore, and thus reduced costs in this direction do not appear probable.

Total Extraction Costs are made up as follows:-

Cost of Extraction

Wages and Superintendance		
Stores		
	General	
	Explosives	
	Timber and Cement	
Repairs		
	Wages	
	Stores	
Renewals and Depreciation		
Fuel		
	Petrol	
	Crude Oil	
	Lubricants	
Power		
	Electric	
	Total	Operating Costs

Indirect Costs

Compensation Act 1920-1934		
General Charges		
	Total	Indirect Costs
	GRAND TOTAL	EXTRACTION COST.

Year.

'000 are omitted.

1930 '31 '32 '33 '34 '35 '36 '37 '38 '39 '40 '41 1942

Tons '000

1,360 Treatment Tonnage

1200

1040

880

720

560

400

240

Ore Tonnage Treated Annually. Read from the Left in '000 Tons.

Red graph shows Tonnage of Copper annually produced - Read from the Right.

Scale showing cathode Copper in Tons

14,000

13,000

12,000

11,000

10,000

9,000

8,000

7,000

Graphs relating to Mt Lyell Mining & Ry Co Ltd - Compiled from information supplied by courtesy of the Company.

Copper Recovery in tons.

Copper Assay of Ore per cent.

4·5

3·5

2·5

1·5

·5

% Assay of Copper in Ore Treated.

Percentage Recovery of Copper.

100%

92·5

85

% Recovery of Copper.

Year.

1930 '31 '32 '33 '34 '35 '36 '37 '38 '39 '40 '41 1942

CHAPTER IV

TREATMENT.

CONCENTRATION OR REDUCTION.

	Milling Costs per ton of Crude Ore Treated			Milling Cost per ton of Copper	
Year	Shillings per ton	Index Relative	Tonnage Tr. Rel. Index	Rel. Index	Cost in £A
1929	7.52	224	41		
1930	6.48	193	58		
1931	5.21	155	70		
1932	3.76	112	86		
1933	3.36	100	100	100	7.038
1934	3.16	94	94	114	8.053
1935	2.54	76	115	91	6.459
1936	2.63	78	165	101	7.143
1937	2.18	65	208	111	7.843
1938	2.15	64	256	128	9.025
1939	2.19	65	267	137	9.571
1940	2.047	61	313 *	Figures not available	
1941	2.17	64	320		
1942			374 *		

* Estimated

Compiled from figures (Supplied by courtesy of Mt. Lyell Co.)

Treatment.

The second phase in copper production is that of treatment of the ore mined. The treatment plant is centralised in the closest convenient proximity to the place of mining. The capitalization required is extensive, involving a capital outlay of approximately £500,000 in the industry here analysed.

The plant at Mt. Lyell as in any copper

industry falls into three principal divisions :-

1. Concentration, or reduction
2. Smelting
3. Refining

After passing through these three, it is then electrolytic copper, which is bought and sold on all metal exchanges. There is, however, a fourth stage, that of melting into various marketable forms such as wire, copper bars, ingots and sheet copper. The first three are generally located at or near the mines, but the fourth is more often closer to the market where the various forms of copper are in demand. Port Kembla (N.S.W.) adds this fourth utility to Australian mined copper, but for Lyell, treatment problems are centred around the first three mentioned. The economic importance of treatment is obvious when it is realised that 40% of operating costs are attributed to this phase of all production. We will now review each phase of treatment separately, as they are singularly distinct.

1. Concentration :- known as the milling, or reduction concentrates the crude ore, assaying approximately 1% (that is passed out from the mines and conveyed to the mill to a 25% concentrate which is then fed to the smelters.

No part of the industry is more responsive to increasing returns or decreasing costs through increased output than is this section. From the Table on Page 31, this is most readily evident. Milling is responsible for the greater part of the approximate 40% of operating costs attributed to treatment, followed by smelting. The three phases of treatment, concentration, smelting and refining are in the approximate ratio of 9 : 7 : 2 respectively, but as costs are constantly changing, there is nothing in the nature of law or permanancy in thisrelationship.

In 1929, milling costs per ton of ore treated were 7.52/- and by 1941 were only 2.17/-. The tonnage treated in 1941 was seven times as great as in 1929, and costs were reduced to less than one third the 1929 figure. It was this phase of milling that helped Lyell so admirably to reduce the production cost of copper at a time when it was a hard battle to survive the setbacks from a falling market as reviewed earlier. The chief economic factors entering into milling costs in approximate order of importance are as follows:-

Firstly, there is the cost of operating materials, such as re-agents to float the copper, steel balls for ball mills, together with numerous replacements and renewals.

Secondly, the power factor takes prominent place. Hydro electric power used is cheaply supplied, but without this, power costs might prove too high for economic reduction in Tasmania.

Thirdly, there is labour, a portion of which is highly technical, and consequently highly paid, also a good deal of experimentation and research by the metallurgical staff is a constant cost.

Finally, there is capital for plant installation and accessories. The cost is heavy in the initial stages, but the former three weigh more heavily in operating or working costs. Of course, with capital outlay there is depreciation, which is always a considerable charge against working costs in a reduction milling plant. Obsolescence is a big factor, especially where technical change is rapid, as in metallurgical processes.

At the present, milling costs are more substantially dependent upon the first two. Any big increase in the cost of these might throw the industry into the extra-marginal cost position. Milling costs are also sensitive to wages, which in the last two years have

shown a persistent rise, owing to the necessity to pay overtime rates due to a shortage of manpower.

Capital charges are also important, because this section of the plant is receiving constant technical improvements and other innovations to effect higher recoveries, and although these charges generally reduce total milling costs, the tendency is for this item's relative importance to increase. Although mechanisation has here gone the furthest of any section of the industry, the tendency is to increase the fixed capital in proportion to labour.

But for cheap power, milling costs would be greatly exceeding present figures. Cheap power is the most important factor of all affecting the low milling cost for Lyell.

It is thus seen that the principal economic factors required in this section of the industry are cheap power, a large capital and technical and skilled labour. Lyell has always attracted the best technical labour, and has also been careful to train sufficient to meet the growing needs of the industry. There is no shortage of technical staff in the industry at this stage. As regards capital, the Company has sufficient to meet any improvements, other changes or additional plant necessary to effect the most economical concentration. Finally, the industry is able to produce the cheapest power in the Commonwealth for an undertaking of its size. These are the favourable factors. The only big factor that is unfavourable to milling is that of size of plant, or the scale of operating, Considering the low grade of ore required to be treated. Lyell is treating 5,000 tons of ore daily, but in comparison with Rhodesian mills, which treat 50,000 tons, and USA, 75,000 tons daily, Lyell is unable to recover the fullest economy to be gained from decreasing costs as it applies

so particularly to this section of the industry, and is so urgently required of a low-grade proposition.

The major problem faced in the milling section has been that of treating an ever-expanding tonnage for a lower cost per ton of copper. This has been a tall order in the face of a rapidly falling assay. In 1930, the mill treated approximately 1,000 tons of ore for a recovery of 40 tons of copper. In the late thirties, it had to treat more than twice that tonnage to get the same return of copper without increasing total milling costs. Today, the milling plant has to treat approximately 4,500 tons for the former return from 1,000 tons, but as the price of copper is now much above the level of the thirties, the business of reducing or stabilizing total milling costs is not so urgent.

Milling costs are now rising slightly as seen by the Table on Page 31 and are bound to do so with increased prices for re-agents used in floatation, replacements and renewals, and all operating materials, together with more overtime rates to labour because of the necessity to maintain and if possible increase output.

Lyell's pressing cost problems for the time lie partly dormant, and will probably not assert themselves, but then with renewed vigor, until after the war. Today, her milling problems, apart from the shortage of labour, are mainly technical. The desirability of effecting a greater recovery from the poorer ore now milled is one of these, although for the class of ore milled, their recovery is equal to the best in the world.

SMELTING AND CONVERTING - COST PER TON OF COPPER PRODUCED.

Year	Cost in £A	Relative
1933	6.111	100
1934	6.981	114
1935	4.893	80
1936	5.328	87
1937	6.263	102
1938	6.965	114
1939	7.506	124
1940) 1941) 1942)	Increasing with higher price of coke and increases in wages.	

(Information supplied by courtesy of Mt. Lyell)

Smelting and Converting.

The cost of smelting and converting in 1939 was £7.506 per ton of copper, approximately 14% of total production cost.

The chief economic factor in the smelting is that of fuel - coke being that used, and re-agents such as limestone. As it requires approximately two thirds of a ton of coke to smelt a ton of copper, coke forms a large item of cost. Other factors of importance are wages and replacement costs to the furnaces and general depreciation. The furnaces have to be relined every three hundred days.

Converting is a process to reduce the copper matte containing 40 to 45% of copper to blister copper of 99.2%. The chief costs here are those of electric power and replacement of converters, which demand new lining about every 300 blows.

Wages also materially figure in all costs connected with this phase of copper production, but not in the proportion of fuel and power.

Lyell has considerably reduced her consumption of coke by the furnaces with improved technical methods. Today, one small furnace can smelt more copper than was formerly attempted by eight large furnaces. Coke was once such an item of cost that it paid Lyell to have their own coke works at Port Kembla, but these have now been dismantled.

Smelting and converting costs per ton of blister copper have risen steadily since 1936 from 109.20/- to 148.22/- in 1939, and have increased still further to the present year (1943). The reason for this has been the increase in the price of coke, freighting of, and insurance on same, together with a rise in the basic wage and the increased cost of materials entering into replacements on the furnace and converters.

The position of a smelters is a matter of importance. At Lyell it is erected close to the concentrating plant. It is a common saying in mining circles that "all ores make for the smelters." Smelting generally takes place as close to the place of mining as is economic. A typical furnace charge consists of :-

Copper Concentrate	3,300	dry lbs.
Fluedust	1,000	" "
Silica	400	" "
Converter slag	1,000	" "
Limestone	200	" "
Coke	575	" "

As the silica and limestone are quarried in close proximity to the smelters and the flue-dust and converter slag are returned from the plant, it is at once seen that it is cheaper to transport the coke to the smelters than to transport the copper concentrate to the coke, even if limestone and silica could be obtained as cheaply near the coke.

The economics of smelting at Lyell is also decided by the economies to be gained by electrolytic refining at their own plant, which is served by cheap electric power from Lake Margaret. Even if Lyell

could find cheaper smelting accommodation, taking into account the transport cost of the concentrate as against the coke, if costs at their own refinery are less than those elsewhere, then it is a question of retaining the smelting at the place of refining, unless smelting elsewhere was so cheap as to allow the extra cost of refining elsewhere, or re-freighting to their own refinery. Smelting accommodation, on the other hand, is very limited in Australia, Lyell providing the largest accommodation in the Commonwealth.

The smelting and converting has not the problems of reducing costs as in mining and concentrating, and figures show a degree of stability. The smelters are always fed with a concentrate of 25% copper, and so no more coke is being used to treat 1,000 tons of ore at 1% copper than 500 tons at 2%. The concentrating plant hands the same quantity over to the smelters in both cases.

The smelters' present problem is that of securing sufficient coke. The furnaces are faced with a shortage through delays on the coal fields in N.S.W., and through shipping difficulties. During the war period, it can be expected that Lyell's smelting costs will increase, despite price fixing which can only retard the acceleration in rising costs.

COST PER TON TO REFINE COPPER ELECTROLYTICALLY.

Year	Cost in £A	Relative
1933	1.702	100
1934	1.684	98
1935	1.439	84
1936	1.671	98
1937	1.735	101
1938	2.157	127
1939	2.099	122
1940	Figures not available.	
1941		
1942		

Compiled from information supplied by courtesy of the Mt. Lyell Co N.B. Increases in this index are mainly due to increase in power costs, part of which is now drawn from the Govt. Hydro-Electric Commission to satisfy the extra requirements of this department, together with increases in wages and operating materials.

Electrolytic Refining to Pure Electrolytic Copper.

The third stage of treatment is that of refining the blister copper from the convertors. Prior to 1929, blister copper was shipped to U.S.A., later to the Electrolytic Refining and Smelting Co. Ltd. at Port Kembla (N.S.W.) As the Mt. Lyell Company had power considerably in excess of requirements, the Company decided that the establishment of its own electrolytic refinery was warranted. Refining commenced in 1928, the capacity being 9,000 tons per annum, and in 1931 it was increased to 13,000 tons capacity, and finally in 1932 to a capacity of 14,000 tons. Capital expenditure involved was approximately £75,000

The chief economic factor in the electrolytic refining is that of cheap electric power. This,

the Company gets from its own plant. The transport factor is of no concern as blister copper is 99.2% pure and electrolytic copper 99.98%. It is just as cheap to ship one as the other.

During this process, a number of insoluble impurities are obtained, including the gold and silver present in blister copper. These are known as the slimes, and are 1.1% of the total blister copper produced.

Second to the power factor is wages, which figures considerably in this section of treatment, followed closely by operating materials, such as acids and other re-agents, together with replacements and renewals to plant. The upkeep and replacements to the refinery are a big cost factor, butthe deciding one as to the position of the plant is power. The power consumption per ton is 500-560 kilowatts per hour.

This section of the industry has not revealed the virtue of decreasing costs, but, on the contrary, costs here have been increasing with the increased capacity.

Two factors are mainly responsible for this. The first is that of increased power costs. Since the establishment of this plant at Lyell, and especially since the capacity has been increased from 9,000 tons to 14,000, the Company has had to draw on the State Hydro power scheme to provide additional power. The price of this outside power is considerably above Lyell's own power costs. The second factor is that the cost of operating materials is steadily rising due to war condition and together with wages has added further cost burdens.

It is therefore unfair to say that this section of the industry is not capable like the milling of contributing to the decrease in costs. When operating costs settle down to some stability, a study in this direction would prove more accurate and deductions

would consequently be more reliable.

The concluding fact is that Lyell's refining of their own copper is definitely an economy as compared with refining elsewhere, and cheap power is the factor which is wholly responsible for giving Lyell this advantage.

C H A P T E R V

ADMINISTRATION - REALIZATION.

Administration Cost.

Year	£A per unit ton of copper	Relative Index
1933	1.807	100
1934	2.536	195
1935	1.344	74
1936	1.537	85
1937	1.757	91
1938	1.731	90
1939	1.348	71
1940	Figures not available.	
1941		
1942		

Compiled from
(Information supplied by courtesy of the Mt. Lyell Co.)

Administration.

This cost has shown a steady decline with increased production, but a marked increase in 1934 is recorded, when production was seriously curtailed, and a steady decrease from 1937 to 1939 when production was greatly increased.

The cost of management is only a very small fraction of total cost, being for 1939, 2.4%. This cost therefore has no serious bearing upon the course of

production cost like mining does.

The cost of management is a fairly constant charge, and is not subject to any great variation. It would not appreciably rise or fall if production fluctuated by 50%. For the first 1,000 tons of copper it is very high, but for the next 1,000 tons it may not even increase. It does not materially influence marginal production, unless the industry is getting beyond the point where the administrative efficiency is at its optimum.

AVERAGE UNIT COST OF REALIZATION.

Realization Costs in Marketing of Copper in £A per ton of Copper produced.

Year	£A per ton Av. Unit Cost	Relative Index
1933	5.260	100
1934	4.795	91
1935	4.645	88
1936	4.505	85
1937	4.220	80
1938	4.338	82
1939	4.547	86
1940) 1941) 1942)	Figures not available.	

Compiled from
Information supplied by courtesy of the Mt. Lyell Co.

Realization.

By realization is meant that cost occasioned in marketing the cathode copper. It begins at the refinery, and finishes after all freight, shipping, wharfage, insurance and other expenses required to market the metal have been deducted, together with the cost of melting it into wire bar (the form in which it is in this case required by the purchaser.)

The middleman's function is made unnecessary by refined copper being a highly homogenous product, and because producers have command of large capital resources and credit facilities, the need of credit being supplied by a third party other than the banks is not required.

The bulk of the world's copper is produced by large concerns, many of which have their own selling organizations and direct business between producers and consumers, thus playing an important part in the market. This is particularly so in U.S.A., where the the price is fixed by the chief producers. Outside of U.S.A., the price and also a large part of the actual copper business is governed through the London Metal Exchange.

For copper the L.M.E. has developed a standard contract, which gives the seller the option of delivering various precisely determined classes of copper. Differences in quality from the "Standard" are allowed for by premiums or rebates. These standard contracts refer always to 25 tons of copper, the minimum quantity which can be bought or sold on the exchange. The contracts are met by the delivery of warrants issued by official warehouses on copper stored by them, and confirmed by the L.M.E. The members of the L.M.E. are frequently agents for both producing groups and consuming interests. Also, the provincial or foreign wholesale metal merchants (who supply the consumers of their own district) are usually in contact with members of the L.M.E. At the same time, the L.M.E. acts as the hedging market for practically all extra-U.S.A. producers, so that London can be regarded as the clearing house of the extra-U.S.A. copper trade. In 1937, the copper turnover of the Exchange reached the high total of over 711,000 long tons.

Copper is marketed in different shapes and forms. On the L.M.E., unrefined copper is deliverable in slabs or bars, fire refined copper, can be delivered in cakes, ingots and ingot bars, while electrolytically refined copper is deliverable in the form of cathodes, cakes, ingots, ingot bars and wire bars. These exterior forms of copper are mostly determined by the purpose for which the metal is used. Thus the cake is particularly suited for rolling copper plates, the wire bars for wire production, and the ingots for casting and production of alloys.

Prior to the immediate pre-war years, when the Commonwealth of Australia began to consume the whole of Mt. Lyell's copper output, the Company exported to Great Britain and sold its copper on the L.M.E. in electrolytically refined wire bar, or as cathode copper.

The demand for either wire bar or cathode determined what course was adopted. A premium was allowed on wire bar above cathode copper. If wire bar was required for export, the cathode copper had first to be shipped to Port Kembla (N.S.W.) and there melted into wire bar by Metal Manufacturers Ltd., a Company specializing in that work, and in which Lyell itself is a large shareholder. From Port Kembla it was re-shipped to London.

Factors entering into realization costs at this stage were:-

1. Freight to Regatta Point (Macquarie Harbour, Tas.) per the Mt. Lyell Railway.

2. (a) Shipping and insurance charges to Port Kembla, together with handling expenses if wire bar was required.

(b) If not wire bar, but cathode, then shipping and incidental expenses to an Australian port where it could be picked up by an overseas ship, (e.g. Melbourne)

3. Melting into wire bar at Port Kembla if 2(a) operated.

4. Re-shipping to England, together with insurance and handling charges.

5. Storage and marketing costs by the London Metal Exchange

For that part of the copper which was required in Australia, Nos. 4 & 5 did not apply.

The Realization Cost Chart on Page 42 reveals a fairly steady figure over a period of ten years when these costs account for approximately 8.4% of all costs entering into production and realization.

The War-time Marketing of Copper for Lyell.

With the war, marketing prededure has changed somewhat. There is now no copper sent outside the Commonwealth, which was also true of those years which immediately preceded the war.

Mt. Lyell's copper is all shipped via Regatta Point to Port Kembla, where it is melted into wire bar by Metal Manufacturers Ltd. for the Commonwealth Government. This process is an expensive one. The Australian price for refined electrolytic wire bar as fixed by the Prices Commissioner is £100 per ton delivered buyers premises.

Just where the Commonwealth Government requires delivery is not known. Metal Manufacturers Ltd., acting as agents, sell the copper to the Commonwealth Government, receiving payment in full, and out of such, deduct all expenses in marketing, including their own remuneration for melting.

The main difference now is that the price is no longer a fluctuating factor, and all copper goes to Port Kembla. The Commonwealth Government purchases the whole supply. Export is banned.

Mining	29	Figures not obtainable	24.8	30.5	26.3	23.2	25.9	29.5	28.8	Figures for years since 1939 not obtainable.
Treatment	33.5		14.8	16.7	14.0	14.2	15.8	18.2	19.2	
Management	3		1.8	2.5	1.3	1.5	1.8	1.7	1.3	
Realization	12		5.2	4.8	4.6	4.5	4.2	4.3	4.5	
TOTAL	77.5		46.6	54.5	46.2	43.4	47.7	53.7	53.8	
Less Precious Metals & Pyrites			4.9	6.0	6.5	6.7	6.2	7.2	7.4	
TOTAL PRIMARY OPERATING COSTS	77.5		41.7	48.5	39.7	36.7	41.5	46.5	46.4	
Prosp. & Development	5		2.3	1.9	2.0	2.5	2.2	1.6	2.0	
Depreciation	4.5		2.2	2.5	2.5	3.5	3.8	4.0	4.8	
TOTAL SECONDARY	9.5		4.5	4.4	4.5	6.0	6.0	5.6	6.8	
TOTAL COST	87.0		46.2	52.9	43.2	42.7	47.5	52.1	53.2	
LONDON PRICE OF COPPER £A	102.0		46.0	45.5	41.8	50.9	75.5	56.0	61.6	
£A PROFIT or LOSS PER TON	Profit 15.0		Loss 0.2	Loss 7.4	Loss 1.4	Prof. 8.2	Prof. 28.0	Prof. 3.9	Prof. 8.8	

Cost to Produce & Market Copper in £A per Ton.

Compiled from information supplied by courtesy of the Mt. Lyell Mining & Railway Co.

C H A P T E R V I

A CLASSIFICATION OF COPPER COSTS AT LYELL.

A. Total Primary Operating = Sum of 1, 2 & 3

1. Production Costs
   - (i) Extraction
   - (ii) Treatment
     - (a) Milling to a Concentrate
     - (b) Smelting and Converting
     - (c) Refining to Cathode Copper.

2. Realization Costs, including smelting into wire bar and marketing

3. Administration

B. Secondary Operating Costs
   - (i) Prospecting and Development
   - (ii) Depreciation

The Sum of A & B give all Costs or TOTAL COST.

The above classification of costs differs from the general accounting practice. The method adopted here is believed to be more suitable to an analysis of mining economics.

The concept of primary operating costs are all those costs assigned to actual production and realization, including administration. They are the costs which the industry must cover over a period, generally taken to be a year; and which are directly attributable to that period. They will be high for a low production of copper, and will decline with increased output if the total costs for a period is divided by the output for that same period. We will henceforth refer to them as primary costs, meaning always the concept adopted.

On the other hand, secondary operating costs include prospecting, development and depreciation, and are a sum set aside out of profits to provide for future production. Whereas primary costs occur in winning present output, secondary operating costs are directed

towards ensuring future output. Nevertheless, the present capacity to produce is determined by past sums set aside for what we term secondary operating expenses. If capacity is low, operating costs per ton of copper will be high, and if the provision made has been liberal, costs will be lower by reason of greater output. We will henceforth refer to this group of costs as secondary costs.

If a mining company is unable to meet primary costs, it must close down, unless the stress is believed to be only temporary and credit is available On the other hand, secondary costs can be neglected for a time. A mine can live on its capital. The Mt. Bischoff Tin Mining Company failed to meet total operating cost in 1923, but has carried on to this day by living on ~~their~~ its fixed capital.

Nevertheless, there does come a time when after ignoring secondary costs, ~~that~~ primary costs can no longer be paid, and then there is no alternative but the cessation of operations. To postpone secondary costs today means to increase primary costs tomorrow.

With tin-mining Companies, ~~who~~ which are often forced into temporary difficulties owing to their cost structures being unable to adapt themselves to severe price fluctuations, the policy of ignoring secondary costs has often to be adopted. Companies ~~who~~ which are financially strong generally allow their larger profits to provide for leaner times by building up reserves funds to meet such contingencies.

TOTAL PRIMARY OPERATING COSTS.

Total Primary Costs for Mt. Lyell cover approximately 90% of total costs, and consist of the following - mining, treatment, realization and administration. These over the years from 1933-1939 as analysed on Page 46 have shown a certain stability.

There is a persistency to rise, and since the war it is well known that they have increased more rapidly, but over a period of ten years they have been fairly constant. 1934 was the year of water shortage, with consequent reduction in operations and in that year costs did materially rise.

Further, it is to be noted that all items entering into total primary costs have generally maintained their usual proportion. If assay returns had remained constant, costs would have shown a decline, but with the contrary of falling returns of copper per unit quantity of ore treated, it has been a battle to keep these from rising. The ability shown has been almost entirely due to the principle of decreasing costs through increasing production. Another factor was the return to open-cut mining operations

The market price of copper was often so low that the industry had difficulty in meeting its total costs. In 1934 these were not met, and there were other years when realized returns from copper showed a very small margin over total costs. During all the years of operation, except 1934, the Mt. Lyell Company has been able to show some surplus over primary costs.

SECONDARY OPERATING COSTS.

Year	Prosp. & Devel.		Depreciation		Total amt. set aside for secondary costs
	£A per ton of copper	Rel. Index	Rel. Index	£A per ton of copper	
1933	2.289	100	100	2.251	£47,400
1934	1.923	89	111	2.500	32,482
1935	2.000	90	111	2.500	61,672
1936	2.500	109	155	3.500	76,579
1937	2.185	95	169	3.810	76,572
1938	1.647	72	181	4.085	73,656
1939	1.964	86	212	4.877	92,186
1940	Information not available.				92,935
1941					95,965

Compiled from
Figures supplied by courtesy of the Mt. Lyell Co.

Total Secondary Costs.

The secondary operating costs in mining are the next concern. They, too, are necessary costs and a mining industry in order to survive for any length of time must be able to meet these too. However, they have the advantage that they can be more heavily provided against during good times and less during lean years. There is always a chance that they are not properly provided against by small Companies, which are eager to see quick profits and rising share values. This means that when lean times do come, and it becomes necessary to embark on a big prospecting and developmental programme in order to maintain production, neither the equipment nor the funds are available to pursue such. The rich Mt. Bischoff tin mining company is such an example. Overhead costs were not nearly sufficiently provided against, and as a result, Bischoff has been going

down and down, while Mt. Lyell, having made this proper appropriation, has been increasing production despite unfavourable factors, such as encountered at Mt. Bischoff. A Comp y unable to provide for secondary costs is a dying one.

Secondary Costs at Mt. Lyell.

These form approximately 10 - 12% of total costs from the Cost Sheet figures on Page 50. They include the items of prospecting and development and depreciation. A mine is a wasting asset, for once worked it is valueless to the Mining Company. Two heavy expenses have constantly to be carried by a mine working at full production or endeavouring to increase its output, the first of which is prospecting and development. To a Company the size of Mt. Lyell, that is breaking some 10,000 tons of ground per day in order to recover 5,000 tons of milling ore, an enormous amount of preparatory work must be undertaken to locate sufficient reserves to maintain production, and to give the necessary data upon which to base future calculation. Thus prospecting, which demands today the highest technical skill in the form of geologists, surveyors, engineers and other technical experts, is something which must be going on ahead of present production. It is futuristic in nature, but the present returns must be sufficient to cover and warrant this necessary expense, otherwise the industry will find itself without the ore to feed its mills. When a Company is unable to set aside sufficient funds for prospecting, it is not long before production so falls that operations are unable to continue on a payable basis - the Company then frequently lets the mine on tribute to those who care to pick the eyes out of what is left. This spells the ruination of a mine that is potentially good. Again, consider a Company like

the one under discussion, with assay values falling, treating an immense tonnage, and also fighting a battle to produce for a most keenly contested world market. The ability to produce without incurring rising costs is imperative. It has a number of mines from which to draw ore for the treatment plant, and each mine varies in assay of copper, and each has its own particular cost to mine. The Company has so to arrange its mining of ore that it is not drawing all first grade at the same time, with a consequent over-feeding of the milling plant, smelters and refinery during one period and starving it in another. To accomplish this evening up of the sample and to maintain a fairly constant quota for the milling plant, prospecting and development must be undertaken. This is secured by intensive geological surveys, drilling and sampling so that the Company knows exactly where to work from month to month.

Besides, huge reserves must be located years in advance to feed a plant consuming 5,000 tons daily. This must be in sight so as calculations can be made to meet future problems or to overcome present ones. One way Lyell met its problem of rising costs was to increase production, which necessitated a huge capital outlay. If the Company had not proved, by prospecting and development, the existence and extent of its reserves, such a policy might have proved most disastrous. That is where the Heemskirk (West. Tas.) tin field failed, through insufficient prospecting and development, to prove the existence and extent of ore, to warrant the capital outlay made.

Development includes something more than prospecting, and the locating of the ore and testing and sampling. It implies all that necessary preparation before operations can be started. It often means the

removal of a huge overburden tonnage, or the construction of a tunnel, driving rising, road or rail construction.

For Lyell, it is a considerable problem, and requires much technical knowledge and experience, which demand a high reward for their services.

It will be seen from the Cost Sheet on Page 50 that prospecting and developmental Costs per ton of copper have declined with increased production, but their total outlay is becoming greater as a result of Lyell's extensive search for copper and the larger development of the West Lyell fields.

Factors entering into Prospecting and Development are as follows:-

Direct Operating Costs

Wages and Superintendence

Stores
- General
- Explosives
- Timber and Cement

Repairs
- Wages
- Stores

Diamond Drilling

Power and Fuel

Other Charges — Total Operating Costs

Indirect Costs

Compensation Act 1920-1934

Other Charges — Total Indirect Costs

TOTAL — DEVELOPMENT COST

Depreciation.

Depreciation as a charge to production has two cardinal aspects. Firstly, there is the financial aspect, which includes all those considerations which focus their attention on liquidity, the proposition that realization of assets should cover liabilities

of which shareholders' capital is generally the most important item. To satisfy this demand, there is a need to write fixed capital down to very nominal amounts as quickly as profits will allow. If such a measure is satisfied, production costs will reap the benefit if the mine is a long producer. For, under such a plan, there must come a time when depreciation will not figure so highly, unless huge reserves are being accumulated. Depreciation then becomes a fictitious charge to costs. The possibility of depreciation becoming a fictitious cost is remote for the majority of mining companies, who are more prone to underestimate their depreciation cost and by thus doing, live on capital, which economists term disinvestment.

Fixed capital, must be kept intact if maximum production is to be maintained over a number of years, and the securing of this is ~~provisional~~ conditional on a sufficient sum being set aside from current profits to ensure a replacement of depleted capital known in technical language as re-investment.

Disinvestment leads to higher costs in the long run, because capacity to produce is reduced with consequent increased operating costs, while reinvestment and investment (additional capital spent) reduce production costs for the reason that they maintain or increase the present scale of operations. This second aspect thus assumes supreme economic importance.

In all phases of the Mt. Lyell copper industry depreciation is high, but in the mining section it is the highest of all. A mine is a wasting asset, and probably wastes more quickly than most assets. In this division we have depreciation, not only of equipment used, such as electric shovels, trucks, drills and hand tools, but the depreciation charge against construction

and mine development. The North Mt. Lyell tunnel cost £60,000, and its use appeared limited to the life of underground workings there, which cut out after only a few years. The Company has found a use for this tunnel, since, but this was fortuitous, rather than planned. At the present stage, the rate of working is so enormous that expensive developmental work such as roads, tunnels, arches and cuttings become obsolete after a matter of months.

The treatment plant, for reasons that technical change is often rapid, is also subject to a high rate of depreciation. Wear and tear is also great in this phase of production. Mining machinery is expensive, firstly because the type called for has a very small market. Such a condition renders production costs high and generally allows a monopoly profit to the manufacturer. A machine required by Lyell may have no other demand elsewhere in the world. Expensive plant therefore demands bigger depreciation provision.

Mining plant, installations and railways, etc., are generally located in places where their value on realization would not anything like equal capital expended and as mining companies are seldom able to forecast what tomorrow might bring, it is always felt wise for financial reasons to write down fixed capital values as early as profits allow. This policy can have no economic repercussions, for if harder times do come, then the company will be in a better position to meet the demand to adjust costs.

At Lyell, depreciation is rising, and is now 100% more per ton of copper than it was ten years ago, but this mainly is due to the increased mechanization of the industry. The importance of the machine relative to labour has increased, and depreciation, which is the charge for the use of the machine during current pro-

duction has therefore increased. The relative position of depreciation as a cost to production increased over the period 1933- 1939, but total production costs would have been much higher if the rate of mechanization had been reduced, and the true rate of depreciation falling. A rising rate of depreciation generally means a falling rate for total costs, and then there is nothing necessarily or inherently bad in such a feature.

T O T A L C O S T S

These are the sum of primary and secondary operating costs. It will have been seen from the study of these separately that total costs have been fairly stable over the decade previous to the outbreak of hostilities in 1939, although showing a big reduction overtwenty years from £94 to £53.2 per ton (See Page 46)

Owing to serious price fluctuations in copper, the industry has not always been able to cover total costs. This was the case during 1933, 1934, and 1935, when the Company made losses amounting to £0.2, £7.4 and £1.4 respectively per ton of copper produced.

During the last five years, total costs have risen for Mt. Lyell, because of the increased price for the factors entering into production, and also by reason of an intensification of the scale of operations with the existing plant and dwindling supply of labour. It is likely that before the war is finished, ~~that~~ total costs will approach their previous high level for the 1916-1921 period of £94 per ton. If they do, it will be largely due to the diminishing returns, arising from the geological nature of the copper lodes, together with price increases for labour, operating materials, and mining plant. The former factor is the more influential in affecting total costs.

& COST INDEX FOR EACH PHASE OF PRODUCTION AND REALIZATION PER TON OF COPPER

A.

Primary Operating Costs.

Year	Index of Tonnage Treated	Mining	Milling	Smelting & Converting	Refining	Administration
1933	100	100	100	100	100	100
1934	94	123	114	114	98	195
1935	115	106	91	80	84	74
1936	165	94	101	87	98	85
1937	208	105	111	102	101	91
1938	256	119	128	114	127	90
1939	267	116	175	124	122	71
1940	272	Not available for these years.				
1941	320					

Secondary Operating Costs.

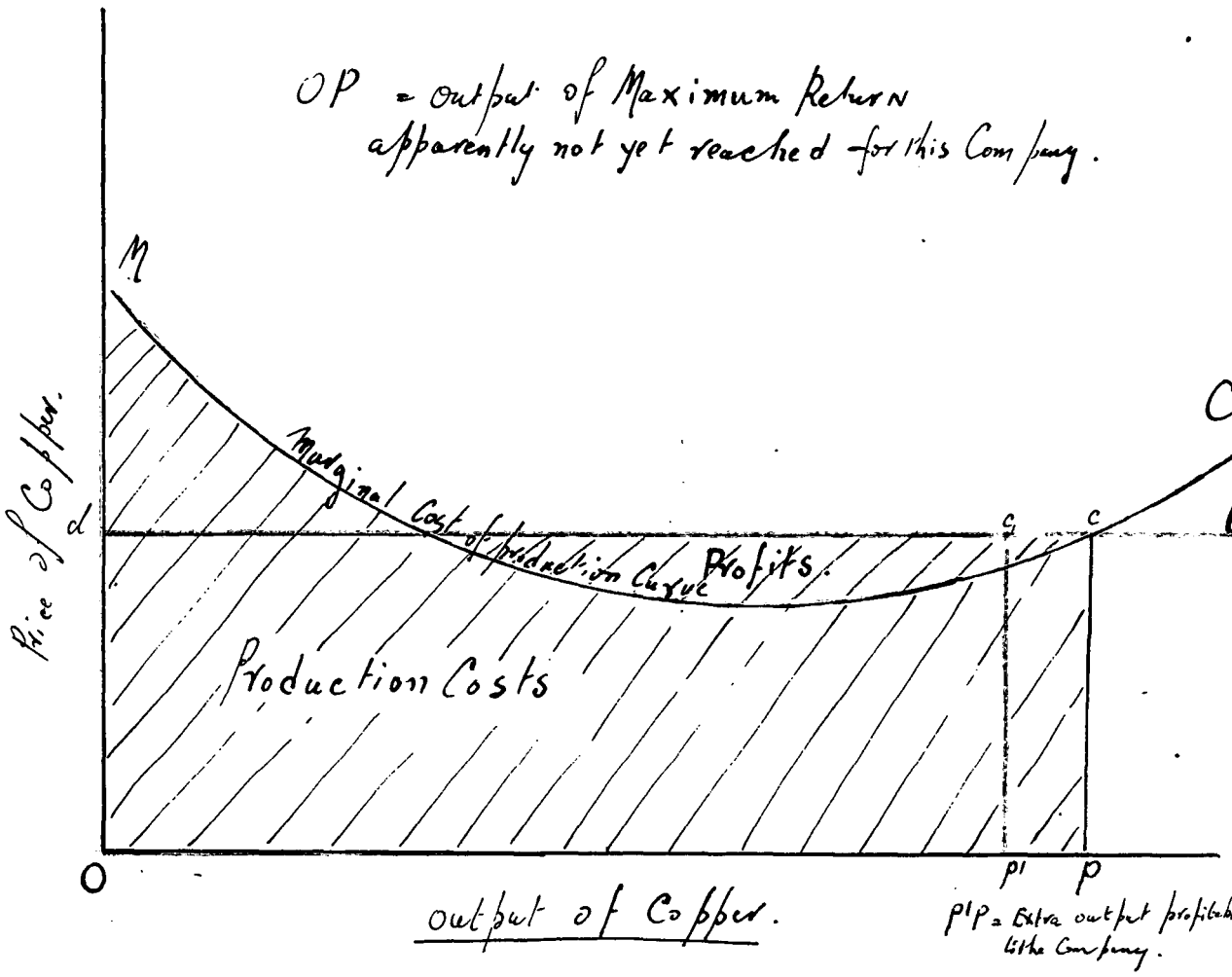
B.

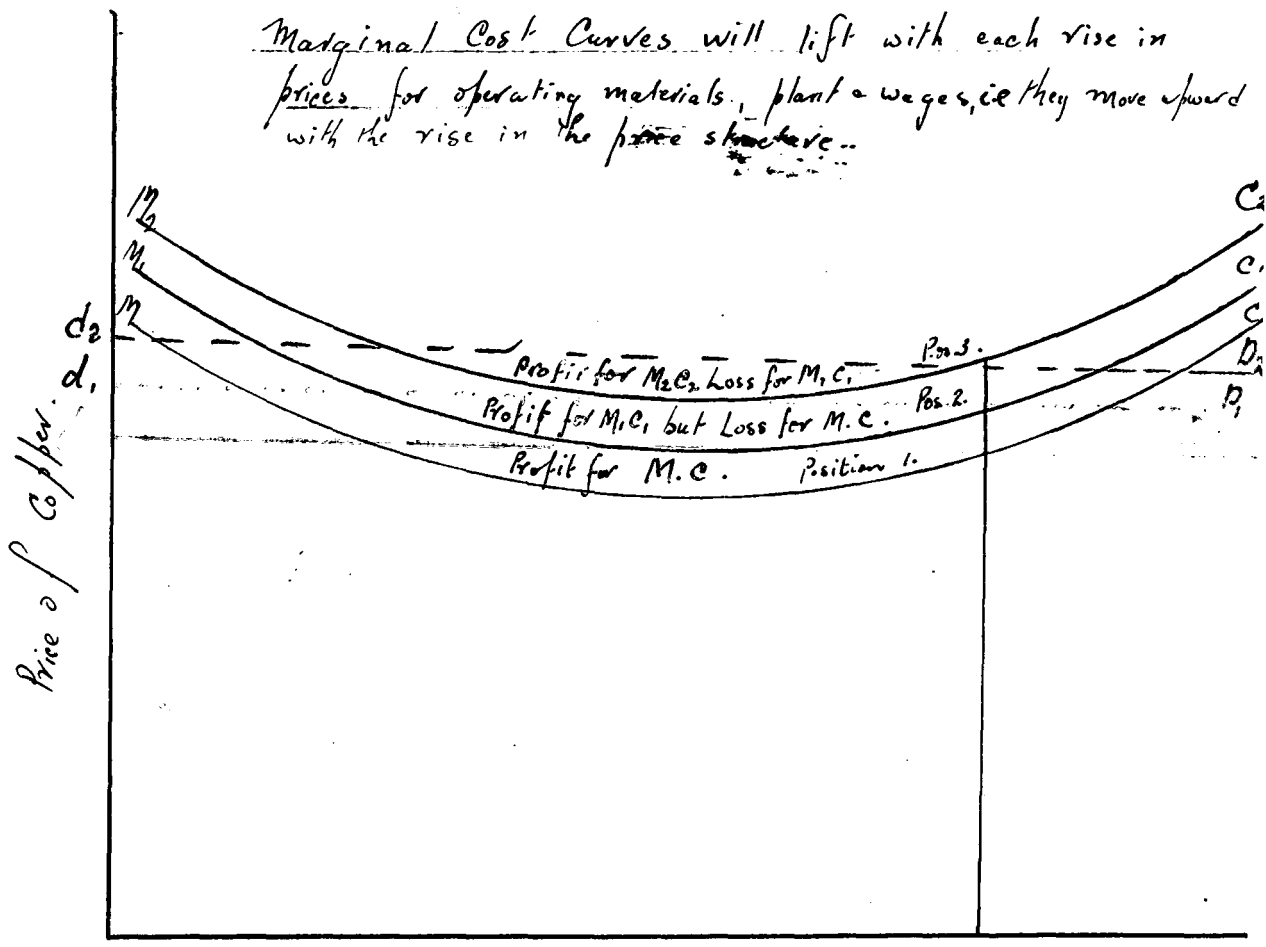
Year	Index Tonnage	Realisation	Depreciation	Prosp.& Devel.	Total Oper. Cost	London Pr of Copper Index
1933	100	100	100	100	100	100
1934	94	91	111	89	114	99
1935	115	88	111	90	93	91
1936	165	85	155	109	92	110
1937	208	80	169	95	102	164
1938	256	82	181	72	113	122
1939	267	86	212	86	115	132
1940	272	Not available for these years.				
1941	320					

A+B. All figures are based on data supplied by the Mt. Lyell Co.

The Relative for each year is a percentage based on 1933

Marginal Cost Curves - Graphically :- Not Authentic for Lyell. but Assumed on evidence.





Position 1. Profitable with price at d D.
Position 2. only profitable if price moves to $d_1 D_2$.

CHAPTER VII

WARTIME PROFIT MARGINS AND BY-PRODUCT ECONOMICS.

War-time Profit Margins.

The profit margin per ton of copper produced in 1939 was £8.8 when the price averaged £A61.6. In December of the same year the Prices Commissioner fixed the price at £63/17/6, and further increased it to £76 in February, 1940. It was again increased in May, 1941 to £86/10/- and in May 1942 it was fixed at £100 plus £5 bonus for all copper produced above a quota given to each producer. The reason for these big upward steps in the fixed price of copper has been to encourage copper production.

With such a handsome price offering, it would appear that Lyell's profit margins must now be very large. In 1939, production costs were £53.2, and since this time, the price has increased by nearly 40%. Have production costs increased at or near a parallel rate? No figures are available, as the Company is obliged to refrain from any publicity of costs for security reasons. Before we can arrive at any conclusion, we must consider the following facts.

Firstly, the assay of copper has fallen by 33.3%. This alone would occasion a cost increase of something like 15%. Secondly, there has been a rise in the price of labour, and of all operating materials and services, together with increased depreciation and prospecting and development costs, because of more capital sunk at higher prices in machinery at the treatment plant, and increased prospecting and development at West Lyell. This has probably raised costs by a further 15 to 20%. Thirdly, the speeding up of operations with supply of plant and

labour practically fixed, has increased costs by a further amount, which is more than 5% and is probably now nearer 10% (December, 1942) Adding, we find that the approximate increase in costs is nearly 50% more than in 1939, which would make production costs for 1942-3 about £80 to £85, leaving a margin for profit say, of £15. But as the output of copper has fallen by approximately 1,500 tons for the same period, total profits are not likely to increase during the currency of the present fixed price.

The magnitude of this increased production cost cannot be accurately stated, but it will have the tendency to swallow the margin of profit, which may become so small that the Company may yet have to ask for an increased price from the Prices Commissioner.

Lyell is a private enterprise, and for this reason is not likely to increase the pressure of operations beyond the point where marginal costs are equal to marginal revenue. On the other hand, it will be to the benefit of the Company to extend production to that point where for the last ton of copper produced it is costing £100 (the highest fixed price obtainable for copper) for at that stage the industry will be receiving its maximum net return.

Theoretically, we can reckon, it terms of the diagram, that the demand for copper is a straight horizontal line dD. The Commonwealth Government stands ready to purchase all copper that can be produced in Australia at a fixed price of £100 plus £5 per ton on all produced above the base tonnage set for the industry concerned. Lyell's marginal cost to produce copper is shown by a curved line line MC. The industry is likely to employ every available means to increase the capacity of operations by such means as a more intensive application of capital, and the use of the man-power available

with overtime rates, until the output equals OP. This would be the maximum effort that Lyell, according to the incentive given to private enterprise, is likely to make, unless such influences as patriotism are brought to effect other than profit considerations.

But with production costs rising, Lyell's marginal costs will be changing with every rise in these costs, assuming technical methods are unchanged as is reasonable to expect, and there will be new marginal cost curves M1C1, M2C2, etc. with each rise in costs. We could expect the marginal cost curve to be constantly rising and with such happening, profits will be constantly dwindling until that place is reached where at OP production is profitless, and where the incentive to hold production at that capacity has lapsed. But as the Commonwealth Government requires the maximum output physically possible, it is more likely that we can expect to see not a shrinkage of output, but a rise in the horizontal line representing price demand (d_1D_1 or d_2D_2). As has been pointed out, marginal costs at Lyell can hardly be expected to have yet reached the selling price of copper to the Government. Just what is the marginal cost to produce a ton of copper cannot here be accurately stated, nor can we show with any degree of accuracy the semblance of what MC at Lyell approaches, without a closer audit of actual costs for various scales of output. The diagram shown only applies to the industry as it is now, and on the assumption that plant and manpower are not likely to receive any alteration.

It is difficult to forecast what the future holds in war. Arguing on the basis that demand will remain strong, and that Lyell will be obliged to treat its present record tonnage of 1½ million tons annually with ore assaying only .8% copper, it will be necessary to keep the industry geared to long hours for labour

and a high rate of depreciation for machinery, plus a large sum for prospecting and development.

On this assumption, it is quite reasonable to believe that before the war is finished, the marginal cost curve for Lyell will so shorten below dD that the Government will be obliged to quote a new fixed price for copper above £100 to help the Company meet rising costs and thus make operations payable at OP, the point of greatest physical output with the available supply of fixed capital and labour.

THE ECONOMICS OF A TOTAL RECOVERY.

Contribution of By-Products, with Index to show the trend.

Year	Value of Precious Metals and Pyrites in £A per ton of Copper	Relative Index
1933	4.9	100
1934	6.0	125
1935	6.5	133
1936	6.7	134
1937	6.2	127
1938	7.2	147
1939	7.4	151

Compiled from information supplied by courtesy of the M.C. Lyell Company.

The Economics of a total recovery, (as it applies to Lyell with its corresponding application to other mining industries.)

The gain from a full recovery of all minerals present in ore milled is vital to many mining ventures. Most ores, especially Tasmanian ones, are complex in nature, and contain other minerals of commercial value in addition to the metal for which the mine is worked. In the Lyell ore, for instance, there is silver, gold and iron sulphide, the latter being an important source of sulphur most suitable in the manufacture of farm fertilizers. Although the gold and silver are present in very small quantities, their recovery is important

as will be understood from the Table on Page 65, which shows the annual values from this source. The gold and silver are recovered in the refinery slimes at Lyell, and these are treated at Port Kembla (N.S.W.) to effect a separation and purification to their respective metallic forms. Their recovery at Lyell costs nothing more than refining would otherwise cost in their absence.

The pyrites (iron sulphides), on the other hand, is recovered from the mill tailings that would otherwise be washed away in the river slimes. In earlier years, it paid the Company to mine this mineral for itself alone, and now it could be saved with only minor additional cost to previous milling practice.

The total recovery of these extra metals and minerals without any further material burden of cost is to the industry a "windfall profit."

The value of these by-minerals and metals has increased in the case of Lyell. In 1933, for every ton of copper produced, the Company was able to show a reduction in copper costs of £4.9, which sum was entirely due to the windfall profit from the by-minerals, and by 1939, production costs showed a reduction of £7.4 per ton, due to the returns from these.

To an industry struggling at the margin of profitable production as Lyell was during the thirties, the contribution obtained by a total recovery of all marketable products is very important. In 1933, but for the assistance given by the by-metals and minerals, the Company would not have been able to meet even primary costs, nor been able to meet total costs of production in 1936, 1938 and 1939. (See Cost Table on page 46.)

The great importance of this subject is not evident when a mine is flourishing with a wide margin of profit, but when it enters upon the stage where it begins to fall close to the margin of profitable production, then

the advantage of a windfall gain becomes vital. It is often the deciding factor between operation and closing down.

The same implication follows for a full recovery from the principal metals. To the Magnet and Bischoff mines, when metal prices were good and the mines rich, neither recovery nor utilization of slimes were of concern. Big profits were being made, and little attention was paid to the matters mentioned here, but when they became marginal producers, these matters at once brought concern.

The concept of a "total recovery" (recovery of all metals and minerals of value) and the maximum recovery metallurgically possible from all of them is more economic in the case of the large mining Company than in the small mining Company. A total recovery to a Company handling 1,500,000 tons per annum is of much more consequence than to one handling only 100,000 tons. At Mt. Farrell, for instance, there is a small percentage of zinc present in the silver-lead ores, which is slimed away in the mill tailings. Its recovery would present no technical difficulties whatever, but because of the small tonnage annually handled, its treatment would not be profitable, but to a Company on the scale of Lyell, this metal would be most remunerative. The scale of operations generally determines the economic gain from these by-metals and minerals.

We can conceive of the value of these by-metals and minerals in two ways:-

(i) As a windfall gain - something in the nature of a surplus over that which was first anticipated.

(ii) As a factor in reducing production costs.

The latter method is the one adopted in the survey of Costs on page 46.

PYRITES SAVED AT Mt. LYELL

Year	Tons	Value in £A
1931	507	£253
1932	274	150
1933	1498	1,498
1934	12,030	12,030
1935	25,555	25,555
1936	33,711	33,711
1937	40,630	43,723
1938	50,277	62,845

QUANTITY AND VALUE OF SILVER IN BLISTER COPPER AT Mt. LYELL

Year	Ozs.	Value in £A
1931	148,782	9,650
1932	161,634	12,905
1933	127,562	10,414
1934	89,940	8,726
1935	132,857	17,543
1936	103,189	9,150
1937	82,233	87,518
1938	66,982	5,758
1939	67,886	

QUANTITY OF GOLD IN BLISTER COPPER

Year	Ozs.
1931	3,834
1932	4,769
1933	4,998
1934	4,082
1935	7,532
1936	7,015
1937	6,430
1938	7,619
1939	7,689

AVERAGE ANNUAL PRICE FOR COPPER £ STERLING

Year	London Quote Standard Spot	Australian Fixed Price (Prices Comm.) (not Av. price)
1922	£62. 3. 6	
1923	66. 7. 4	
1924	63. 4.3	
1925	61. 9. 7	
1926	58. 0.8	
1927	59. 5. 7	
1928	72. 2.10	
1929	75.19. 7	
1930	54. 3. 7	
1931	38. 7. 9	
1932	31.14. 7	
1933	32.11. 4	
1934	30. 6. 4	
1935	31.18. 1	
1936	36.12. 6	
1937	60. 5. 9	
1938	45.16. 9	
1939	49.17. 7	Fixed in Dec. 63.17. 6
1940	62. 0. 0	Feb. 76. 0. 0
1941	62. 0. 0	May 86.10. 0
1942		May 100. 0. 0 plus £5 bonus
1943		100. 0. 0 "

London Quote from Director of Mines Report (Tons). Yrs 1922 - 41.

Australian fixed price fr... Prices Com. Hobart.

C H A P T E R V I I I

WORLD COPPER AND MT. LYELL.

Owing to the number of producers being small and demand wide, copper is a very important product of international trade. During the last few decades there has been a great transition from selective mining of limited deposits having the quality of exceptional richness to the mass production of generally poorer ores. In the 19th century, the grade of ore averaged from 6 to 8% while today the working of lodes containing less than 1% is not uncommon. The world average for ore worked today would be about 2.3% ✱.1 The industry is now influenced by mass production methods, calling for a huge investment of capital in order to operate profitably. A small movement of price has become of greater concern, and cyclical movements from prosperity to depression have been fairly frequent in this new era.

Extreme price fluctuations in the copper market have been common. "In December, 1916, the average London price of standard copper was £145.32. In 1930 the average price was £54, and during each of the next five years just over £30 per ton. It rose to £60 in June, 1937, but declined thereafter to £35 in June, 1938, only to rise again to more than £42 in June, 1939." ✱ 2 From September, 1931 to September, 1932, the average price of copper was £A 38/3/1, but in July it was as low as £A20/7/0. In 1937 for the same period, the price averaged £A75/10/4, but the fluctuations were violent, rising from £44 and falling again as low as £54.

✱ 1 See Zimmerman "World Resources and Industries" page 666

✱ 2 Australian Year Book 1939 and 1940.

This fluctuating price for copper has subjected the industry to an intense review to improve relative cost positions in order to compete on the world market, and the results have often caused radical and dangerous surprises demanding drastic changes in organisation for large sections of the industry.

A metallurgical process known as floatation has made profitable the treatment of low grade ores. This process was first tried out ~~at Lyell~~ in Australia, with abounding success, and since then has been adopted by the world's largest producers. The low-grade ores thereby became competitors with the high grade ones, and as the extent of the former are generally on a much grander scale than rich ore lodes, the former, by application of full mechanization have been able to more than favourably compete with the latter. In fact, the scale of mechanization and increased size of plants is so favourable to the low-grade propositions that capital has sought investment with them rather than with those small rich lodes, where the scale of operations is smaller and general working life shorter.

An improved process of floatation known as selective floatation as used at Rosebery enables the treatment of comples ores where metals as gold, silver and nickel, manganese, lead and zinc are present besides copper. The famous International Nickel Company of Canada is operating on the ores of the Sudbury district in Ontario where copper is found with nickel bymeans of this method of selective floatation; The Pasco Copper Corporation of Peru, which in 1929 produced over 16 million fine ounces of silver together with 50,000 short tons of copper and the Anaconda Copper Company of Chile which for the same year produced 8½ million fine ounces of silver from ores containing 140,000 tons of copper, also use this process. Thus selective floatation has

brought the complex ore bodies to that place where they also are keen competitors against the simple ores. By-product copper, and copper recovered from scrap are new competitors which have helped to break up price monopolies when the field of producers was much smaller.

The last decade has seen the rising importance of Chile, Peru, Mexico and Canada as producers, where American capital has been dominant in exploitation of these copper resources, while European capital has been directed to the rich African deposits.

World production of copper

World production of copper has since the last war been on the increase:-

1913 World output	-	990,000	metric tons	(1 metric ton = 2,205 lbs.)
of this U.S.A. gave		550,000	" "	(or approx 60%)
Chile		42,000	" "	
Canada		35,000	" "	
1929 World production	-	1,947,000	metric tons	
of this U.S.A. supplied		930,000	" "	
Chile		321,000	" "	
Canada		113,000	" "	
1937 World production	-	2,338,000	metric tons	
of this U.S.A. supplied		820,000	" "	
Chile		396,400	" "	
Canada		210,000	" "	
1938 World production	-	2,040,000	metric tons	
of this U.S.A. supplied		570,000	" "	
Africa		348,100	" "	
Chile		337,500	" "	
Canada		222,700	" "	

Between 1939 and 1942 world production was greatly increased

The relative copper output as between countries has changed during the period of increased production (1913-42). Today the richest deposits known are in Central Africa, stretching from the southernmost province of the Belgian Congo (Katango) far into the neighbouring British territory of Northern Rhodesia. The Belgian Congo in 1911 produced only 1,000 metric

tons, but by 1937 it was producing approximately 170,000 metric tons.

More recently the expansion of the Belgian Congo has been overshadowed by the development of mines in Northern Rhodesia. These mines in 1937 produced 280,000 metric tons, and are now probably producing in the vicinity of 500,000 metric tons.

"These African deposits are so favourably situated and the quality of the ore is so good that production costs are extremely low, and the new areas can more than challenge America in price and when fully developed in quantity also." (Manchester Guardian, May, 1938.

The position of the Canadian copper is different. Copper is there produced as a by-product of nickel, and thus production costs are only nominal, and it is impossible to restrict production without cutting down the production of nickel and other metals which are in great demand.

The mines of U.S.A., although giant producers of copper, are high cost producers, but because U.S.A. was until recent years the dominant producer in the world, she was able to control market prices so as to be favourable to her own high cost industries. During the thirties of the last decade, America's control of the world market was broken by the low cost producers of Africa. It was during these years that things looked very ominous for the Tasmanian industry. In 1932 copper prices fell as low as £20/2/-, and in 1934 African copper was being delivered in London for £21 per ton.

By 1939 copper prices had improved. This was mainly due to an agreement to restrict production by the chief low cost producers of Chile, Northern Rhodesia and the Belgian Congo, and in addition some individual producers of Mexico, Spain and Yugoslavia. This scheme

was adopted in March, 1935. From the price chart will be noticed the associated gradual improvement in the London price of copper. These low cost producers of the Belgian Congo, Rhodesia, Chile, and including Canada, were in 1939, producing more than 1,200,000 tons per annum, and were in control of the world market outside of U.S.A., whose industry was protected by a prohibitive import duty, and for this reason was a closed country for copper. Their production costs were very low, averaging less than £25 per ton for standard copper (c.f. with Mt. Lyell in 1939, £53.2)

Production and cost figures for the war period to 1942 are not available, but it is well known that production has greatly increased. Some idea of the expansion of the Rhodesian Copper mines can be gained from these figures obtained from "Economist", Nov. 1939.

Mines	Annual Production. (Calculated from Monthly Output)	Cost of Production
Roan Antelope	66,000 tons of blister copper	£18/16/10
Mufulira	75,600 " " " "	21/ 2/ 5
Rhokana	136,000 " " " & electro. "	21/17/5 23/16/ 5
		(£ sterling per ton.)
TOTAL	277,600 tons.	

All of these mines were anticipating even a far greater output. The Mufulira alone, with a capital expenditure of only £100,000 expected to bring output capacity up to 96,500 long tons per annum. The Roan Antelope schemes projected for completion by the end of 1939 were calculated to raise production capacity to 107,000 long tons per annum.

SOME POST-WAR CONSIDERATIONS AND THEIR IMPLICATIONS FOR TASMANIA.

The relative copper producing capacity as between countries in the period after the war will depend almost entirely on whether international commerce is resumed on the basis of free trade or pre-war national-

istic measures designed to protect particular industries.

We are not able to state authoratively what is going to emerge from this present conflict, but we do well in examining those principles expressed in such as the "Atlantic Charter", and speeches made by leading Allied statesmen such as Anthony Eden, Cordell Hull, Roosevelt, Churchill and Molotov.

Here are some extracts from a few of them:-

1. Mr. Eden's Mansion House Speech, 1941.

"When peace comes, we shall make relaxation of our war-time financial arrangements as will permit the revival of international trade on the widest possible basis."

And again from the same speech:-

"Let no one suppose, however, that we for our part intend to return to the chaos of the old world. To do so would bankrupt us no less than others."

The Atlantic Charter signed the 14th August, 1941, expresses the principle of free economic co-operation and the destruction of such nationalistic designed devices as trade barriers."

Mr. Cordell Hull in a broadcast to the US.A. American Republics and Europe makes these assertions:-

1. "Extreme nationalism must not again be permitted to express itself in excessive trade restrictions."
2. "Non-discrimination in international commercial relations must be the rule, so that international trade may grow and prosper."
3. "Raw material supplies must be available to all nations without discrimination."
4. "International agreements regulating the supply of commodities must be so handled as to protect fully the interests of the consuming countries and their people."

Many more instances expressing these same principles for economic relations could be produced.

Given victory, it does appear that free trade rather than protection is likely to be the rule of international commerce. If such proves the case, the implications resulting can be fairly accurately prophesied. High cost centres of production will have to give way before the competition of low cost centres. Each country will concentrate on developing those economic resources where its costs are least as measured in terms of a common unit of currency.

Prior to the war, the world copper market was suffering from over-production, and only by means of restriction quotas, prohibitive duties and other such measures did the high cost producers survive. Also, some 60% of the world's copper production had, until the entry of African competition, been controlled by the big American Copper groups including nearly the whole of the low cost Chilean production. With the development of the African deposits, the production of copper exceeded demand, and high cost producers such as Lyell would have been forced to close but for the re-armament programme, which increased demand and annulled restriction agreements. During the war period, production has been greatly increased, and is now being geared in all belligerent countries to meet the requirements of expanding war needs.

With the cessation of hostilities, the demand for the majority, if not all heavy metals is likely to decline. Supply might then exceed demand, especially now that the industry is geared to such exceptional proportions. Large numbers of mines have opened that would be considered extra-marginal producers normally. Agreed that no measure of restriction in trade will be tolerated, there is only one course for high cost producers and that is to cease operations, if the resources of low-cost producers are adequate, and it appears that they are more than so. The world price of copper will make

this imperative. The world market will then be available to those large low-cost producers who will be anxious to maintain trather than contract their productive capacity in view of their huge reserves and superior cost position.

Again, if gold is not likely to resume its pre-war importance, then the governments of South Africa and Rhodesia will be most eager to keep copper mining at war capacity.

The pre-war consumption of copper for the world averaged about 2,900,000 metric tons. At the present rate of production, the low cost producers of Africa, which are now producing over 500,000 metric tons, together with Canada and Chile, where production is approximately 700,000 metric tons, 60% of the world total demand (based on the pre-war figure) is satisfied. We would do well, however, to consider the possibility of an increased demand after the war.

Future Prospects in the world demand for copper.

"Next to iron, copper is the most useful metal in modern machine civilization"* The demand for copper comes principally from the electrical trades and industries connected therewith. The main ones are the telephone, telegraph, cable and electrical power industries. The source of demand appears decidedly singular, i.e., the electrical industry. Next to silver, copper is the best conductor of electricity, but has been ~~substituted~~ displaced by aluminium for transmission lines. Other competitive substitutes are rustless steel, nickel, and lead for pipes and water connections, etc., where a rust resisting metal is required. Its price is,

* "World Resources and Industries" by Zimmerman.

therefore, limited by the competition of these other metals. At the present, aluminium and nickel reduction makes these metals much more expensive than copper, and the silver price differentiation easily gives copper the preference.

The maintenance and progress of the copper industry appears to wait on the electrical industry. Although this industry has gone very far in the Western civilizations, copper is not harnessed to a dying giant like steam, but to a growing one. If the good resolutions of the Allies are not forgotten when the war is concluded, and the standard of living is to be raised in those countries where mechanization has not gone far, then huge power schemes dependent upon the production of copper must be a major post war feature. Further, the production of much plant and equipment in which copper is used, that has not been able to be replaced during the war years in all countries that have suffered restrictions, will bid for more refined copper. Many power schemes in our own country have been postponed because of the shortage of copper. If investment occupies the place that we are led to believe it will in the post-war period, and the development of eastern civilizations such as China, and the backward western countries such as Bulgaria, are attempted on an appropriate scale with the aim of raising the standard of living for their masses, secondary industries dependent upon electrical power must be a prominent feature of the new order, and prove a common reality. There must be added to this the reorganization of such countries as Russia and Germany, where the destruction from war has been great, the new organization of which will demand much industrialization requiring electrical power - the consumer of copper.

In view of this line of thought, then the demand for copper should be strong. There is even room to suppose that relatively high cost producers may survive by reason of this tremendous world investment phase.

Danger of Substitute Products appears in aluminium and rustless steel, especially the latter. Production costs in these two industries will prove a dangerous rival. The possibility of the electrical trade switching to one of the above is tempered by the fact that a change-over would entail a great deal of expense, but once the changeover was made, it might be hard for copper to regain the lost position.

The Implications for the Tasmanian industry can be summarised thus :- Mt. Lyell is a high cost producer. The industry has survived difficult times and costs have been materially reduced over the years under the pressure of competition, but this ability to reduce costs came from two factors which cannot now be expected to operate - (1) Return to open-cutting, and (2) Increased scale of plant. It is unlikely ~~that,~~ in view of the diminishing nature of Lyell's ore reserves which are only in the vicinity of ten years, that plant is going to be enlarged.

But it may be argued that Lyell has never had more than a limited ore body in sight. That is so, but against that argument, we must accept the position from the recent prospecting and drilling campaign undertaken at great expense to the Company by a geologist of world experience. The results of that survey, and after drilling according to his recommendations have shown a complete blank.

If the war continues for many years longer, there will not be the reserves to work, and if reserves are left for after the war, the cost of working them will be very high. Production costs would not even hope

to compete with the big low-grade producers of U.S.A. that have entered the high cost category, but where the size of operations are as great as seventeen times that of Lyell, let alone the low cost mines of Africa.

For the Tasmanian industry to survive in the post-war world, there is only one course if better deposits cannot be located, and world demand slackens, and that is government assistance.

Even if protection was given, there is the position of the new producing centres such as Mt. Isa. It is now known that Mt. Isa is planning to produce on a scale equal with Mt. Lyell, and the ores there are greatly superior in quality to those of the latter. If the Australian demand returns to the normal pre-war figure of approximately 15,000 tons annually, and with Australian production at a war peak of about double that figure, then an export surplus would result, which may not be able to find a market if copper prices are falling.

We can thus summarize the position for Tasmania:-

A. Under Free Trade, it is difficult to see how production could be maintained and operations remain economic.

B. Under Protection, Lyell could possibly survive with a substantial Government bounty if the home market was able to absorb its copper; but if a superior home industry challenged it for this market, then its position would be hopeless.

A P P E N D I X.

Late in 1943, the Commonwealth Government announced through the Australian press, that, as a result of a change in the munitions and wartime programme, the consumption of copper had been reduced by nearly 50%. It was stated that Mt. Isa, which had switched from zinc lead production to copper by earlier orders from the Commonwealth Controller of Minerals had now been asked to revert to the production of zinc and that copper production there would cease.

This recent action appears better for Lyell's post war period, for otherwise Mt. Isa may have emerged from the war a keen competitor for the Australian market. From a recent report in the Tasmanian press ("Advocate" January 21, 1944) it appears that the Commonwealth Government had built up large emergency stocks of copper from imported sources; and that Mt. Lyell will no longer be required to produce at the 1942 pressure. In fact, already manpower is being released from Lyell for other essential work and the military forces. It is likely, if production falls to 10,000 tons, that costs will accelerate further, and this will probably cause some anxiety to the Company.

It is known, however, that although the Company has been working very low-grade ores of .8% during the currency of the high fixed price of £100 that there are still substantial reserves of a better grade. The Report to Shareholders' for the year ending 30th September, 1942, gave the reserves at 14,850,000 tons of an assay of 1.14% copper, 0.07 ozs silver and 0.012 ozs. gold. No doubt Lyell is working the least payable ores while the price of copper is so favourable to its high cost position, and will revert to the better grades as soon as harder times come.

MT. LYELL MINING AND RAILWAY COMPANY LIMITED

PROFITS £A. (Figures supplied by courtesy of the Mt. Lyell Mining and Railway Co. Ltd.)

Year	Deductions for Prospecting & Development	Deductions for Depreciation	Taxation	Net Profit	Profit before Taxation	Income from Other Sources	Income from Mt. Lyell Mines
1922	3,430	33,716	12,500	127,491	139,991	No figures available	
1923	4,121	50,713	21,032	151,003	172,035		
1924	6,245	29,415	10,658	151,082	161,840		
1925	11,273	31,314	10,043	177,605	187,648		
1926	15,567	33,524	10,110	175,861	185,971		
1927	25,641	47,941	10,200	178,000	188,499		
1928	25,237	36,701	12,594	203,050	215,644		
1929	46,158	65,576	34,120	324,128	358,248		
1930	58,354		16,118	131,178	147,296		
1931	29,810	No allocation	13,419	78,056	91,475	Disappointing	
1932	43,913	for these years,	3,777	43,980	47,757	Revenue low	
1933	47,400	the two are	1,389	49,214	50,603	Not satisfactory	
1934	32,480	included	1,489	6,374	7,863	54,834	- 46,971 Loss
1935	61,672		10,450	65,912	76,362	57,879	18,483
1936	76,579		12,362	187,291	199,653	70,487	129,166
1937	27,869	48,603	73,889	343,852	417,471	71,611	346,130
				150,830	170,113	85,953	84,160

TASMANIAN COPPER RESERVES

Field	Tonnage	Assay % ozs. Copper	X	Gold	per ton Silver	Other minerals Sulphur	Pb	2n
Mt. Lyell	15,760,000	1.15%	X	0.012	0.07	30		
Read Rosebery	1,500,000	.5%		0.06	2.3	26.6	5.9	18.4
Other Mineral Fields		No Estimate possible						

Pb - Lead, 2n - Zinc

Mt. Lyell present worked have proved to be much less than this figure and are now about 0.8%.

It is likely that Lyell is working poorer grade ores while the price is high and is keeping her richer reserves for the post-war period when price is likely to be far less favourable.

Compiled from Information released in Directors Reports to Shareholders.

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THE MOUNT LYELL MINING AND RAILWAY COMPANY LIMITED.

BALANCE SHEET
(Figures are stated to nearer £)

30TH SEPTEMBER, 1941.

LIABILITIES.

Authorised Capital			
2,500,000 Shares of £1 each		£2,500,000	
Less Unissued Capital			
950,000 Shares of £1 each		950,000	
Capital Paid Up		£1,550,000	
Reserves (Used in the Company's Business)		1,598,301	
Profit and Loss Account		149,078	£3,297,379
Removal of Overburden - West Lyell			9,026
Sundry Creditors (including provision for Income Tax)		112,148	
Deposit		22,000	
Bank Accounts Overdrawn £260,254			
Less Accounts in credit and cash in hand	4,237	256,017	390,165
			£3,696,570

ASSETS.

Mine Properties and Development (at cost less amounts written off)			£520,551
Freeholds and Leaseholds (at cost less deprec.)			19,369
Machinery, Plant & Equipment (at cost less deprec.)			316,411
Hydro-Electric Power Plant (at cost less deprec.)			185,101
Railways and Rolling Stock (at cost less deprec.)			216,494
Shares in Companies quoted on prescribed Stock Exchanges (at cost or under)	£55,404		
Shares in other Companies (at cost or under)	1,676,987		1,732,391
Stocks on Hand - Stores, Coke, Fuel Timber Explosives, etc. (at valuation)	307,854		
Sundry Debtors	95,167		
Estimated net value of Ore on hand and Metals on hand, in process and in Transit	303,232		706,253
			£3,696,570

(Taken from Mt. Lyell Co's. Reports & Statements of Account for year ended 30th Sept., 1941)
by Courtesy of the Co.

Figures taken from No 19. Mines & Metals Statistics.

COPPER PRODUCTION IN AUSTRALIA BY STATES IN TONS (2240 lbs)

State	1931	1932	1933	1934	1935	1936	1937	1938
New South Wales	541	632	706	777	856	1,251	1,205	1,963
Queensland	3,135	3,024	2,861	2,820	2,842	3,824	5,149	4,458
South Australia	22	-	72	207	256	450	340	254
Victoria	-	-	-	-	-	-	-	-
West Australia	-	-	35	-	-	2	12	5
Tasmania	9,833	10,998	10,739	8,208	13,036	13,030	12,420	12,729
Northern Territory	1	4	-	-	-	-	1	37
TOTALS	13,532	14,658	14,413	12,012	16,990	18,561	19,127	19,446

EXPORTS FROM AUSTRALIA (from Customs Statistics)

	1931	1932	1933	1934	1935	1936	1937	1938
Refined & Cathode Copper	9,378	9,207	8,024	1,859	3,430	3,377	42	12
Copper in Blister Ore & Concentrates	2,765	1,099	1,109	1,122	1,361	2,770	2389	3,216
					4,791	6,147	2,431	3,228

VALUES OF AUSTRALIAN COPPER PRODUCTION

State	1934 £A	1935 £A	1936 £A	1937 £A	1938 £A
Tasmania	267,342	464,007	556,734	759,332	580,238
New South Wales	25,398	30,371	53,687	72,406	87,905
Queensland	95,903	101,489	161,688	308,968	203,967
South Australia	8,475	11,065	22,699	21,620	15,333
West Australia	-	-	97	986	1,275
Northern Territory	-	-	1,972	55	4,362
AUSTRALIA	£397,118	£606,632	£796,787	£1,163,367	£893,080

Taken from Commonwealth Year Book, 1940

SECTION II

TIN.

C H A P T E R I

INTRODUCTORY.

Tasmania ranks equal with New South Wales as a source of tin in Australasia. During the war, which has deprived the Empire of the abundant and cheap supplies from Malaya and the East Indies, Tasmania, by virtue of potential resources, is likely to prove a more important producer. The exploitation of these idle deposits depends upon many factors, the majority of which are not subject to the industry's control.

Tin has played a very influential part in the early history of the State, and was for a number of years the chief mining industry. The values and quantities of tin mined since 1880 is shown on the Table on page 85. Production since 1918 has been on the decline, although increasing slightly since 1938. The annual value of tin mined has also declined for the same years, yet recent years have shown a material increase due to the high fixed price for the product in this country. The whole industry now provides direct employment for approximately 900 men. The low price for tin between 1930 and 1934 was responsible for a serious drop in output. The price of tin rose in 1929 by 22% on that of the previous year, but production fell by 44% through a major catastrophe in one of the principal producing fields.

The history of the industry has largely been connected with ore mined from the world-famous Mt. Bischoff tin mine. Outside of Bischoff, Heemskirk and the North-Eastern fields, there is little of importance to note.

TIN PRODUCTION AND VALUES

(taken from Sec. of Mines Report, 1941)

Return showing the quantity and value of tin exported from Tasmania from 1880 - 1904 (compiled from Customs Returns only), tin ore produced during the years 1905-1918 inclusive and metallic tin produced during the years 1919-1938. (Relatives computed from figures in Repor

Year	Quantity actual in tons	Quan. rel. to 1928	Price rel. to 1928	Value in £A actual
1880-1904	76,708		Taking London quote for that year. £216/6/6	7,167,564
1905	3,891			362,670
1906	4,472			557,266
1907	4,342			501,681
1908	4,520			421,580
1909	4,511			418,165
1910	3,701			399,393
1911	3,953			513,500
1912	3,713			543,103
1913	4,010			513,983
1914	2,572			259,300
1915	2,599			292,306
1916	2,854			350,852
1917	2,637			427,917
1918	2,256	190		488,798
1919	1,580	139		395,794
1920	1,310	115		369,362
1921	790	68		130,257
1922	679	60		112,407
1923	1,160	102		236,955
1924	1,108	97		275,014
1925	1,129	99		297,515
1926	1,096	96		322,526
1927	1,105	97		317,593
1928	1,140	100	100	258,676
1929	640	56	122	130,014
1930	511	45	565	69,592
1931	588	52	54	70,634
1932	793	68	63	109,767
1933	957	84	90	190,041
1934	952	84	106	219,246
1935	1,131	99	104	258,918
1936	1,004	89	91	206,656
1937	1,089	95	117	260673
1938	1,278	112	87	244,037
1939	1,250	110	104	282,798
1940	1,430	125	119 (150)	367,127
1941	1,256	110	119 (160)	328,340
	149,731 tons			£18,690,021

Relatives in brackets approx. only based on Aust. fixed price.

TIN PRODUCTION IN AUSTRALIA BY STATES 1927 - 1938
(in tons of 2240 lbs.)

Year	Tasmania	N.S.W.	Q'land	S.Aus.	Vic.	West.Aus.	N.Ter.
1927	1,106	1,089	778	-	46	58	67
1928	1,125	1,020	586	-	65	56	38
1929	640	934	561	-	17	66	21
1930	419	590	350	-	15	62	15
1931	589	794	298	-	19	34	16
1932	794	793	487	-	22	24	18
1933	957	1,135	635	-	29	23	31
1934	952	1,161	780	-	22	29	42
1935	1,131	1,096	829	-	20	39	15
1936	1,004	1,114	774	-	85	25	25
1937	1,090	1,143	819	-	136	38	30
1938	1,279	1,190	703	-	118	26	13

(Taken from No. 19 Australian Mines and Metals Assoc. (Incorp.) Statistics for years 1927-1938.)

REFINED TIN PRODUCED IN AUSTRALIA, and METAL IN ORE AND CONCENTRATE EXPORTED FROM AUSTRALIA.

Year.	Refined Tin Produced	Metal in Ore and Concentrate exported from Australia.	TOTALS
1927	2989	12	3,001
1928	3133	-	3,133
1929	2,260	4	2,264
1930	1,544	-	1,544
1931	1,690	17	1,707
1932	1,958	101	2,059
1933	2,360	139	2,499
1934	2,330	198	2,528
1935	2,837	289	3,126
1936	2,717	246	2,963
1937	2,907	192	3,099
1938	3,229	102	3,331

EXPORTS FROM AUSTRALIA FROM CUSTOMS STATISTICS

Year	Refined Tin Exported	Metal in ore and Concentrates exported from Australia.	TOTALS
1927	1,421	12	1,433
1928	1,445	-	1,445
1929	998	4	1,002
1930	564	-	564
1931	885	17	902
1932	752	101	853
1933	1,379	139	1,518
1934	1,174	198	1,372
1935	934	289	1,223
1936	540	246	786
1937	675	192	867
1938	1,209	102	1,311

(Australian Mines and Metals Statistics No. 19)

CHAPTER II

HISTORICAL.

Western Tasmania.

The discovery of tin ore at Mt. Bischoff in 1871 marked a new era in the history of Tasmania. In 1870, little more than a year previously, the well-known English author Anthony Trollope had visited the island State and had written that it was "sad to have visited a British colony that had seen its best days." Coming at a time of extraordinary trade depression, "no event before or since has produced such a far-reaching effect in the industrial development of this country." * Agriculture, the chief industry of the State at the time, had been checked. The Victorian markets were closed to Tasmanian produce because of large shipments from New Zealand and South Australia, and the imposition of a protective tariff.

Mining, too, was at a standstill. The coal mines of the Eastern district and the silver lead prospects of the North Western district had failed to reach expectations and only two goldmines were in operation.

It was at this critical period that the richest lode tin deposit in the world was discovered. Although years passed before the significance of this discovery was fully realised, a hitherto unexplored region had been opened which would provide a base for further exploration. The incentive thus given led to discoveries of great importance to Western Tasmania. During the following decade, tin was discovered at Heemskirk and Renison Bell, silver lead at Zeehan, Magnet and Heazlewood, copper at Lyell, zinc lead at Rosebery and Mt. Read, gold at

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* "Mt Bischoff Tin Field" by A.W. McIntosh Reid, Geol. Survey Bulletin No. 34.

Corinna, and iron at the Rocky and Savage Rivers.

In 1873, a company with a nominal capital of £60,000 was formed with Launceston capital, of which only £12,000 was ever called up, to exploit the tin lode discovered by "Philosopher" James Smith, at Mt. Bischoff. The mine soon became world-famous, and the Company's £5 shares never fell below £80 for many years. Some 2,000 tons of tin were won annually by open-cut methods. Production costs were very low, as may be judged from the fact that half of the value of production went to shareholders. These facts will give some idea of the wealth that was obtained by the Mt. Bischoff Tin Mining Company. The quantity of metal produced has been in the vicinity of 82,000 tons, the value of which was nearly five and a half million pounds. Dividends paid to shareholders have amounted to more than £200 per share, totalling nearly two and a half millions.

Depletion of the original alluvial and gossan deposit, reduction in quality of the ore, the greater hardness of the material to crush and treat, and the change in the lode from gossan to pyritic formation greatly increased costs and output of the mine. By 1914, unfortunately, the depletion of the rich deposits synchronised with the collapse of the market. In 1921, costs had risen from 6/7d. per ton of ore treated in 1905, to 10/10d which were made up as follows:-

Wages	6/11.73
Materials	5.97
Firewood	1/7.63
Power	1/0.23
Maintenance	8.45
Total	10/10d.

The mine has continued to go down as a producer until the present day.

It cannot be said that Bischoff faced any greater problems as a tin producer than did Mt. Lyell as a copper mine. The Directors of Bischoff never

embarked on a bold policy of treating their low-grade pyritic tin and of reducing costs by increased output. Such a policy called for increased capitalization, but Bischoff was never prepared to take the risks that Lyell took. The Company paid to shareholders enormous dividends rather than provide reserves against less favourable times. Nor did they provide sufficient capital to enable the finding of an economical metallurgical process of treating the mine's large low-grade pyritic lodes. Even to the present time, little consideration has been given to the metallurgical side of the question, that of finding a method to yield more than 50% recovery of metal from milling pyritic ore. The results of pursuing too conservative a policy in risk-taking and too liberal a distribution of profits in good years have undoubtedly helped to bring the Bischoff mine to its present low-producing level.

Tin on the Heemskirk Massif.

The success of the Mt. Bischoff mine greatly encouraged prospecting for metals, and in particular led to a more systematic search among the mountainous regions of the West Coast. The wealth of Bischoff's shareholders was the ambition of thousands. Prospectors financed by syndicates, or on their own resources, pushed their way into the mountains to the south of Waratah. Business and professional men and workers alike became members of syndicates and eagerly financed the expedition of some prospecting party. Many believed that another Bischoff was only waiting to be discovered. Experienced miners found little difficulty in getting parties together, and could generally get a syndicate to pay expenses.

The fame of Bischoff spread to London, and when other finds of metal were reported, there was no lack of British capital waiting to be invested. The spirit of prospecting was indeed sharpened.

The Heemskirk Massif lies a few miles north of Mt. Zeehan, almost on the sea coast, to which the main range, almost five miles long, runs parallel. Here in the granite massif, traces of tin were discovered.

By far the most important result of the widespread prospecting was the discovery of silver lead at Zeehan. However, serious mining, did not come to Heemskirk till 1890. The results of prospecting certainly did not warrant the boom that came almost immediately to the field. Experience proved that prospectors' reports were much exaggerated. Small rich shoots of ore do occur in the field, and then finders, after examining the detrital from various outcrops, immediately assumed that enormous bodies of rich ore lay waiting to be found.

The public, already excited with the success of Mt. Bischoff, which at that time was producing 250 tons of tin oxide a month, value about £8,000, was only too willing to believe in the existence of another rich field. Consequently, much money was available, and speculation was so keen, and confusion so great, that many sections were pegged having no prospects whatever, while in others that were actually floated, a pick had never been put into the ground. Pegging out was carried to such an extreme, and amid such confusion, that many of the sections extended out to sea.

Even those sections with good prospects were not developed to test the depth or width of the supposed ore to be worked, for all available capital was used in building roads and tramways, securing and conveying machinery, advertising and boosting the field before any actual mining was done. "There was quite a stampede to erect batteries, without waiting to determine whether the propositions warranted such procedure." Again in some sections where machinery was installed, black tourmaline was mistaken for tin "with anything but dissatisfaction

to shareholders." (Tas. Geologist's Report, 1915). 16, 000 acres were pegged in 1879, the year of the Heemskirk Boom.

None of the mines ~~were~~ was successful, and only about 700 or 800 tons of dressed tin was raised from them altogether. It is estimated that more than £100,000 was spent in these mines, the majority of which might have been spared from such futile investment if a little systematic prospecting had been done, and more developmental work undertaken from the commencement.

Investors, on realising that their capital had been spent on unproductive works, naturally "cooled off", and their apathy spread rapidly to intending investors. The result was a lack of confidence in the Heemskirk field. The Heemskirk bubble burst, and for years its name was almost sufficient to condemn a proposition. The good that Mt. Bischoff had done, Heemskirk had undone. Although the field has seen several revivals, and more capital has been spent since, nothing of note has come of this field. Some scratching only is carried on to this day.

Other fields - North Eastern District.

The most important source of present tin production is the North Eastern district. With the decline of Mt. Bischoff in the twenties of this century, and favoured by a high steady price for tin, small companies increased their scale of operations on the alluvial and lode deposits in this part of the State, until their importance outweighed that of Bischoff's waning production The deposits of the North East are scattered, and varied in nature, and for this reason their exploitation favoured the development of the small company or syndicate. The mines of this region have had a devious (?) deviating career due to such factors as insufficiency of capital and the limited nature of deposits, and also because of the fluctuating

price of tin. Here some rich alluvial tin has been mined profitably when tin has been as low as £40 per ton, but these finds were never extensive, and have largely disappeardd, and now tin production in this area has become a high cost industry when compared with the principal producers of world output.

C H A P T E R III

PRESENT SOURCES OF SUPPLY.

Metallic tin mined in Tasmania for 1940 was 1,430 tons, the value of which was given as £367,127, both figures being a record for all years since 1919, but production fell to 1256 tons in 1941. Production is being maintained at about 1200 tons annually, but recent developments implemented by the Commonwealth Government give promise of increasing present output.

Tasmanian sources of tin are both primary, (or lode) tin, and alluvial deposits. Generally speaking, the primary deposits have cost more to exploit than the alluvial ones, for the reason that the former are not nearly so rich, but now such features as increased overburden and lower returns have offset much of the latter's advantage.

In the North Eastern districts both primary and alluvial deposits occur, the greater production coming chiefly from the alluvial fields. We will now examine the chief primary fields for the State:-

A. Primary Deposits.

1. The Storey's Creek field is the most important primary deposit in the North Eastern region. The field is accessible by rail within 14 miles, and then a road connects to the rail. Two mines occupy the field - they are known as the Aberfoyle and Storey's Creek mines. At Storey's Creek wolfram is the principal

mineral, being in excess of tin - the average grade being 1.4% wolfram (tungstic acid) and .35% metallic tin. Ore reserves are considerable, 154,000 tons was the 1937 estimate, but recent prospecting and development has revealed a considerable increase. During 1941 (1940) a total of 13,000 (12,676) tons of ore from stoping and development was milled for a production of 205 (259.6) tons of high grade wolfram, and concentrates containing 44.35 (33.5) tons of metallic tin. The average number of men employed was 91 (100). This mine has operated success fully over a long period of years.

At the present time (1942) there is an acute shortage of labour, which is estimated at 40% of that figure required to work at full capacity with the existing plant. The reason for this shortage is the fact that employment became plentiful elsewhere owing to the war, and because of the poor accommodation provided on the field, its isolated nature, enlistments and the occupation al disease rate, which is high, Storey's Creek lost man-power before the imposing of the restriction to transfer one's labour to employment elsewhere. The mine has been brought under the notice of the Commonwealth Controller of Minerals, and to Storey's Creek additional manpower is likely to be transferred in the near future. The potentialities of the field as a source of wolfram is are the main reason for Commonwealth concern. The wolfram concentrates from this mine are regarded as the best in the world, being 75% pure tungstic acid. The production of tin is secondary, but is important as such a time as this.

The mine is poorly mechanised - the mill being very antiquated. If the mine were modernised, production could be greatly increased. Whether or not the Government will require this to be done cannot be authoritatively stated.

The Aberfoyle Tin No Liability at Rossarden is a primary tin producer with approximately five years' reserves in sight and more than that period of possible reserves. During 1941 (1940) 16,185 (16,653) tons of ore were milled and sales were completed of tin concentrates containing 252.8 (318) tons of tin and 28.48 (20) tons of wolfram. The average number of men employed for that year was 108 (116). Production is more satisfactory here than at Storey's Creek, but with increased manpower output could be stepped up. The recovery of tin is 96% due to the coarse grain nature of the tin and the employment of Government metallurgists. Both mines are worked by underground workings to a depth of about 600 feet.

2. Another primary deposit is the Anchor Mine in the North East, operated under tribute from the Tasmanian Tin No Liability Company, which field is connected by eighteen miles of road with Herrick, the terminus of the North Eastern railway, 85 miles from Launceston. The deposits here are tin-bearing granite of an average grade of approximately 0.2% metallic tin which can be cheaply worked by open cut methods. Past production amounts to over 3,000 tons of tin oxide. In 1941, 26.11 tons of metallic tin were produced. Here again the tin comes from granite country, and the grain is coarse and the recovery good. This feature, together with open-cutting methods makes the proposition payable despite the low grade.

3. Mt. Bischoff. This mine of historical renown is the source from which 82,000 tons of tin oxide have been recovered by treating some 5,400,000 tons of ore. In 1941 (1940) the total production from this mine was concentrates containing 93.57 (130.22) tons of metallic tin valued at £24,549 (£33,506), these operations affording employment for 97 (115) men. Since 1929,

production has fluctuated with the price of tin. No exact estimate of reserves can be given, but it is well-known by all those who are associated with the field that there is still much tin to be won there. Operations are carried on by surface and underground workings. No prospecting and development of any scale has been undertaken for years, and the plant has fallen into an obsolete and out of repair condition. The mine has operated on the tribute system for about 20 years. The royalty paid by the miners to work the lease and have access to plant is now a flat rate of 22% instead of the previous sliding scale depending upon the price and output of the mill.

This Company has been asking for Government assistance to the extent of £4,000 to increase production. The Commonwealth Mineral Production Committee was prepared to recommend £2,000 to assist directors to increase production. The Commonwealth Mineral Production Committee was prepared to recommend £2,000 to assist directors of the Mt. Bischoff Company, but this was refused. Under the present management, production is falling. Costs are extremely high, and until the price of tin was fixed at the present high figure, it was stated that production was unprofitable and the Company asked for an increase in the price of tin.

A Proposition for Mt. Bischoff.

Data: Mt. Bischoff is now a low grade proposition with comparatively extensive reserves of low grade ore. The plant is definitely obsolete, and the mine requires mechanizing in a modern fashion. The Company is willing to relinquish ownership for £10,000 and the estimated cost of modernizing the plant and developing the mine is anything from £50,000 to £100,000, depending upon what scale operations are considered appropriate.

It is imperative that the present Company be deprived of the management if production is to increase.

This Company has long been indolent to the mine's prospective character because the majority of the shareholders and directors (mainly a select group) had made fortunes out of its past returns, and were satisfied to let well alone. Whether the Commonwealth Government should purchase the mine, or take it over on a rental basis for the duration would be immaterial to production. The Commonwealth Government must find the necessary capital to put the mine in order and to increase production. It is well known that the proposition's success depends upon the present high price of tin, and that the industry is likely to be a war-time one. For this and other reasons private capital is not likely to be forthcoming.

Having secured the mine, the Commonwealth Government could either appoint its own managerial staff or lease to some industrious Mining Company with the staff and experience necessary. If the latter method were adopted, all necessary capital and manpower would have to be made available to the private enterprise as is done with munitions' annexes.

If the mine were put under new management and given the necessary capital, there is every indication that the field would add materially to the Commonwealth's drive for more tin. Mt. Bischoff is at present only a partial producer with distinct possibilities of contributing to the Commonwealth requirements.

It cannot now be contended that because private enterprise is not prepared to assume the risk that the proposition is not sound. Capital and manpower restrictions are such that private enterprise is unlikely to try to launch any large scale ventures. In face of these conditions, the Commonwealth Government must be prepared to assume the responsibility if the tin is required.

(Since drawing the above conclusions, it was

been announced later in 1942 that the Commonwealth Government had taken over Mt. Bischoff for the duration on a rental basis. The exact terms of this arrangement have not even been fully revealed to the Directors of the Mt. Bischoff Tin Mining Company. The extent to which the Government intends applying capital and labour to the field is not known.)

4. Renison Bell is a lode tin proposition of low grade, where two small companies, the Renison Associated Tin and the Tasmanian Associated Tin, are independently operating and recovering less than 150 tons a year between them. This field is reported to have the largest pyritic deposit in the Commonwealth, where it is estimated upon data provided by prospecting and development that reserves are 2,500,000 tons. The assay is low, and probably would not be much in excess of from ~~1.35~~ .9 to/.3%. Recovery at the present stage of metallurgical science is only 50%, but even with such a poor recovery, mining operations could be so staged as to mill 5,000 tons daily, and by this effect a yearly output of 3,000 long tons of metallic tin. This field is admirable suited to open-cut methods , which provide cheap mining. It is estimated that if £300,000 were made available, concentrates would be forthcoming in six months. This cost instalment figure could probably be greatly modified.

Private enterprise could not be expected to provide the capital at this stage, but if the Commonwealth Government provided the capital and allowed a specialist company to effect the detailed control arrangement, the same should prove most satisfactory. The method adopted would be the same as for the munitions' annexes. The field is served by the Government Hydro power, and connected by the Emu Bay Railway with Burnie.

The main world sources of tin have been the rich alluvial deposits of Malaya, Bolivia, East Indies

and Thailand. Pyritic tin deposits have always been regarded as high cost producers, and unable to compete with these other sources of supply. For this reason, little, if any, attention has been given to a successful metallurgical treatment, and at present recoveries are very low (50%). It is suggested that if attention were given to this aspect, then the future of these deposits might become a valuable one. Tasmanian pyritic tin is today where her sulphides were at the time of the last war. A successful and economical method of recovery is urgently awaited.

A proposition for Renison Bell.

The Commonwealth Government to provide capital for the extension of operations as previously suggested or the two present companies to amalgamate and use their combined resources in developing the field and then solicit Government assistance in the form of a loan to step up production.

(It has been reported recently (late 1942 and early 1943) through the press that the mine has been brought to the notice of the Commonwealth Controller of Mineral Production, who has ordered an immediate geological survey. Dr. Fisher of the Melbourne University is at present making the survey. If reports are satisfactory then the Commonwealth Government will give financial assistance. During the visit of the Commonwealth Controller of Minerals, it was pointed out to the Companies operating that it would be in the best interests of the Commonwealth that the companies should amalgamate and pool their resources before Government assistance would be given. Both companies are insufficiently staffed to attend to their metallurgical difficulties and to the saving of the fine tin now being lost. It is understood that Mt. Lyell is now giving the technical assistance required.

It is expected that Renison Bell's large

reserves of low grade ore will soon become Australia's chief source of tin, but the fact of this expectation is yet to be seen. Everything appears favourable for its development, so long awaited.)

B. Alluvial Deposits (North Eastern Districts.)

The Briseis Consolidated No Liability Company is the largest producer of tin in the Commonwealth, and has been in continuous production for over 50 years. The mine is situated at Derby, 61 miles from Launceston by either rail or road, and is managed by the Burma Malay Tin Ltd. with head office at 117 Pitt St., Sydney, and has a subscribed capital of £150,000.

The proposition is an open cut one worked with hydraulic nozzles to remove overburden of some 120 feet to reach drifts of 280 feet thickness, containing alluvial tin. The following facts were obtained by courtesy of the Briseis Consolidated No LiabilityCompany.

The workings have yielded in the past over 15,000 tons of tin concentrate of a 74-75% standard. Production figures for the year 1941 (1940) were "Overburden removed by sluicing, 205,000 (202,000) cubic yards tin-bearing drift sluiced 733,000 (752,000) cubic yards which were estimated to contain 425.09 (481.89) tons of metallic tin whose sale value delivered to Launceston was £A123,204 (£A134,190). The average number of men employed in the same period was 152 (163). Average working cost for 1941 (1940) was 18.98 (16.54)pence)per cubic yard, while recovery was 1.65 (2.03) lbs of tin oxide per cubic yard.

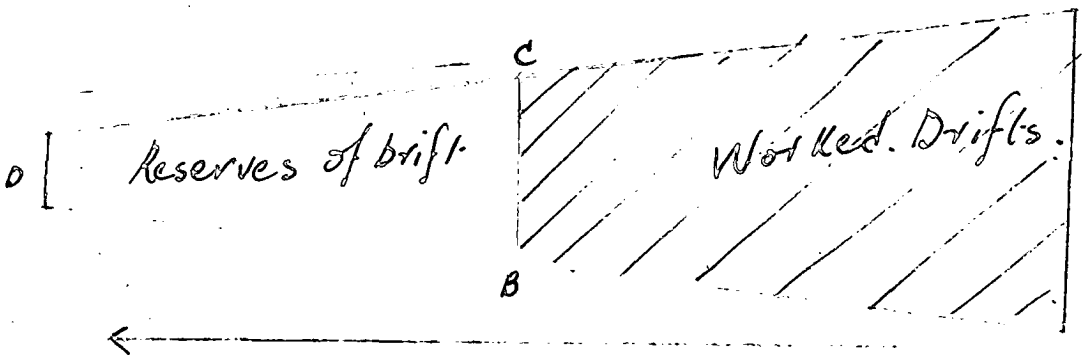
In 1942, the recovery assay was 1.35 lbs of tin oxide to the cubic yard. This deterioration in the nature of the lead, together with the increased price of labour and stores was responsible for a considerable increase in total working cost.

The mine is well-developed, and complete with modern equipment and hydro electric power. The Company is now purposing to work further leases at the instigation of the Mineral Production Committee.

At present, May 1943, 140 men are engaged by the Company. Present difficulties, due to war conditions, are shortage of manpower and difficulty in securing necessary supplies.

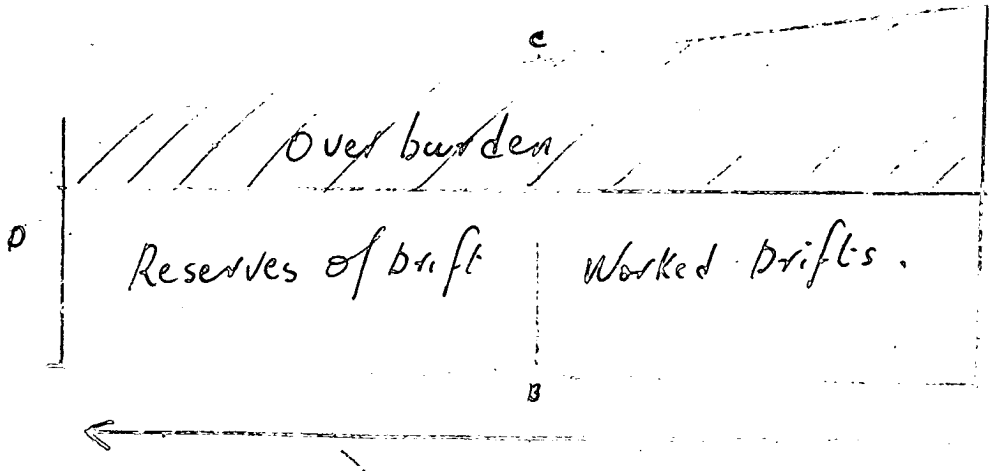
The lead that is at present being worked resembles a giant sluice box. The head of tin has been extracted, and the lead is now becoming poorer in assay and size.

One might represent it thus :- (Plan looking down)



Part shaded has been worked. One factor in favour of operation is worth noting, and that is, as the lead grows poorer in returns of tin, the removal of overburden becomes less. This fortunate gift of nature is a big factor in helping to steady rising costs.

Elevation view is thus.



The Company is working in direction of arrow, and is now in position of BC, and working toward a point D.

Reserves. The Company has recently undertaken a big

1938 10/4.

BRIMBIS CONSOLIDATED NO LIABILITY (Registered Canberra)

Liabilities and Capital

Authorised Capital			
6,00,000 shares of 5/- each £150,000			
Issued Capital			
600,000 shares of 5/- each (fully paid up)	150,000	0	0
General Reserve (used in the business)	21,222	19	9
Depreciation Reserve (used in the business)	9,904	0	0
Provision for Taxation	41,117	8	11
Sundry Creditors	873	8	2
	£223,147	16	10

Assets.

Freehold Land at Cost				£298 9 0
Mining and Real Property Leases at Cost				6,616 0 0
Development A/c at Cost				81,382 13 11
Dams and Races at Cost				60,991,11 1
Plant, Machinery & Motor Vehicles at Cost				26,278 4 10
Pipe Columns at Cost				13,110 12 8
Mine Buildings at Cost				5,481 1 7
Office Furniture and Fittings				339 9 5
Stores on Hand				5,168 12 7
Debtors				10,948 3 6
Bank	5,522	18	3	
Deposit at Call	7,000	0	0	
Cash on hand	10	0	0	12,532 18 3
				£223,147 16 10

(As shown in Directors' Report to Shareholders for the year ending 31st December, 1940.)

boring survey in an attempt to estimate the future of the mine. The reserves of ore cannot be stated accurately but they are believed to b e very indefinite and not at all promising. It has recently applied also to the Prices Commissioner for an increase in the price of tin (May, 1943) as its total costs, including allowance for depreciation, have now reached the place where the profit margin has been eclipsed. If the price of tin is not raised, the Company will probably receive a subsidy from the Tin Pool.

It is extremely difficult to see how the Company will operate in the post-war period as costs are now so high that even the present high price of tin is insufficient to make production profitable.

Two other important alluvial properties are the Endurance mine, operated by the Eddurance Tin Mining Co. No Liability, some 20 miles north of the Briseis at South Mt. Cameron and the Goshen Tin Co. (formerly the Siamese Tin Co.) near the coast at St. Helens.

The Endurance is similar in character to the Briseis, but is now penalised by basaltic overburden. Hydro electric power is now available for the mine and plant. Production over the past seven years ending December, 1941 is approximately 700 tons. Total reserves of wash are given as 5,112,800 cubic yards containing 1,385 tons of tin oxide or 0.6 lbs per cubic yard. The mine is well developed, and operated by modern hydraulic sluicing methods. Boring carried out in 1939 proved an area containing 3,882,000 cubic yards of tin-bearing ground averaging 0.6 lbs of tin oxide per cubic yard providing 1,045 tons of tin oxide to be exploited. During 1941 (1940) a total of 447,700 (356,700) cubic yards was treated for concentrates containing 60.73 (111.91) tons of tin with some 81.44 (27.46) ozs of fine gold. Present reserves of ore are in the neighbourhood of eight to ten y ears.

The Goshen Tin Company at St. Helens is another small producer, which in 1940 produced 25.6 tons and increased production in 1941 to 41.45 tons of metallic tin.

Besides these principal mines, there are many small fields employing from one to half a dozen men, and which are producing en masse over 250 tons of tin annually

KNOWN DEPOSITS AT PRESENT NOT WORKED.

Besides these fields that are fully producing, and those only partially producing, there are in addition some other fields where tin is known to exist, and which have received some attention from prospectors and geologists. They are:-

1. Mt. Heemskirk, which has been previously dealt with.
2. Blue Tier deposits in Eastern Tasmania. These have received insufficient prospecting, and development to give any reasonable evaluation of their worth. Suffice it to say State Geologists do not hold much hope of their proving anything more than a place for scratchers.
3. At Mt. Cleveland on the Corinna Rd., south west of Mt. Bischoff, there is a large body of pyrrhotite which is a source of tin similar to that of Renison Bell. It is more easily decomposed than pyrites, and is one of the State's potential fields. The assay, of course, is very low, and the proposition requires much capital. The field is unlikely to receive much attention while Renison Bell's potential reserves remain idle.
4. Stanley River. This field has not received sufficient attention by the geological prospector. It appears to have distinct possibilities, but capital is not likely to be forthcoming until something attractive is discovered. The old-time prospector has disappeared, and consequently the field has received little attention since the first and only geological survey was made in 1913. Transport difficulties have militated against its development.

Packing charges have been about £12 - £14 per ton. At one time speculators gambled freely over its claims, but this soon died away when no metal was forthcoming.

5. Cox's Bight and the country to the south of Macquarie Harbour. Although several discoveries of minerals have been reported from this region to the south of Macquarie Harbour, including gold, copper, iron and tin, nothing of importance has been noted. From 1913-1918 some work was done on the field and again during the thirties tin-scratching was in favour.

6. Granite Tor. The Granite Tor and High Tor are mountains to the west of Barn Bluff in Western Tasmania, and are featured by granite protrusions which is the usual parent of tin-bearing ore. Traces of tin had been reported from this region as early as 1893 and between 1915- 1920 a tin show was worked on the Bluff River. Although no mines have been opened up in this region, the area is regarded by prospectors as distinctly promising.

C H A P T E R I V

STAGES AND COSTS IN TIN PRODUCTION.

Mining The first cost occasioned in tin production is that of ore-extraction. Extraction costs in turn depend on the nature of the lode. There are both primary and alluvial deposits. Primary deposits are worked by both open cut and underground workings, while alluvials employ only the former method.

With Storey's Creek, Aberfoyle and Bischoff, which are worked chiefly by underground workings, the chief items entering into costs are:-

1. Wages
2. Timbering
3. Stores - explosives, etd.
4. Power

while with the Briseis, and some of the others on alluvial deposits, the chief cost items are:-

1. Wages
2. Water
3. Stores
4. Power

The alluvial drifts are covered with basalt often to a very great depth, and this overburden, as it is called, is broken down by hydraulic nozzles supplied with a head of water. This breaking down by hydraulic means requires a regular and enormous supply of water. At the Briseis Consolidated, 2000 cubic feet per minute are brought to the mine from a distance of 30 miles. As the summer months are usually dry, this water is often brought very great distances with consequent heavy expense. The rainfall in the area is only about 40 inches, which necessitates water conservation schemes. Water rights have also to be obtained at additional cost. Cheap hydro-electric power is now supplied to the chief mines. It is suggested by engineers that present high mining costs occasioned through the present method of using a head of water to wash away over-burden and also

the alternative method of supplying hydro electric power to pump water for this purpose when the former is not practicable, could be reduced if the problem was attacked from another angle - that of using the cheap hydro-electric power direct. By some mechanical device of bucket elevators (dredging) the overburden might by carried away off the alluvial drifts. It is hoped that engineering science will be able to reduce the mounting extraction costs on Tasmania's principal alluvial mines. Some device of this sort will be urgent in the post-war period.

Milling.

The process of reducing the crude ore in the case of the primary lodes is more costly than that of reducing the alluvial deposits.

In the case of the former, the ore has first to be crushed and then milled according to its specific nature. In the case of the gossan (iron oxide) and granite country carrying tin - the process is simple. The ore has simply to be ground finely enough to effect a separation by gravitation through the medium of water. The water requirements for this process are not very great. If the primary deposit is a pyritic body, then the process is more complicated. Not only must the ore first be crushed to a fine powder, but chemical analysis is needed to separate the fine iron pyrites from the equally fine tin oxide. In applying a metallurgical process requiring reagents, or roasting in furnaces, costs are increased to nearly double that of the gravitation method. Here, too, a poor recovery of only about 50- 75% of tin adds to the cost of production. Alluvial reduction is simple and comparatively cheap, gravitation methods being effective.

A factor reducing production costs.

Some of the mines recover with their tin

either gold or wolfram, or both. Both of these metals are very valuable, and for this reason afford a handsome additional return. Wolfram and tin are easily and cheaply separated by magnetic attraction, while the gold can also be simply recovered with the tin concentrate. Separation costs for these metals are small, and their presence is therefore a valuable factor in helping to make otherwise uneconomic lodes profitable.

Transport Costs.

All Tasmanian tin mines produce a concentrate containing tin oxide, which in comparison with its value is not of any great bulk, when compared with such metals as lead or copper. For this reason, transport costs are not heavy. Also, the concentrate is of remarkable purity for the majority, and this further helps to reduce transport costs. All the principal mines of the State are easily accessible to the ports, and in no case does metal have to travel more than 100 miles by rail before reaching a port. It is there shipped to Sydney, where two smelteries give accommodation to all the Commonwealth's tin concentrate.

Smelting and Processing

The smelting process is simple, that of reduction with coke. Tasmania did have a smeltery at Launceston when Mt. Bischoff was fully producing, but today this is not warranted.

When smelted the metallic tin is in close proximity to those consumers who require it either in ingots or place. It is then processed into various saleable forms to suit the many tin buyers. This market is, generally speaking, now close to the place of refining

Marketing.

Prior to the war approximately one-third of our refined tin found its way to overseas markets, but a very small proportion, only about 3% was exported in ore or concentrate. The remaining two-thirds of output

was absorbed by the home market. During the present war, the Commonwealth Government has assumed control of the output from her smelteries, and export is subject to license.

Finance - A Marketing Cost.

Fortunately for the industry, concentrates can be shipped regularly and payment received promptly. Finance has therefore not to be arranged for any long periods as with silver lead concentrate shipped to America. The cost of credit accommodation therefore assumes small proportions, as a home market for tin greatly reduces the cost of finance.

AN ANALYSIS OF COSTS AT THE CHIEF CENTRES OF PRODUCTION.

Unfortunately, production costs could not be procured for many of the mines considered in the fore-going survey. The chief producing Company - the Briseis Consolidated No Liability at Derby courteously supplied the following information which gives a valuable appreciation of their rising costs in producing tin from alluvial sources in this State.

BRISEIS CONSOLIDATED NO LIABILITY - MONTHLY COST SHEET @ OCTOBER - 1942.

Cost of Overburden Removal		Pence per cub.yd.
Wages	£1161. 11. 6	7.444
General Stores	74. 4. 8	.494
Explosives	451. 0. 6	3.077
Head Races (water)	31. 2. 10	.208
Salaries	117. 17. 0	.786
Insurance & Lease Rents	160. 7. 1	1.069
Power	17. 11. 9	.117
TOTAL	£1968. 15. 4	13.125

Cost to work Drifts		Pence per cuB.yd.
Wages	£1674. 19. 2	5.911
Gneral Stores	309. 8. 10	1.092
Renewal & Repairs to Pump	53. 8. 7	.187
Head Races (water)	99. 17. 9	.352
Salaries	235. 14. 0	.836
Insurance & Lease & Rents (for water & mining rights)	374. 0. 0	1.320
Power	702. 9. 5	2.478
TOTAL	£3449. 14. 9	12.176

ANALYSIS OF COST FACTORS FOR BRISEIS CONSOLIDATED IN ORDER OF IMPORTANCE

These figures are arrived at from Cost Sheet for month of October, 1942 (See page 108)

	Overburden Cost pence per cub.yd.	Drift per cub. yd.	% of Total Cost paid to factors.
1. Wages (Operating labour)	7.444	5.911	53%
2. General Stores (including explosives)	3.581	1.092	19
3. Water (Lease Rights & Races)	1.277	1.672	11.8
4. Power Electricity	.117	2.478	10
5. Administration * (Salaried Staff)	.786	.836	6.1
6. Renewal & Repairs to pump for sluicing drift		.187	.1
	13.125	12.176	100%

* Administration here is more correctly the amount paid to salaried staff which includes some operating labour such as salary to the electrician, engineers and surveyors If the generally accepted concept of administration were followed, the percentage due to this item would be correspondingly reduced. Nevertheless, administration cost in small mines is high compared to large ones.

Approximate Percentage of Cost paid for factors of production as analysed is not exact, but is a general guide to the allocation of costs, reckoning the treatment of drifts in the proportion of 2 : 1 respectively.

The total working cost for October, 1942 spread over drift removal was 19.124 pence per cubic yard. Although it cost 13.125 pence per cubic yard to remove overburden to allow working of the drift, the cost spread over the drift yardage treated was only 6.948 pence per cubic yard. This figure, added to 12.176 pence - the cost to treat the drift, gives us the total cost per cubic yard to work the drift, which is 19.124 pence as stated above. For comparison with costs for other months of 1942, total cost to treat drift was:-

in February	17.136 pence per cubic yard
July	21.85
August	20.015
September	21.206
October	19.124

The Company was unable to release the average working cost for the whole year (1942) for National Security Reasons, but an average of the months given is sufficient for our purpose, and is fairly indicative of the average working cost for that year.

Average working cost for	1939 was	16.02	pence per	cub.yd
	1940	16.54	" "	"
	1941	18.98	" "	"
	1942	19.86	" "	"
		(as estimated from above)		
	1943	Costs have increased.		

The Company receives £12 per bag of 112 lbs for its tin concentrates delivered to Launceston, from whence it is shipped to the smelteries at Sydney. That is 25.7 pence per lb of concentrate and with a yield of 1.35 lbs from a cubic yard of drift, returns would realize a gross sum of 34.695 pence.

Profit margins on each cubic yard of drift may be represented thus for 1942:-

Profit & Loss Account.

Total Working Cost	19.86	By Gross Returns on Concentrate	34.695 pence
To Gross Profit	14.835		
	34.695		34.695

Out of Gross Profits must be deducted the following:-

To freight & realization expenses	.05	By Gross Profit	14.835
" Prospecting & devel.	3.0		
" Depreciation	3.0		
" Incidental Expenses	.05		
" Head Office Admin.	.05		
	6.15		
" Net Profit	8.685		
	14.835		14.835

In April, 1943, the Company announced that its plant was now operating in ground of 0.58 lbs average per cubic yard. This was a decline of approximately 55% in returns, and which with other factors driving up costs, must have brought expenses to the point where profits were being eclipsed. The Company had at that time applied to the Prices Commissioner for an increased price for its tin, but more probably it received assistance from the Tin Pool.

Setting aside the price of labour, which is outside of the industry's control, we can now summarize the chief factors responsible for high production costs:-

The Briseis

Firstly, poor returns for the amount of overburden to be removed to arrive at drift is now a problem of the first magnitude. Secondly, sluicing costs, which are high, because such a procedure of removing overburden is slow. A huge supply and head of water is required, which necessitates damming at higher altitudes, securing of water rights and conveying by way of pipes for a distance of over 30 miles. Thus, to operate profitably, the low grade alluvial, either sluicing costs must be reduced, or a new technique found. The latter alternative appears the only one likely to provide a solution.

Renison Bell. The difficulty is not one of ore extraction as at the Briseis, but one of ore reduction. The tin is so very fine that it will not gravitate through water to effect a reasonably high recovery. As no effective metallurgical process has yet been discovered, that will guarantee an efficient reduction, sufficient capital has not been attracted to the field to provide the necessary investment required to treat a big low-grade proposition on a payable basis. The futile attempts of too many small scale ventures have helped damn the field's prestige in the eyes of enterprise and capital.

Mt. Bischoff The obsolete state of the mine and plant together with the fact that the ore remaining is of a comparatively low grade militates greatly against re-investment on this field. If the mine had been kept is reasonable repair, then re-investment wouldnot have to be undertaken on such an extensive scale making for smaller odds in the venture. The distepair of a mine is a big factor when it comes to restarting, as the initial outlay is often enormous before anything can be returned.

Storey's Creek. There is urgent need of modernization of mining plant with an extension of mechanization. Further, the mine is an unhealthy one, and there is frequently a shortage of manpower with consequent under-capacity.

Aberfoyle. This is perhaps the lowest cost producer of any of the larger mines in the State, with the exception of Storey's Creek, but even here costs are high compared with overseas sources. Extraction costs are high because underground workings are necessary to operate the lode tin deposits. Plant is also antiquated, and in need of complete modernisation.

CHIEF TASMANIAN TIN MINES

(Production figures taken from Sec. for Mines Rep. To-

Field & District	Mines Operating	Nature of Deposit	Past Production	Assay 1939 - 1941	Production Metallic Tin in Tons 1939	1940	1941	Reserve Tons in 1940
North Eastern	Storey's Cr.	Primary	408 tons	0.35%	34.7	33.5	43.35	154,000
Rossarden	Aberfoyle	"	1,863 "	1.5%	192.73	318.0	252.18	61,616
North N.E. & Eastern	Goshen Anchor Arba Ruby Flat	Primary & Alluvial	-	Variable	20 34 17 11.11	13. 24 28 10	41.45 14.27 6.86	Nothing Exact
do.	Others (synds.) including Scratches				273.26	181.88	194.07	
North East								
Derby	Briseis Consol.	Alluv.	15,000	1.5 1.35 Lbs to cub.Yd	363	481.89	425.09	Not available
Sth.Mt.Cameron	Endurance	"	Not procurable	0.6 0.6 lbs to cub.yd.	96.89	111.92	67.73	5,112,800 cub. yds.
Western	Scratching				14.32	7.87		
North West.	Mt. Bischoff Tin Co.	Primary (Gossan & Pyritic)	82,000		136	130.27	93.57	No estimate
Western Nth.Dundas	Renison Assoc Tin. Tas. Assoc.Tin	Primary (pyritic) Gossan	sold over £250,000	.9 123	3	57.8 11.8	80.2 41.0	2,5000 tons
Heemskirk Western	Heemskirk (scratching only)	Primary& Alluvial		variable.	5.35	1.8	3.1	

THE GENERAL PROBLEM - HIGH COST OF PRODUCTION.

There is now no present source of supply that has not a very high cost of production. In all cases there are either high extraction costs or high reduction costs, and these in turn are the result of any one or a combination of the following factors:-

1. Insufficient mechanization, scale, and modernisation of plant.

2. The nature of the deposits worked, which are either of small extent or low content.

Some companies feel that modernisation and increased mechanisation or scale of operations are definitely not warranted in view of the very limited nature of their ore reserves. Others are faced with the problem whether their low grade deposits are worth the risk associated with the large investment of capital required to reap the benefit of mass production. Thus in all cases, operations are on such a limited scale and often with such antiquated plant, that there is really no company that can expect to effect a satisfactory solution to its problems.

The hope of substantially reducing production cost can only come by :-

1. Better Deposits
2. Improved technical methods
3. Increased mechanization and modernization of plant.
4. A reduced wage rate for operating labour.

During the war period, it is difficult to see any one of these factors coming to the assistance of the industry - better-yielding deposits are not likely to be found when all companies have insufficient manpower to speculate in search of richer ground. A more economical technique in sluicing of alluvial or treatment of pyritic ores depends on invention, the coming of which appears in the lap of the gods. The increasing of mechanization

and modernisation is being effected very slowly, for the reason that such a measure is difficult in war-time when firms once turning out mining machinery are often engaged on other work, or having difficulty in securing raw materials to continue manufacturing economically. Again, many companies are reluctant to effect a modernisation of their plant when they are uncertain as to the extent of their reserves. A very high price for tin such as is ruling today encourages high costs. There is no great pressure to recast production in a mould where costs can be curtailed when the price for their product is so high. This latter consideration is more than ever true when the taxation machine is clipping companies' profits drastically during a major war. Finally, reduced wage rates are unthinkable when the cost of living is rising, and labour is scarce. It therefore appears that high costs must continue while the war lasts.

CHAPTER V

THE INDUSTRY DURING THE WAR.

The tin industry in Australia is required to increase production to meet the urgent demands of war. Britain has lost 29% of the world's total output with the Japanese occupation of the Malay States, and her war demands are outstripping supply? Australia, although only producing some 4% of the world's tin, is Britain's second most important Empire source of this vital commodity.

The increasing of output in Tasmania is now an urgent matter. The Commonwealth Government has appointed a Controller of Mineral Production, who has formed local State Committees to investigate the industry and make recommendations to help increase output in all the tin-producing States. The export of tin is now subject to strict Government control. Every effort is

being made to conserve the use of tin. All tin plate is subject to Government license, and cannot be used by manufacturers or distributed by refineries without a permit. The wartime need is to conserve the use of and increase the production of tin.

Tin production in Tasmania has been stimulated by the high fixed price of £376 per ton (April,1943) but the degree of stimulation, as is to be expected, has been limited by the Commonwealth manpower control. All fields are short of labour, varying in degree, and as mechanization is extremely difficult to substitute for labour in wartime, and for the reason that mining requires a fairly high proportion of labour to capital, even where mechanisation has gone far - expansion in the industry has been most difficult.

Again, because many of the mines were poorly equipped at the beginning of the war before being encouraged to develop and modernly equip by the Commonwealth Government, their production figures do not represent their potential capacities. The majority of the companies are working leases carrying reserves, promising an output of something higher than present scales for periods ranging from five to ten years. A further deterrent is the fact that financial resources of the majority of producers are small, and consequently, many have done insufficient prospecting and development work to allow proper organization and planning.

Production for the next five years under the present high price of tin is likely to keep the incentive to produce at the present high level. There is little possibility of materially increasing the State's capacity to produce without direct Government assistance to those fields such as Renison Bell, and where manpower requirements are urgent.

Production of tin in the North East is very largely and almost directly dependent upon the rainfall. A very dry year could seriously interfere with the State's output. Approximately 50% of the mines would be affected if the rainfall was in any way erratic. Many of the small mines are closed for the summer months, and production on the larger ones is often slowed up for a part of the season. This factor could be partly overcome by applying directly the hydro power to remove over-burden by some mechanical device, and thus ease the reliance on water.

Apart from this seasonal factor, production could be stepped up by the application of more labour and more up-to-date mining plant. There is now every indication that the Commonwealth Controller of Minerals is going to do something to aid mining companies here. Already Mt. Bischoff has been taken over by the Commonwealth Government and Renison Bell has received a bonus of £6,000, but exactly how much further assistance is going to be given is not revealed. As the mines stand at present, and seasons remaining normal, the companies operating will find it hard to maintain present production for a period longer than five to seven years.

Given material assistance, production should be easily stepped up by 500 tons annually, with a possibility of 1,000 tons. By increasing production at Aberfoyle, Storey's Creek and Endurance by 20%, and at Bischoff by 100%, production could be annually increased by 500 tons. It is not thought likely that they could continue this rate for more than five years.

Then if Renison Bell were given what capital it should have to work economically, production there should be 500 tons annually. These figures are not extravagant, as most authorities place Renison Bell's capacity from 1,000 to 3,000 tons annually. But it is assumed in this article that the Commonwealth Government

cannot spare the maximum requirements of manpower and capital to float these ventures on the scale that many would like to see. In arriving at the figures given here, consideration is taken for only what might be reasonably expected by way of Federal Government assistance.

Controller of Minerals.

The Controller of Mineral Production, in collaboration with the Tasmanian Director of Mines has been very active in recent months investigating the tin industry and giving attention to claims for assistance by mining companies.

One scheme to augment production has been nearly completed. A 500-ton dredging plant formerly used for alluvial gold drifts is now installed in the North East to work alluvial tin deposits in the Ringarooma Valley.

Another is the re-opening of the Valley tin mine, which is now to be operated by the Briseis Company on a fairly large scale. In the former workings, the drifts were not treated in the deepest parts, but sufficient water rights have now been obtained to treat the whole of the alluvial deposits there economically.

Production has thus been stepped up by :-

1. Re-opening of old mines where production is now profitable under the new price regulations.
2. Application of capital and labour to new deposits.
3. Intensification of production on fields partially working to bring them to full capacity by (a) bringing them under Government control or (b) financing them to acquire a more effective plant or to enable them to carry out further prospecting and development and (c) placing more manpower at their disposal.
4. Maintaining production from sources that have become extra-marginal producers by means of subsidisation with funds from the Tin Pool.

PRICE PEGGING IN AUSTRALIA.

Shortly after the outbreak of war in 1939, the Australian Federal Government pegged the price of tin which in December of that year was £A299 a ton. It was stated through the press that the Government intended to keep to the policy of pegging, although tin was not pegged in London.

The price has been gradually raised under the system of pegging until in May 1942 it was £A371 a ton, and is now, May 1943, £376. ~~Too,~~ The Federal Government appointed a Tin Committee to investigate the industry, and this Committee made a tour of the Tasmanian fields in the early months of 1942. There is no doubt that the recommendations of this Committee have been responsible for the price increase from time to time.

The Prices Commissioner stipulated in May 1942 when the price was raised £51 that £10 for each ton paid for at the new price of £371 was to be placed to a common pool to be used to stimulate production in less profitable areas.

It has been the policy of the Controller of Minerals to increase production by recommending a high price for tin, common to all producers. The result of this scheme has been to bring about the greatest activity with the capital and labour at the disposal of the mining companies, but there has been little incentive to solve the problem of rising costs in production.

With the price pegged, companies felt confident to venture, knowing that the risk of price fluctuation was temporarily removed, risk always being a deterrent to enterprise.

The policy of the high fixed price brought many extra-marginal producers into the profitable category and so helped to increase production from that source.

The effect of the high price for tin may be summarised as follows:-

1. Increased profit margins have stimulated the search for new deposits.

2. Former extra-marginal producing fields re-entered as producers.

3. Prospecting was stimulated and a flow of fresh capital was more easily brought to where production had reasonable prospects that were formerly untenable or otherwise doubtful.

4. Stimulation of activity on all fields to push output to that place where the marginal ton of tin produced paid the cost of its production.

Thus on mines showing big profit margins, much that would otherwise have gone to shareholders has been put back into prospecting and development. Bigger contract prices have been paid to labour to increase output and overtime rates paid for longer hours worked with the same object.

A comparison of price and production is interesting. There is one disturbing factor to the matter of comparison, and that is the rainfall on the NorthEast. Although the price factor has stimulated activity, the impossibility of getting the tin out without sufficient water makes a study in this direction difficult, and figures are therefore deceitful.

Undoubtedly, the high pegged price of tin has done much to bring production in this State to its present high level, and from statements made from time to time by directors, managers and press reports there is every indication that production is only possible by virtue of this factor.

WORLD PRODUCTION OF TIN ORE IN METRIC TONS (000's omitted)

Country.	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	
Fed. Malay States	68.1	63.1	54.3	27.3	23.0	36.6	41.4	65.7	76.6	41.8		Obtainable.
Nether. East Indies	31.1	35.1	27.8	17.1	12.8	20.0	20.5	31.2	39.8	27.7		
Bolivia	47.1	38.8	31.6	20.9	15.0	23.5	25.4	24.4	25.5	25.9		
Siam	10.7	11.7	12.7	9.4	10.5	10.3	9.9	12.7	16.2	14.0		
China	6.5	6.3	5.9	7.3	8.4	8.0	9.9	10.6	11.3	9.0		
Australia	2.3	1.5	1.8	2.2	2.9	m 3.0	3.2	3.4	3.7	4.0		
Others	The difference between the total and those listed.											
World Total	191	179	151	100	89	124	139	182	211	158		

SMELTER PRODUCTION IN METRIC TONS (000's omitted) OF PRIMARY TIN ONLY (excludes that derived from scrap)

Br. Malaya	107.2	98.5	88.9	50.8	47.7	50.4	61.5	85.9	96.9	65.8		Not
United Kingdom	56.3	48.1	36.2	29.0	18.5	26.0	29.6	34.7	34.3			
Netherlands	.7	1.9	3.0	5.1	13.6	15.9	21.2	27.0	27.0			
Neth. East Indies	13.6	14.6	13.0	8.2	8.9	10.7	11.4	13.1	14.0	7.4		
China	6.5	6.3	5.9	7.3	8.4	8.0	9.9	10.6	11.3	11.8		
Australia	2.3	1.6	1.7	2.0	2.4	2.4	2.9	2.8	3.0			
Others	The difference between the total and those listed.											
World Total	192.0	176.6	154.6	105.1	96.7	118.9	141.9	180.8	199.9			

Figures obtained from the Statistical Year Book of the League of Nations 1938/39.

C H A P T E R V I

THE FUTURE OF THE INDUSTRY IN TASMANIA.

Tin is an indispensable metal that enjoys a wide market in all modern states throughout the world, but production is confined to a few of them. As yet, no entirely satisfactory substitute for tin plating as a safe food container metal has been discovered, and consequently tin assumes the importance of a strategic commodity in most countries. 95% of all tin produced is used as metal chiefly in the form of tin plate for the canning of foods. The other 5% is used in the chemical industry mainly for certain glasses, enamels and for mordants in dyeing. 40% of the metal goes into bronze and numerous alloys necessary to the automobile, aviation and electrical industries. A small percentage is used for tin foil and collapsible tin tubes.

Although great progress has been made in economising in the use of this metal and in the art of tin recovery from scrap (U.S.A. in 1928 recovered 32,000 tons, or more than one-sixth of world output), there is much evidence thashow that demand will increase with the raising of the standard of living and with the progress of civilization generally. Especially as more people become engaged in secondary and tertiary industries, and the proportion of agriculturalists decreases, while urbanization also increases, will tin plate for food-canning purposes increase in demand. The greatest competitor to tin-mining appears in tin recovery from scrap.

World production of tin for 1938 in long tons is shown hereunder, and for all years between 1929 and 1938 on Page121, the chief centres being in order of importance, Malaya, Bolivia, and the Netherlands East Indies, which between them supplied two-thirds of the world's supply.

WORLD PRODUCTION FOR 1938

Country	Long Tons	Percentage
Malaya	43,247	29.40
Bolivia	25,371	17.20
Netherlands East Indies	21,024	14.24
Siam	13,520	9.19
China	11,246	7.64
Congo	7,316	4.97
Nigeria	7,305	4.96
Burma	4,000	2.72
Australia	3,600	2.43
Cornwall	2,000	1.36
Japan	2,000	1.36
Argentine	2,000	1.36
Others	4,655	3.17
	147,284	100

The chief centres of production may be divided into roughly three, firstly, the Eastern division comprising Lower Burma, Siam, Malaya and the Western part of the Dutch East Indies, Indo China, and the Chinese province of Yunna. This region provides about two-thirds of the world's tin supply.

The second region is in Bolivia, comprising an area of 500 miles long and approximately 100 miles wide, and stretching over a tableland at an almost constant altitude of 12,500 feet. Thirdly, there are the African deposits - chief of which is the plateau region of Upper Nigeria. Tin ore has been located in many parts of Central and South Africa, and it is hoped that this region will yet assume considerable importance.

The Asiatic deposits differ from the latter in that the former appear in the so-called detrital deposits, as alluvial which is found on the surface or at a shallow depth. The ease with which alluvial can be mined in these detrital deposits and the simplicity of the smelting of the tin oxide accounts for the large participation of natives, especially Chinese, interests in the industry. This has also accounted for the large number of producers on these tin fields operating on a relatively small scale, commencing with the labour

engaged with only pans and simple sluicing devices and ending with the more mechanized plant consisting of hydraulic sluicing and bucket dredging. In contrast, the industry in the Dutch East Indies is highly organized and capitalized. In Bolivia and Nigeria, the tin occurs in lodes (primary deposits) and requires underground and open cut mining, similar to that employed for primary deposits in Tasmania. Such enterprises require mechanization, and hence much more capital than is required by those operating on the alluvial drifts in Malaya. The Bolivian and Nigerian lodes are generally worked by highly mechanised plants on extensive capitalistic lines.

Production costs on the alluvial mining fields of Asia are very low, because rich drifts, a cheap labour supply and little capital provide the factors responsible. In Bolivia and Nigeria, deposits cannot be so cheaply mined as in the above, but here the lodes are very large, allowing extensive exploitation by means of large-scale capitalization with ensuing low costs.

The world's capacity ot produce tin, althoggh limited to a small number of countriesm is great. The erratic nature of production is stated by some authorities* to be due to the organization of the industry, in which a considerable number of small enterprises, especially large numbers of natives, play so important a part.

Production was embarrassing supply in the early thirties, and so a restriction scheme was inaugurated by the leading producers. Each was given a production queta, with penalties for exceeding. Serious difficulties in all concerted curtailment schemes are the effect upon unit cost. This is particularly the case where much capital has been invested. Reduced capacity means rising costs. The tin cartel has met this difficulty by operating only a limited number of mines at full capacity.

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* Zimmerman - "World Resources and Industries"

Tin markets improved towards the outbreak of war. In 1941 the quota was fixed at 130% of standard tonnage, and this was the highest since the scheme was initiated. With Japan's occupation of Malaya and the Netherlands East Indies, this scheme naturally became no longer operative.

These sources are now in enemy hands, and their capacities are therefore unknown. What damage they might sustain before re-entering as world producers is also unknown. Even after peace is declared, it may take some time before former production levels are reached, or again, they may re-enter as bigger producers. But the fact remains, the world's capacity to produce tin is great, and our production costs are high compared with the main centres of output.

As Australia's contribution to the world's tin requirements are very small (approximately 2½%), conditions in the post-war world are not so bright if free trade on an international basis is restored. Under free trade, it would appear inevitable that tin-mining in this State would decline.

Under Commonwealth protection, the industry would stand some chance of maintaining operations on something like its present scale, if the peace-time requirements of the Commonwealth were equal to output. Prior to the war, approximately one third of our tin had to find a market overseas, but there is evidence for believing that this country with immigration and a rising population will be able to absorb our total supply. We may conclude with the following statements.

Full pressure activity is assured for the industry for the duration of the war, providing war demands do not slacken, as with copper. There is no indication that any other Commonwealth source will rival Tasmania during this period, or in the post-war future,

but if the war is a long one, present rate of production is likely to exhaust our present principal reserves. The industry's hope then rests, if marketing conditions remain favourable, with one or more of the following possibilities

1. A successful opening up ofthe pyritic lodes.
2. New discoveries of alluvial or primary lodes on a scale to allow extensive capitalisation.
3. New discoveries of numerous small, rich deposits where costs could be kept down to a reasonable figure.

The factor that has for years militated against the progress of the industry is that reserves of reasonable assay have not been sufficiently extensive to warrant big scale production, so as to acquire the profits to be gained through the principle of decreasing costs, which is so applicable to the mineral industry.

If Renison Bell and Bischoff could be invested with sufficient capital to work them on the scale employed at Mt. Lyell, then there is the grand possibility that tin production would become for this State what our copper industry has long been. If this is not attained during the war with a most favourable price, then it is difficult to see how the post war world will prove opportune to the heavy capitalization of the industry, if tin prices begin to slump, as it is expected they must. It is therefore very doubtful whether our pyritic lodes will ever rise above that scale of production which the war makes possible and which is not likely to be very extensive because of the acute shortage of manpower and materials.

Tasmania's best and most likely card is the discovery of new alluvial and primary deposits, and much of her tin-bearing territory has received scant attention.

The possibilities of more capital being directed toward new discoveries will largely depend on the length of this war and the political and economic legislature to follow. Such measures as these may help the industry -

full employment for all, making ourselves a more perfect economic unit, either to avoid trade repercussions or ~~in~~ to the event of future wars, the loss of other Empire sources, such as Malaya to U.S.A., ~~or perhaps to~~ an independent States of Malay; the abandonment of free trade principles; Government subsidisation of strategic commodities; subsidisation of industries likely to help carry a larger population; and the like. Such possibilities are bound to exert a profound effect on the industry's future in this State.

S E C T I O N I I I

SILVER-LEAD.

CHAPTER I

INTRODUCTORY.

Productive silver mines have generally been confined to the West Coast Range, and the chief sources of extraction have been from galena, a silver lead sulphide mined at Zeehan, Dundas, North Mt. Farrell, Mt. Magnet and the Mt. Claude district, secondly, from blister copper mined at Mt. Lyell, and thirdly from complex zinc lead sulphide ores of the Read-Rosebery field

Silver lead as a source of silver has always taken priority to blister copper. The production of silver during the early years of this century was considerable, but with the decline of Zeehan, galena from Mt. Farrell, the Magnet and the Round Hill mines at Moina (Mt. Claude district) remained the chief sources. With the re-opening of the Read-Rosebery field by the Electrolytic Zinc Company in 1936 the zinc lead ores from that field then became easily the most important source of silver in this State.

Lead, on the other hand, has been produced in joint supply with either silver or zinc or both. The lead industry until 1913 centred around Zeehan, where the Zeehan and neighbouring fields produced ore which was smelted at Zeehan to a silver lead bullion and sold as such overseas. But with the closing of the smelters in 1913 and the impoverishment of the lodes on the Zeehan and Dundas fields, together with the closing of the Read-Rosebery mines because of an uneconomical metallurgical process, North Mt. Farrell, Mt. Magnet and the Round Hill mine remained the chief sources of both lead and silver until 1937. During these years silver lead ores were worked to produce concentrates of about 70% pure metal and sent to Europe, principally Belgium, for smelting and refining.

The State production of silver lead realised in 1912 £309,098, of which Zeehan and Dundas galena mines produced £140,000, Read-Rosebery (zinc-lead sulphide) £135,000, and North Mt. Farrell (galena) £25,000.

By 1922 State production of silver equalled £122,437, and lead £188,257, totalling in all £310,694 and for the various mines the output was Magnet (galena) £84,590, North Mt. Farrell (galena) £79,000, Zeehan and Dundas (galena) £53,000, Mt. Lyell (copper sulphide) £18,511 of silver only and Round Hill (galena) £7,000.

In 1932, the position had again changed, production of silver equalling £37,304 and lead £32,637, totalling £69,941. Zeehan, Dundas and Round Hill mines had ceased production, and only the Magnet and North Mt. Farrell continued under difficulties. Silver-lead production faced a crisis at this time. Prices were very low, although moving slightly upward, but it appeared that the good ore lodes were rapidly becoming exhausted. Zeehan, Dundas and Round Hill had ceased because of depletion in ore reserves. Mt. Farrell and Magnet were also in search of richer lodes, where the main ore body appeared worked out.

By 1937, silver lead production was again promising, producing values for the State being for silver £95,770 and for lead £212,492, total £308,262, of which Read-Rosebery produced approximately £202,000, North Mt. Farrell £55,329 and Mt. Lyell £7,518 silver only Further figures giving production of silver and lead are shown on Sheet No. 107A.

Since 1937 Read-Rosebery figures have appreciated North Mt. Farrell increased production to 1941, but since then has fallen, and Mt. Magnet has ceased operations altogether. The reason for cessation of production on these fields ~~was those features~~ is discussed in the historical sections of the following chapter.

TASMANIAN SOURCES OF SILVER LEAD 1935 - 1941.

Year	Read-Rosebery	Mt. Farrell	Magnet	Zeehan Montana Dundas	Mt. Lyell	TASMANIAN TOTAL
1935	Not					
Tons lead	Producing	1,201	218.5	Prospect-		1,488
Ozs.silver		137,066	37,388	ing and	132,857	323,901
				Developing		
1936			Small	to resusci-		
Tons lead		1,634	prod.	tate pro-		7,563
Ozs.silver		186,618	only	duction	103,189	906,458
1937			Modern			
Tons lead	7,492	1,467	floatat.	-		9,116
Ozs.silver	794,264	157,467	Plant being installed		83,233	1,060,785
1938						
Tons lead	8,576	1,751	290.3			10,652
Ozs silver	929,750	183,589	35,480	-	66,982	1,219,550
1939						
Tons lead	8,515	2,365	Prospec-	Devel.		11,020
Ozs silver	937,264	249,721	ting	only	70,515	1,278,116
1940						
Tons lead	9,283	3,997	Produc-	79.8		13,550
Ozs silver	1,041,953	468,081	Abandoned	9,488	58,659	1,608,681
1941						
Tons lead	8,829	2,856		66		11,753
Ozs.silver	940,377	335,352	-	6916	43,830	1,326,738

TASMANIAN LEAD PRODUCTION VALUES

Year	Tons of 2240 lbs.	Value in £A	Relatives (1928 -100) Price	Quantity
1912	90,123	309,098	(Zeehan field still working)	
1919	2,357	64,403		
1920	3855	142,268		
1921	1,434	32,241		
1922	4,925	118,257		
1923	4,784	127,542		
1924	4,559	154,881		
1925	5,525	197,452		
1926	5,892	188,167		
1927	5,583	135,403		
1928	4,786	101,616	100	100
1929	5,983	138,793	103	102
1930	4,237	77,590	80	89
1931	2,189	29,024	57	45
1932	2,694	32,637	54	56
1933	2,644	30,987	52	56
1934	1,507	16,723	48	31
1935	1,488	21,390	63	30
1936	7,563	134,413	72	160
1937	9,116	212,492	102	190
1938	10,652	163,102	69	222
1939	11,020	173,670	69	230
1940	13,550	338,771	110	283
1941	11,753	293,837	110	246
1942				

(Figures taken from Nos. 36 and 30 Report of the Director of Mines, Tasmania.)

C H A P T E R I I

ZEEHAN - THE SILVER CITY.

The discovery of silver on the 8th December 1882 by Frank Long, a veteran prospector of the West Coast when prospecting with Johnston, Healy and Monks, marks another era in the development of Western Tasmania. These men were prospecting for two separate syndicates and had come south from Waratah in search ofgold. The high percentage of lead in the ore rather than the silver drew the attention of capitalists, but as lead was only £6 or £7 a ton at the time, they considered the difficulties of transport detracted from the proposition, and that it was not deserving of any serious consideration.

Sufficient attention was, however, given to the silver to cause hundreds of acres of land to be taken up chiefly for speculative purposes, but practically nothing was done on the claims, and later almost all were forfeited Some years passed, and nothing wasdone to prove the worth of the field.

Then at the time of the Broken Hill discoveries interest in the Zeehan field revived. A new impetus to silver mining in Tasmania had been given, and the abandoned sections were soon taken up and thousands of acres besides, till by 1901 nearly 10 square miles had been pegged for mining purposes. The discovery by George Bell in 1887 of a silver lode on the Zeehan field, afterwards to become the property of the Silver Queen Mining Company heightened excitement and the interest in the fieldd A slight rush ensued, with all the confusion and excitement of an 1851 Victorian gold rush. Claims were staked at random, and changed owners profitably. Investing in imaginary companies was common, and this was responsible for removing much support from investors, so essential to the development of mining fields. The fields being tested elaborate expansion became the order. The scattered and

and isolated tents of the prospectors gave way to a line of huts and crude buildings, and finally a city took shape, becoming known as the Silver City.

The Zeehan field at this stage was a most isolated one. A railway had been constructed to Waratah in 1884, but some fifty miles of the most rugged country of the island separated the two fields.

From Trial Harbour, 15 miles north of Macquarie Harbour, a road was built to the Zeehan mines, 12 miles at a cost of £32,000 and before long there were over 100 teams hauling machinery and all necessary supplies to the mines. Freight was £5 a ton to Trial from Hobart and anything from £5 to £10 from Trial to Zeehan.

Silver lead prices had improved, and transport difficulties could be overlooked. Newcomers found a rough and rugged road to the field, and until the building of the Strahan-Zeehan railway by the Government in 1892 and the Burnie - Guildford - Zeehan by the Emu Bay Company in 1900, transport continued to be the chief drawback to extended settlement. "Though railway communication with a seaport was an absolute essential to the success of the silver mines, it was not until after much agitation through the press and by public meeting that the formation of a line was seriously considered by the Tasmanian Government"&

By 1888, Zeehan had grown enormously as a direct result of mining, although there was nothing else that contributed to the growth of this town. The Zeehan field was taken up by a number of companies, a dozen of more of which were in a fairly big way. The Government Geologists Report of 1900 on the field was "The lodes are numerous and well-defined, strong and rich and have every indication of being permament in depth." By 1890 the field was a scene of intense activity and share prices were rising. The future looked prosperous and secure. Monday, 3rd August,

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& Tilley - "Zeehan and Dundas Mines"

1891, brought a temporary reverse to the intense activity of the Zeehan field. A half-sheet of notepaper on the window of an insignificant looking structure "Closed until further notice" for the time shattered people's hopes and brought all mining operations to an abrupt standstill. The stoppage of payment by the popular and trusted Bank of Van Dieman's Land which held probably as much of the public money as all the other local banks combined was the crucial test of the solidity of Zeehan's prospects as a mining centre, but the town soon recovered from the shock, and shares resumed their normal value.

The years 1900-1903 were depressing to the mining industry in Tasmania due to the prolongation of the South African war, disturbing financial equilibrium through out the world and also preventing the introduction of English capital for the development of some of the mines. A further obstacle to progress was the insecurity of tenure to leaseholders of mining properties which has since been altered by Parliament; which made capitalists dubious about investing in Tasmanian ventures.

The lodes of the district are in fissure veins and it was soon found that they were erratic and complex in their occurrence and that they did not live down to any great depth. Most of the companies were faced with heavy expenses from the bgginning in the erection of concentrating plants and were exhausted of reserves to meet any big developmental programme, and consequently, when the rich ore lodes had been worked out they were not sufficiently financial to stand the expense of dead going. Further, the companies did not retain sufficient reserves in the good times or do sufficient developmental work, but were rather too anxious to distribute the biggest dividends possible, with the object of inflating share prices.

For a time great prosperity had attended the field. Rich lodes were found, but were quickly worked out.

One of the most successful mines was the Western. The Company was formed in 1888 and in its fourteen years of working produced 38,520 tons of galena containing 20,532 tons of lead (value about £260,000) and 3,709,861 ozs of silver (value about £650,000) and paid £274,092 in wages and salaries, £67,700 for stores, £6560 for tramways, £17,600 for machinery and buildings, £14,000 for a concentrating mill plant and then paid £102,000 in dividends. There were a dozen or more companies working on a similar scale, each with its expensive steam boilers to produce motive power. The surrounding forests were readily demolished to supply wood to the many furnaces and many were engaged in the timber industry. In a few years the population of Zeehan was 8,000 and by 1911 was within the vicinity of 10,000 souls, compared with Bischoff, which never drew 3,000.

In 1899 a German Company erected an elaborate smelting works on a large scale, and for years they treated large quantities of ore from the fields. To these smelters ore was conveyed from big and small mines alike and from many small shows worked by individuals and parties in the neighbouring area. In 1907, however, production was falling back, and the smelters were forced to seek Government assistance to the extent of £20,000 by way of a loan. Nevertheless, it was of no avail as the business was not forthcoming from the field, and they finally closed down in 1913. These smelters were later taken over by the Electrolytic Zinc Company to treat Rosebery and Read ores.

By 1907 the mines were facing difficult times. The lodes did not live down as was first thought, or rather, ore rich enough to be payable at that time was not obtainable. The field is low-lying, and water was encountered in most of the mines. Fuel was becoming more and more scarce. Pumping costs mounted steadily in most mines and with steam as the source of power the cost was as high

as £70 per horse power (c.f. Lyell £3 and Government Hydro to Electrolytic Zinc Company £2). Had cheap electric power been available, it would have meant much to those mines faced with decreasing ore values and mounting costs. In 1907 the Zeehan Western (the deepest mine on the field) was subsidised by the Government to the extent of £3,000 to sink as far as 1,000 feet, with unsatisfactory results. Most of the lodes petered out at depths ranging from 300 to 400 feet. Work on many mines was abandoned, owing to the temporary closing of the Tasmanian Smelting Companyds smelters. The Secretary for Mines Report for 1909 stated "The Zeehan and Dundas fields have been passing through a time of great depression, and many of the small mines have closed down during the year owing to the cessation of smelting operations at the Tasmanian Smelting Company's works, and the output of ore has in consequence been considerably reduced." This brought alarm to the State, and in 1909 an exhaustive examination of the field was made by Twelvetrees and Ward, the Government geologists. These gentlemen stated in their report :- "Any idea that Zeehan lodes are superficial phenomena is unwarranted, nor is ther there any reason for believing that processes of secondary enrichment have had much to do with the shoots of ore that have been worked. The lodes, in our opinion, may be followed down to much greater depths without more than ordinary mining risks; in other words, there must be a continuity of lode channel between the shoots of ore already exploited and other shoots, which, according to all sound theory, must certainly exist at an undefined lower horizon in the lodes. The large output which has made Zeehan famous has been won from very moderate depths, and even at these depths has not exhausted the field. Much still remains to be done in the way of horizontal explorations on existing sections, but even though renewed exploration at existing levels may result in fresh discoveries, the

the permanence of the field can only be maintained by continuous sinking."

During the 15 years from 1908 to 1922, the value of production averaged £60,000 per annum and totalled about £950,000, but the last eight years of this period produced only £350,000. The Government spent many thousands on subsidies, and in a State mine, and on prospecting work. It was all of no use, for Zeehan continued to fall away rapidly after 1913. At the present time, except for prospecting, Zeehan rests from production.

The yield from Zeehan and Dundas, the field associated with Zeehan, was £5,000,000. Dividends paid to shareholders amounted to £500,000 (c.f. with Bischoff £2,500,000) Nevertheless, in range of numbers employed, the Bischoff field was small compared with Zeehan. On the Zeehan field, the deposits mined were rich, but shallow. No shaft was sunk below the 1,000 feet level, and the field has not been tested to any greater depth even with the diamond drill. Thelast big mine to work was No. 6 Argent 1925, and there was a revival of hope only a few years ago by the discovery of a new lode. It appears that this lode is extensive, but of a low grade.

The chief producing mines of Zeehan were the Western, Mt. Zeehan (Tas.), Montana, Onnah, King, Queen, Comstock, Spray, Florence, Crown, Boundary, Argent, Colonel North and the Swansea.

Much of Zeehan's prosperity resulted from Englishcapital. Many of the mines were floated and re-floated on English investors' money. Since the days of Zeehan, great progress has been seen in metallurgy, and this, together with cheap power, would certainly help to meet the problem of rising costs if the silver-lead mines were re-opened.

Another feature must be stressed, and that is the neglected prospect of amalgamation. Had some or all

of the companies pooled their resources, worked the leases systematically, employed more diamond drilling to pick up the veins of ore, built up reserves of capital during the more prosperous times, and worked on large capitalistic lines as Broken Hill has done, Zeehan might still have been the silver city of renown, and well able to have met the crisis by a bold policy of development and experiment made possible by big capital reserves held in hand and used in the mines or invested in gilt-edged securities elsewhere. A company in a big way with one large concentrating plant is better able to handle economically the treatment of complex ores and to give attention to the slags that are otherwise cast aside. Especially is this true in such a field as Zeehan, where the ore is complex, and contains such other marketable metals as zinc, copper, tin and pyrites which, treated on a sufficiently large scale can often be made quite profitable and contribute to the success of the industry as a whole. The history of Lyell and Broken Hill have shown this. The serious handicap of permitting the field to be riddled by a number of minor companies under our present system of free enterprise must in the light of mining history be considered the major disaster that ultimately shortened the Silver City's life.

DUNDAS.

An associated field with Zeehan was Dundas, and like Zeehan, has ceased to be among the present producers. Dundas is situated about 6 miles east of Zeehan at the foot of Mt. Dundas, which rises about 3,500 feet above the neighbouring country.

The finding of some rich lodes brought the usual mining boom, and within a year of these finds no fewer than 75 mining companies with a total nominal capital of over £1,500,000 were found to be operating on

the field. A railway with the normal Tasmanian gauge of 3'6" was constructed by a private company, and trains ran twice daily conveying the ores to the Tasmanian smelters at Zeehan. Quite a number of mines were being systematically opened up by 1890, but the failure of the V.D.L. Bank in 1891 shut down nearly all of them. The chief mines of the field were the Comet, the Adelaide, and the Mt. Zeehan and Dundas. The closing of the Tasmanian Smelters in 1913 made the mines unprofitable as the ore unsmelted would not have allowed a sufficient margin of profit after freight charges had been met. The life of the field was short, and not at all a steady producing one. From all reliable reports it must be conceded that surface lodes have been worked out, but there is nothing to prove that Dundas as a field has been worked out. The whole question is one of economic treatment of low grade ores and ability to carry out a big developmental programme. It cannot be passed without mention that had Dundas been worked as an associated field with Zeehan under the organization of one company as the Read-Rosebery field is today, it might have contributed more to the prosperity of the Western districts and incidentally to the State.

MAGNET.

Four miles to the west of the township of Waratah is a silver lead field of about 25 square miles, which is known as the Magnet field. "Following the discovery of the rich Broken Hill silver lode in New South Wales in 1882, a silver boom commenced, and the district was energetically prospected for silver lead lodes. The discovery of the Zeehan silver lead field in the early eighties also helped in the creation of this boom." &

& P.B. Nye M.Sc. B.M.E. Government Geologist in the Geological Survey Bulletin No. 23.

The most important discovery on this field was the silver lead lode found by W.R. Bell in 1891, and since known as the Magnet mine. Very little was done to work the mine for some years. The initial capital subscribed was under £2,000, which was insufficient to permit mine development on sound lines and to provide efficient treatment plant. "The lack of capital has hampered the Company's operations throughout, so that the provision for plant, such as the tramway and the hydro-electric power plant, had to be made from profits." * The mine had a splendid record of continuous production for 36 years, during which time it has produced metal to the value of nearly £3,000,000.

The annual production of crude ore ranged from 12,870 tons in 1910, to 8,968 tons in 1922. The assays of the concentrated ore was approximately 100 ozs of silver and 70% of lead to the ton. The mine was regarded for many years as a most important producer and the third mining field of importance to the west. It was equipped with a concentration plant costing £3,500, a hydro-electric plant capable of developing 650 h.p. which cost over £40,000 and a steam railway and two locomotives of 2' gauge costing £30,000. It was further equipped with a machine shop and the variety of its enterprises made it a small Mt. Lyell. The directors and managers preserved for many years an admirable continuity of wise administration, foresight and careful finance. The greater part of the above improvements were paid for out of profits. The Company paid dividends to approximately £50,000.

In April, 1932, the Company was compelled to go into liquidation, because of low prices for silver lead and owing to the poor recovery from its gravity mill. The Mines Department's tests indicated a loss of 34% of the

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* Report by Mr. E.L.H. James B.C.E. M. Aust I.M.M. date Dec. 19, 1936.

lead and 49% of the silver.

As the township of Magnet was directly dependent on the mine and some 110 miners were thus put out of work due to the cessation of operations by the Company, a number of the former employees of the Company formed themselves into the Magnet Prospecting Syndicate N.L. with the object of keeping the mine open and providing work for the men resident at Magnet. Under arrangement with the Government, an agreement was entered into by the Syndicate with the Liquidator to lease the mine as a going concern. The Syndicate carried on under this arrangement with varied success, and with Government financial assistance to the extent of £10,252 for a period of three years, during which time they produced 3,700 tons of concentrates with a gross value in excess of £43,000, the average silver content being 91.13 ozs per ton and the average lead contents 56.21%. For that period the price of lead was only half that ruling in 1936-39. In 1936 a new Company was floated with a capital of £50,000. The new Company installed a floatation mill, which cost about £10,000 to secure a proper recovery of at least 98%, but it proved unsuccessful, and several attempts were made to secure fresh capital by refloatation to attempt more development and prospecting to find the main ore body. All attempts proved futile.

The mine was finally closed indefinitely in 1941, when the whole of the plant was sold and removed. The reason for closing was the exhaustion of the main lodes. On cutting the lode at greater depth it was found insufficient in extent to warrant the proposed further expenditure. A considerable quantity of low-grade ore was present, and it is now believed that had the Company installed a floatation plant in the twenties to effect better recoveries than it did during those successful years, sufficient funds could have been put aside for

extensive development to cope with the lower grade lodes later encountered. Unfortunately, the tailings and slimes from the old mill had not been dammed so as to enable a retreatment of dumps. If this had been done, the new mill may have been enabled to maintain or partly maintain production from the dumps of ore lost in the gravity mill, while the low-grade ores or smaller lodes were being prospected, and the mine developed to cope with the smaller lodes. The earlier lodes worked at the Magnet mine were very rich, the crude ore assaying up to 36% lead and 60.7 ozs. of silver to the ton, and because of this, the Company persisted with a most wasteful process of concentration as revealed by the Mines Dept.'s assays.

From the history of this mine we might learn the desirability of dumping tailings from milling plants which contain minerals although not at the time marketable or perhaps even recoverable by present metallurgical standards in a convenient place for re-treatment. Often tailings are slimed and washed away in a running stream as at the Magnet, whereas if these were dammed or filtered and dumped, they could be remilled when an economical process of recovery was discovered and/or when market prices warranted their re-treatment. This policy was carried out at the Tullah mine in the thirties before the new floatation mill was erected, and when the dumps were treated, they more than paid for the purchase of the property by the new owners, and gave a valuable production from the start while prospecting and developmental work proceeded.

C H A P T E R I I I

THE CHIEF STAGES OF PRODUCTION AND FACTORS EMPLOYED.

1. Mining. The mining or extraction of the ore is generally accomplished by underground workings. Although the capital equipment used is extensive, the price of labour is most important. The factors used are the same as those employed in copper and tin extraction, and costs are influenced by similar conditions as already reviewed in those industries.

2. Milling. The reduction of the crude ore to a concentrate is done by means of a large milling plant The capital invested in a modern mill may be anything from £10,000 to £200,000 for this State. The place of milling is as near as is practicable to the place of mining. The crude ore carries only a percentage of metal and the object is to reduce it to a concentrate in preparation for smelting

3. Transport. (a) There is the transport of ore from the mines to the milling plant. A company's lease may be extensive, covering some hundreds of acres, or again, a company may mine several leases at varying distances from the reduction works. The reduction plant is placed so as to reduce costs of transport from all of these points.

(b) Secondly there is the transporting of the concentrate to the smelters. For this reason smelters are generally in close proximity to the reduction plant as at Mt. Isa. But where the output of a mine does not warrant the erection of a smelting plant, then the transport of the concentrate becomes necessary. Tasmanian mining companies having no smelters and having to forward all concentrates overseas, find transport a large item of cost unless a company sells its concentrate f.o.b. at the port of loading. If the latter is adopted, the selling price for concentrates is correspondingly reduced, but the reduced cost to finance

production makes f.o.b. selling the most desirable.

4. Smelting is the next stage of production, and this reduces the concentrate to a bullion of silver lead. The economics of smelting is greatly helped through large scale operations, and for this reason smelting plants for lead and silver are usually on a grand scale. Broken Hill Proprietary produce 220,000 tons annually. Overseas smelters are also very large plants of similar size and some have even larger capacities.

5. Refining. The bullion must then be refined and the metals separated. Refineries are heavily capitalized plants and for economic reasons generally have a large capacity. Their location is often in close proximity to the smelters as at Port Pirie, but with the market for the final product overseas then the refinery might be in foreign hands. (e.g. Belgium has big refineries.) Mt. Isa sends its bullion away to overseas refineries.

Although there are all these stages in producing the final product, marketing in Tasmania begins when the concentrate comes from the mill. The mining companies of this State produce a silver lead concentrate of from 50% to 70% lead, and containing anything from 50 to 100 ozs of silver to the ton of concentrate.

The economics of production for them is concerned only with:-

1. Mining
2. Concentration
3. Transporting to the port
4. The financing of production to this stage.

Marketing, Financing and Storage.

For the reason that production of lead is too small to warrant local smelting, marketing for the Tasmanian producer begins early. These producers are approximately 80 miles from the port of Burnie, and freight over this distance approximates to about 10/- a ton for Rosebery and £1/5/- for North Mt. Farrell. These mining companies

must find a market for their product as a concentrate. Overseas markets are still available, America being the present buyer. These foreign buyers sometimes purchase f.o.b. Burnie, and others require delivery to their smelters. Whatever the method of selling, the net price to the producers generally approximates to the same.

Financing is an important item of cost, and more so now that the war has brought shipping difficulties. Today the companies operating have often to wait six months for a ship. This means that not only are storage charges at the Burnie wharves increased considerably, but the burden of finance is also greater. If the Company is selling f.o.b. then no return can be got for its ore until it is loaded on the ship. To a company paying wages fortnightly to a large number of employees and having to meet current expenses of production - this long period of waiting requires a great deal of liquid capital, or demands the extra cost of arranging overdrafts and other such means of credit accommodation.

If the mining Company has to deliver to the foreign market, then the burden of finance is even heavier. At a time like the present, the difficulty of finance can become so great consequent upon a further period of waiting to load a ship, that a small company like Mt. Farrell might be forced to suspend production.

Freight increases, insurance costs and handling charges are now so heavy in the marketing of silver lead overseas that production for North Mt. Farrell is very close to becoming unprofitable. In view of the present marketing difficulties, silver lead production has declined

Returning to some problems in silver lead mining, it can be said that not since the closing of the Tasmanian smelters in 1913 have Tasmanian silver lead concentrates found smelting accommodation in Australia. These concentrates have always been exported to foreign

smelteries, principally Belgium and the United States of Americaa. North Mt. Farrell and Magnet concentrates were concentrated to about 70% metal, and then sent to Belgium where they found their most profitable market. Rosebery concentrates of 50% metal have been sold principally to America.

The chief Australian silver lead mines are located at Broken Hill (N.S.W.) where annual production of lead is about 220,000 tons and 10,000,000 ozs of silver. Mt. Isa (Queensland) is the second important producer with an annual production of 40,000 tons of lead and 3,500,000 ozs of silver. The Mead-Rosebery mines have a production of about 9,000 tons of lead and 1,000,000 ozs of silver. The only other important producer in Australia today is Captain's Flat (N.S.W.)

The smelting of Broken Hill Pty.Ltd. silver lead is carried out at Port Pirie (S.A.) Mt. Isa has a smeltery in the mining field, but only smelts to a silver lead bullion, and ships abroad the bullion for re-smelting and refining to silver and lead respectively.

That is to say, there are really only two smelters that cater for silver lead concentrates and each only caters for their particular concentrates. A smelting charge is worked out for a particular type of concentrate A 50% concentrate may require a different charge to a 70% one, depending mainly on additional minerals present. Foreign matter in one concentrate requires an entirely different charge of reagents to another. For these and other reasons, the Port Pirie smelters will not handle Rosebery concentrates, although both companies are associated. It proves more economic to find smelter accomodation for the Rosebery concentrate in America than to upset the regular routing of smelting at Port Pirie.

For the Magnet and North Mt. Farrell concentrates, which are very clean, and similar in nature to the Broken Hill concentratrates, the refusal to allow

smelting accommodation is another matter. These companies are not associated in any wise with Broken Hill Pty. Ltd, and as the Port Pirie smelters is working at full capacity, it does appear that they do not want to be bothered with small producers' concentrates.

For a long time the question of a Tasmanian smelters has been debated. It has been claimed that the closing of the Tasmanian smelters at Zeehan in 1913 closed many small mines of promise, and seriously dampened the initiative of the prospector. With the re-opening of the Read-Rosebery field in 1936, the desirability of having a smeltery was again given consideration, but it was soon found that cheaper smelting accomodation was available overseas, and on terms that could not be competed with in this State.

But with the war, and the closing of the continental market which had proved so lucrative to the small producers, together with the increased cost and difficulty of shipping to the U.S.A., the question no doubt received some further consideration by those producers interested. At the present time, Rosebery and North Mt. Farrell are the only two producers. It is questionable even if a very small furnace was installed by the principal producer whether sufficient concentrates could be supplied to keep a smeltery continually occupied. A smelting plant has this disadvantage, that once the furnace is started, the concentrates must be forthcoming to keep a charge at full strength for 24 hours in the day and 7 days per week. Again there is the question of whether the two companies concentrates would make a successful and economical smelting charge.

A further consideration is the anticipated length of the war and conditions of trade thereafter. If the world is going to return within a few years to pre-war

conditions, then smelting in Tasmania could not hope to compete with the gains to be obtained by the concentration of smelting in such huge plants as provided by continental and American interests. The disadvantages of transport is more than compensated for in smelting at these larger plants.

Further, as lead exports from Australia are very considerable, and even if smelting took place in this State, the bullion would still have to find an overseas market, the only consideration to be gained would be that of shipping metal as against concentrates, which carry anything from 30% to 50% waste material. If the whole of Tasmanian lead was required by the Commonwealth Government as copper and tin are, then the position for a smelters would have more in its favour.

Working on 1941 figures, which are fairly indicative of the present position, the total amount of lead to be smelted in Tasmania would be 11,750 tons. Although in comparison with copper it appears a reasonable tonnage for smelting, yet for lead it is very small and likely to prove most costly (c.f. with Mt. Isa, 40,000 tons and Broken Hill Pty. 220,000 tons.) A Tasmanian smeltery was forced to close down at a time when silver lead production was far above what it is today because of inadequate supplies of ore coming from the mines. It is therefore extremely unlikely that any attempt will be made to smelt silver lead concentrates in Tasmania. The cost of and difficulties of erection at this time would further prohibit the venture by either of the companies interested.

PRODUCING FIELDS.

North Mt. Farrell Field.

Mt. Farrell is the beginning of the West Coast Range, the latter being famous as the principal source of Tasmania's mineral wealth. The North Mt. Farrell mine lies north east of Rosebery and on the western slope of Mt. Farrell and is separated by Mt. Black from that field. The main Zeehan-Burnie railway passes within six miles, to which the mine is connected by a 2-foot steel gauge. The mine is approximately 80 miles from the port of Burnie.

The field has been sporadically prospected, and several companies have taken up leases and some have undertaken production for a short time, but it has remained throughout its history since 1896 a single mine field.

The North Mt. Farrell Mining Company began operations on a subscribed capital of £14,000, and experienced the usual difficulties of transport and insufficient capital. Production has been continuous since that date, except for a short period in 1931-2 when the depletion of the main ore body synchronised with a chronic slump in silver lead prices. In 1933 a new lode of ore was located and this body has proved extensive and rich. The grade of ore mined in 1939 averaged 17.2% lead and 18.2 ozs of silver per ton. The lode is opened to 700 feet below the surface and is well developed by shafts, drives and crosscuts.

Production over the years 1935 - 1940 is shown on Sheet No. 127A. The mine is fitted with fairly up-to-date plant and a floatation mill is installed to concentrate the ore. State Hydro power is supplied to the mine through the sub-station at Rosebery. The Company's capital cannot be accurately stated, because the mine is now in private hands. Plant installed would require a capital of about £50,000

Mining. The mine is worked by means of underground workings through a shaft. The scale of operations is not large, employing about 60 miners and labourers at the present time (May, 1943), but usually employs 105. The chief cost items are:-

1. Wages
2. Stores
   - General
   - Explosives
   - Timber
3. Repairs, Renewals and Depreciation.
4. Power.

Approximately 65% of mining costs are paid in wages, while stores account for a further 25%, of which timber is the biggest item.

Milling. A floatation plant is installed, and this is electrically driven. This plant is capable of treating 165 tons per 24 hours. The factors entering into cost here are

1. Wages
2. Re-agents for floatation.
3. Power- Hydro power, cost approx. £8 per hp.
4. Renewals.

Milling costs are high for the reason that the plant is small, but the rich nature of the ore milled helps to offset this cost per ton of concentrate. Power costs are approximately £8 per h.p., which is high compared with Mt. Lyell's £3, but this is unavoidable, due to the isolated position of the mine. The Hydro power had to be brought over rough country, and the quantity of power used is small, being only about 400 h.p. and in use only for one shift per day.

Marketing and Finance.

After the ore is milled to a 75% concentrate carrying approximately 88 ozs of silver to the ton, it is railed to Burnie. Transport costs to this stage are 23/- a ton.

Prior to the war, a most remunerative market was found in Antwerp, Belgium, for the concentrate, where it also found smelting accomodation. The wartime prodedure is to ship to U.S.A., where it is sold as a concentrate

to smelting companies for approximately £16 net a ton calculated on the metal returns. Prices are varying from month to month in America, but this is the approximate average return for the war period to date (May, 1943)

As shipping accommodation is very difficult to arrange, it means that large quantities of the ore are stored at the Burnie wharf in anticipation of a ship being available Such periods of storage might be anything up to six months. Handling charges at this stage amount to 6/- a ton, and a further 2/- a ton is charged for wharfage, and more for longer periods.

The American smelteries purchase the ore delivered at their premises. Such a prodedure throws the burden of finding shipping and paying the cost of all freights plus insurance on the Mt. Farrell Company.

Insurance freights are 25% of the insured value, while the United States Government charges a duty of 50% of the declared value for all concentrates entering that country. Were it not for the dollar exchange ratio which is now in favour of exporters, marketing in U.S.A. would be uneconomic.

It will be readily understood that the cost of financing such a procedure during the war years is an item of concern. Operations at the mine have often to be maintained for periods of six months or longer before sales returns materialize into cash. To a small company, which pays a large wages bill fortnightly, financing over this long period is a difficult matter.

Unfortunately, no accurate figures can be procured to show profit margin in the silver lead industry At Rosebery it is purely a matter of book-keeping what profit is accredited to lead. North Mt. Farrell is a private Company and information is therefore not available for publication. It is reliable to state, however, that the margin of profit is gone for this Company and the company

is only marking time in anticipation of better times.

Reserves of Ore at North Mt. Farrell.

Without any further development, the mine has at least two years metal in sight. Prospecting and development are behind schedule owing to the shortage of labour, but it is believed from all reliable indications that further sinking on the lode will reveal metal for many years of working. Towards the end of 1942 a Government geologist spent some weeks making a survey of the field to estimate further probable reserves. No reports are yet available.

Rosebery - the chief source of lead and silver in Tasmania.

This field is situated on the Emu Bay Railway approximately 80 miles from the port of Burnie. The field is worked by the Electrolytic Zinc Company with a most modern plant and workings. There is approximately £500,000 invested on the field in the form of plant and developments. It is second only to Mt. Lyell in mechanization and is supplied with cheap Hydro power by the State Hydro plant through the sub-station at Mt. Lyell.

Mining is carried on principally by underground workings. Some open cutting is also followed. Two workings, one at Mt. Read and the other at Rosebery supply the ore for the modern floatation mill at Rosebery. The ore is a complex sulphide assaying approximately per ton:-

Zinc 20%
Lead 6%
Copper .5%
Silver 7 ozs.
Gold 2 dwt
Iron 15% (unsaleable)

The industry is carried on principally as a zinc mine. For this reason operational costs are best discussed under the heading of our next metal, zinc. Production over the years is shown on Sheet No.

The continuance of the mines at Rosebery as silver lead producers is largely dependent on the profitable production of zinc. Production costs are carried by

a number of metals produced, but a serious fall in the zinc market could bring economic production to a close.

Reserves of Ore.

Known reserves are stated at a figure promising approximately 10 years continuous production at the present scale of operations. Possible reserves are believed as good. The grade of these lodes is not deteriorating as at Mt. Lyell, and for this reason production should prove profitable for many years.

Reserves were given at 1,500,000 tons of average grade ore in the Directors' Report to Shareholders for the year ending 1942.

OTHER KNOWN DEPOSITS - NOT WORKED.

The Middlesex and Mt. Claude mining fields were for some years producing. The most important mine was the Round Hill at Moina where in eight years ending 1927 some £109,000 worth of silver lead was extracted. The mine closed because of the depletion of the main ore body. No further attempts have been made to revive the field.

Pelions. This area has reported wolfram, zinc, lead and copper. The copper deposits are believed extensive but of a low-grade i.e. .5%, together with some lead and zinc. No development of importance has been undertaken to verify the worth of the field.

Stirling Valley - silver lead.

Exploratory work on a comprehensive scale was undertaken and carried forward till 1913, when operations were suspended for the time, pending a removal of the abnormal conditions then prevailing. The lode present does not appear to possess any great magnitude of metal and because of transport difficulties small capital companies have been unsuccessful in attempting to exploit this area.

GALENA - THE POSSIBILITY OF REVIVAL.

The mining of galena for lead and silver extraction declined with the closing of Zeehan smelters and mines. In 1912 the State output was over 90,000 tons but today annual production has fallen to about 3,500 tons. The cause of this decline has already been referred to, and we have seen that the lodes in all cases became too poor to allow profitable production.

Hope of revival rests with the discovery of new lodes, and if these are found, exploitation should prove payable if free trade principles in international trade are provided. Extraction and reduction costs compare favourably with other world sources - but smelting overseas, especially in Belgium, has proved the more economic. This, no doubt, has been close to the German and French markets, which since 1934 have been strong. It is difficult to forecast the post-war demand, but given a strong demand for lead, free trade would favour the industry here. Economic smelting would depend entirely on the quantity of ore to be smelted, which would need to be in the vicinity of 90,000 tons annually. Such an increase in tonnage would require a material revival and consequently substantial finds of new deposits.

The likelihood of new fields being located is not remote. Geological science has revealed in numerous surveys that the geological structure of the West Coast Ranges and its environs gives positive indications of new lodes.

Surface prospecting has now revealed practically all the surface lodes that the enterprising prospector is able to locate with his meagre resources. Regular and systematic geological surveys, followed by diamond drilling and other forms of mineral location will have to be employed to reveal the presence of these new lodes.

LEAD FROM ZINC SULPHIDES.

By means of selative floatation, lead from zinc sulphides has become the most important source since the decline of galena production in 1913. As reserves of zinc sulphides are very substantial and zinc production has proved most profitable in this State with cheap electric power there is every reason to believe that production, although not likely to increase unless new reserves are located, will proceed to maintain production at about 9,000 tons. The prospects for lead can be more readily undersfood after we have considered zinc in Section ~~Book~~ IV

THE FUTURE OF SILVER PRODUCTION IN TASMANIA.

Silver production is now directly dependent upon the profitable production of the following:-

1. Copper at Mt. Lyell
2. Zinc at Rosebery
3. Lead at North Mt. Farrell

Silver mining is not undertaken for itself alone, but is in all cases a product of joint supply? Its presence takes secondary consideration with lead production more remote consideration still in the case of zinc and is of no consideration in the mining of copper.

Because of this, silver prices do not very effectively control production. A survey of Table 2 on Page133 reveals that silver output from silver lead concentrates fluctuates with lead output, and not with the price of silver. For instance, taking a typical case, a galena lode yielding 20% lead and 15 ozs of silver to the ton with lead at £20 a ton and silver at 2/- an oz. returns as follows:- Joint supply from a ton of ore yields 45 cwts of lead, returning £4 and 15 ozs of silver at 2/- is worth £1/10/- A 10% rise or fall in the price of lead is more important in the economics of production to the Mining Company than a 20% movement in silver prices.

The future of silver therefore rests with base metal production. A greatly increased output of lead and

zinc would correspondingly increase silver production and vice versa. For Tasmania, the immediate future is likely to reveal a slight decrease, and the long future can be judged from the prospects for lead and zinc.

SILVER PRODUCTION VALUES FOR TASMANIA. TABLE I

Year	Quantity in Ozs. from Silver lead	Blister Copper	Total	Value £ sterling
1928	564,156	105,270	669,426	£78,901
1929	714,930	149,424	864,354	94,560
1930	528,641	182,978	711,619	56,068
1931	242,950	148,782	391,732	25,754
1932	301,854	161,634	463,488	37,304
1933	361,768	127,562	489,330	39,808
1934	194,747	89,940	284,687	27,127
1935	191,044	132,587	323,901	42,323
1936	803,369	103,189	906,458	81,036
1937	977,552	83,233	1,060,785	95,770
1938	1,152,568	66,982	1,219,550	104,671
1939	1,207,604	70,512	1,278,116	118,310
1940	1,549,859	58,695	1,608,681	161,447
1941	1,282,795	43,830	1,326,738	139,306

Figures obtained from Director of Mines Report No. 36.

RELATIVES WORKED AS A PERCENTAGE OF 1928 FIGURES TABLE II

Year	Silver in Silver-Lead Quantity Rel.	Compare with Lead Quan. Rel.	Lead Price Rel.	Silver Price Rel
1928	100	100	100	100
1929	126	102	103	95
1930	94	89	80	65
1931	43	45	57	56
1932	52	56	54	65
1933	64	56	52	70
1934	34	31	48	81
1935	33	31	63	84
1936	142	160	72	83
1937	173	190	102	83
1938	204	224	69	80
1939	214	230	69	78
1940	275	283	110	95
1941	229	246	110	97

C H A P T E R I V

WORLD LEAD PROSPECTS IN THE POST-WAR PERIOD.

The position of lead in international commerce differs from that of most other non-ferrous metals in that the majority of modern industrialised countries have sufficient lead ores within their own boundaries to make themselves nationally self-sufficient if desirable. Nevertheless, with free trade principles commerce in lead is likely to rank fairly substantially, as quite a number of countries find it cheaper to import than to mine their own ores. The economies to be gained particularly in the smelting make movements of concentrates desirable.

World lead resources, although not known accurately, are believed great. Production is astonishingly responsive to the price factor. World demand over the centuries has been on the increase, and is now very great.

1801-1825	Average	annual	production -	37,910 tons
1826-1850	"	"	"	118,822 "
1851-1875	"	"	"	247,632 "
1876-1900	"	"	"	602,283 "
1901-1925	"	"	"	1,185,187 "
1926-1927	"	"	"	1,847,745 "

As many sources have been worked out, and no large new sources of supply have been discovered during the century with the exception of the Picher field of Oklahoma in U.S.A., Mt. Isa deposits of Australia and those of New Foundland, it appears that the price factor is likely to remain favourable to production in order to guarantee the world's demand, which is seen to be increasing very substantially. Although the war period has geared the lead industry to high pressure production, there is reason to believe that a number of sources will be exhausted or

nearly so on entering the post-war period. Others will be far behind in development and prospecting, and post-war production is bound to suffer on this score.

The demand for lead has been accentuated with the war for munitions, but peace time requirements are also great. An idea of these uses may be drawn from the following table which applies to a modern industrialised nation.

PERCENTAGE OF TOTAL LEAD CONSUMED IN THE UNITED STATES, 1925 and 1929, BY USES.

Use.	1925	1929
Storage batteries	21.02	22.22
Cable coverings	18.21	21.79
White lead	15.29	12.48
Building	10.32	10.16
Ammunition	3.68	4.35
Solder	4.09	3.92
Bearing Metal	3.97	3.49
Calking	3.50	3.33
Litharge and red lead	4.90	3.17
Foil	3.80	3.17
Castings	2.10	1.91
Type metal	1.75	1.91
Automobiles	1.49	1.91
Terneplate	.53	.44
Railway Cars	.52	.37
Locomotives	.09	.08
Shipbuilding	.01	.01
Miscellaneous	4.73	5.29

Figures taken from "World Resources & Industries" by E.W. Zimmerman. Page 711

Lead possesses a rare combination of valuable properties, and because it is so cheap it has a wide variety of uses. Many of the industries now using lead such as the storage battery industry, which is a large consumer of lead, are able to recover much of the metal used. Other important lead-consuming industries in which there is a large return of secondary metal include cable manufacture, building and bearing metal and type metal manufacture. In U.S.A., secondary lead is equal to approximately 50% of primary lead production. "This high rate of recoverability must be kept in mind in any economic appraisal of lead ore reserves."&

AUSTRALIAN LEAD.

Australia ranks third as a world producer, but as her production is only about 14.5% of the world total output, it is not likely that she is able to exert any profound influence on price movements. Of the 274,384 tons produced in 1938, all but 22,896 tons were smelted in this country, and of this 219,433 tons were exported. Thus our lead industry is dependent very largely on profitable exportation.

Our exports over the years since 1928 (from Page 138) will be seen to have been very stable even during the worst years of the depression. Lead concentrates from Tasmanian mines were affected during 1932, but lead exports from our smelteries have been on the increase.

There is nothing in the nature of our production costs to put our lead industry in the place of our copper companies. But whether the export of lead concentrates, in which Tasmania is so interested, will again prove favourable is too difficult to forecast. The continuance of a reasonably strongworld demand for lead and the removal of present marketing difficulties should again make for profitable production in this State.

& Zimmerman : World Resources & Industries Page 713.

The forecasting of lead price movements is difficult. It is commonly assumed that peace will bring a slump in the heavy metal industries. Certainly war demands are heavy and in some cases have developed these industries to abnormal proportions - but the conclusion that the high demand for metal entirely waits on armaments is unfounded. In 1929 ammunition only accounted for 4.35% of all lead consumed in the U.S.A. Undoubtedly there are many other direct and indirect uses of lead occasioned by the war, but there is also evidence to consider in the case of reconstruction and the increased industrialisation of modern and backward states. The growth of industrialisation has revealed the need for increased production. The continuance of primary lead production, it appears, will depend more on the art of secondary recovery than on substitution or decline of use after the war. The new world order and the shape and magnitude it will assume holds the answer to all our speculations.

LEAD PRODUCTION IN AUSTRALIA (Figures obtained from Australian Mines & Metals Assoc. Statistics No. 19)

Table 1 — Lead Contents of Ores and Concentrates Produced in Tons (2240 lbs.)

Particulars	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
In Broken Hill Lead Concentrates	159,886	176,790	184,285	126,722	154,978	169,245	180,475	182,667	182,459	192,492	216,914
In Broken Hill Zinc Concentrates	10,069	8,100	5,237	2,339	3,781	3,781	3,728	3,884	3,513	3,860	4,444
In Rosebery Lead Concentrates	-	-	-	-	-	-	-	-	-	6,226	7,228
In Rosebery Zinc Concentrates	-	-	-	-	-	-	-	-	-	1,775	1,956
In Other Ores and Concentrates	9,379	9,116	21,703	21,703	51,807	48,863	45,622	35,242	37,777	41,712	43,842
TOTALS	179,334	194,006	150,764	150,764	210,566	221,889	229,825	221,793	323,749	246,045	274,384

* Treated by Australian Smelters, including Mt. Isa.

Table 2 — EXPORTS FROM AUSTRALIA (From Customs Statistics)

Pig Lead & Lead Bullion	144,744	152,900	152,216	145,180	171,001	192,625	181,620	190,631	176,787	204,445	196,537
Lead in Concentrates and Ores	21,092	14,103	19,907	15,872	4,126	25,975	22,425	16,512	22,593	20,717	22,896
TOTALS	165,836	167,003	172,123	161,052	175,127	218,600	204,045	207,143	199,380	225,162	219,433

WORLD LEAD PRODUCTION.

Lead Ore Mined in Metric Tons ('000's omitted)

Country	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
U.S.A.	590.0	506.5	367.1	265.8	247.4	261.6	300.4	338.3	421.7	331.5
Mexico	248.4	240.9	226.8	137.3	118.7	166.5	184.2	215.7	218.1	282.4
Australia	197.1	200.8	153.2	213.9	225.5	233.5	225.4	227.3	250.0	
Canada	148.1	151.0	121.3	116.1	120.9	157.1	153.8	173.8	186.9	190.1
Burma	103.7	116.2	90.4	80.1	97.6	90.2	90.8	92.4	92.7	88.9
Germany	60.5	68.7	54.3	51.0	53.7	58.9	60.7	68.6	78.9	
Spain	116.5	109.5	100.7	100.0	75.1	63.1	66.2	42.0 *	27.0 *	
Others	Difference between Total and sum of countries given									
TOTAL FOR WORLD	1715	1663	1334	1197	1189	1326	1390	1512	1705	

* Estimated

Taken from Statistical Year Book of the League of Nations 1938-39.

WORLD LEAD SMELTER PRODUCTION IN METRIC TONS (000's omitted) ORE SMELTED.

Country	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
U.S.A.	702.7	538.4	401.7	255.8	239.2	282.3	294.4	362.1	439.9	348.1
Mexico	229.8	231.2	207.6	130.3	119.6	167.9	181.0	209.7	225.1	207.1
Australia	180.4	171.2	152.9	189.3	208.6	199.2	221.4	196.1	232.2	227.3
Canada	138.1	138.1	126.3	114.8	115.5	142.6	148.6	164.9	181.2	181.9
Germany	97.9	110.8	101.3	95.2	116.6	120.0	122.3	139.0	162.4	185.3 (Austria Included)
Belgium	60.0	62.8	57.1	57.6	61.6	66.7	67.0	Austria 65.1	10.8 84.8	84.6
Burma	81.5	81.0	76.0	72.3	73.2	73.0	73.2	74.3	78.9	81.4
Spain	142.8	123.3	109.6	105.4	88.4	72.2	70.6	46.6	30.0	-
Others	Difference between world total and				these listed					
WORLD TOTAL	1819	1695	1410	1165	1164	1328	1392	1479	1689	1640

Taken from Statistical Year Book of the League of Nations 1938/39.

WORLD SILVER PRODUCTION IN METRIC TONS (ore mined)

Country	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
Mexico	3381	3272.3	2677.0	2155.6	2118.2	2306.2	2351.1	2409.4	2633.9	2517.9
U.S.A.	1893	1484.4	928.6	707.3	719.4	1019.6	1509.1	1902.1	2221.6	1884
Canada	719.8	822.5	639.6	570.7	472.4	570.6	516.9	570.3	714.7	689.2
Peru	666.8	482.1	273.5	210.7	231.1	322.4	532.0	619.4	542.9	635.3
Australia	313.2	313.4	209.3	294.3	336.5	353.2	359.6	382.2	437.3	380.3
Burma	226.5	219.4	183.5	186.6	188.3	180.2	181.2	185.1	192.2	184
Germany	171.5	170.6	179.9	186.4	196.6	184.9	194.6	203.5	210.7	-
Others	Difference between World Total and countries listed									
WORLD TOTAL	8256 *	7744 *	6083 *	5214	5279	5941	6767 *	7593 *	8300 *	8000 *

* Estimated.

Figures taken from the Statistical Year Book of the League of Nations 1938/39.

S E C T I O N I V

ZINC.

C H A P T E R I

INTRODUCTORY.

Zinc is widely distributed throughout the world, and has a great variety of uses. The largest consumers of zinc are those industries engaged in the following - galvanized iron sheet, galvanised wire and rust proof structural steel. Zinc is also used for castings, the protection of various metals in the manufacture of brass, and as an alloy in many compounds such as aluminium zinc compounds which have a wide use in aeroplane construction. Besides these uses, it is employed in metallurgy for the recovery of gold in the cyanide process, and in the recovery of silver and lead; and also in synthetic dye manufacture. Oxides and salts of the metal also find a wide use.

The world's annual production of zinc is shown on Page /45 and it corresponds fairly closely in quantity to that of lead. The chief producers, in order of importance for the year 1938 are, United State, Canada, Mexico, Australia, Germany and Russia; while the smelter production for chief countries is as follows:- U.S.A., Belgium, Germany, Canada and Poland.

Australia does not extract half of her zinc from concentrates produced. In 1938 concentrates and ore produced had a metal content of 162,800 tons, but for that year only 69,820 tons of refindd zinc was produced, while 93,561 tons of zinc in concentrates and ore was exported overseas for treatment.

As a zinc ore producer, Australia occupies a very high place among world producers. During the years 1930 to 1937 inclusive, with the exception of 1931, she was the second world producer. The production relative bears a striking resemblance to that of the price relative indicating that production is responsive to price movements.

Of the 165,386 tons produced in Australia in 1938, Tasmania contributed 25,366 tons from ores mined in the State, and produced 69,820 tons of refined zinc at the Risdon plant.

The chief source of zinc in this State, as is general for other places throughout the world, is zinc blende, a sulphide of the metal. These deposits contain silver, lead, copper and gold, the recovery of which adds to the profitable working of the zinc.

The best known deposits are those of the Read-Rosebery field, where reserves of 1,500,000 tons carry from 18.4% to 21.3% zinc, 6.4% lead, 8.5 ozs of silver and 2.12 dwt. of gold per ton.

The acquisition and final successful exploitation of the large zinc body came as a result of the successful refining of zinc concentrates to the pure metal by the Electrolytic Zinc Co. of Aus. Ltd., at Risdon (Tas.)

Before the world war of 1914-18, the world's annual production of zinc was approximately 1,000,000 tons of which the British Empire produced less than 50,000 tons From the 500,000 tons of zinc concentrates shipped annually from Broken Hill, 200,000 tons of zinc was produced by European treatment plants.

In pre-war days, the various conditions obtaining at the time, including such factors as cheap fuel, low labour costs, long experience and close control prevented Australia from competing in the treatment of her own zinciferous raw material. Further, in 1913, Australia was importing from 30,000 to 40,000 tons of brimstone from Sicily and Japan for sulphuric acid manufacture. It was then thought that if Australia could treat her own zinc sulphide and recover the sulphur for super-phosphate manufacture, for which there was a growing demand, it was evident that zinc production would become much more profitable. North Broken Hill Ltd., Broken Hill South Ltd., and

Zinc Corporation Ltd. became interested for the reason that they were anxious to find cheap treatment in this country for their zinc concentrates shipped overseas. Applying the electrolytic process to their sulphide ores, these companies found a suitable way of treatment. The deciding economic factor as to position for a treatment plant depended upon cheap electrical power. In this regard Tasmania had the outstanding advantage, for her cheap hydro electric power had already been developed by an extensive Government hydro electric scheme which was commenced in 1914.

After careful experimentation, a contract was signed with the Tasmanian Government for 30,000 h.p. of electrical energy, and a plan to produce 100 tons of zinc daily was authorized for construction. In 1920, the Electrolytic Zinc Company of Australia Ltd. was formed and by 1923 production was 100 tons per day. This Company has a paid-up capital of over 3½ million pounds, and production has now reached the capacity of 200 tons of zinc daily, using approximately 42,500 h.p. of power.

The works are situated at Risdon, 5 miles from Hobart on the bank of the Derwent River. Besides the production of zinc, super-phosphates fertilizer are manufactured from sulphuric acid recovered as a by-product. Another by-product is cadmium, small quantities of which are present in the zinc concentrates.

At present zinc concentrate supplies are drawn from Broken Hill (N.S.W.) and Rosebery, Tas. in the approximate proportion of two-thirds and one third respectively. Approximately 70,000 tons of zinc and 175 tons of cadmium are produced annually, together with a lead silver residue containing approximately 2,400 tons of lead and 221 ozs of silver. The approximate production of super-phosphate fertilizer is 22,000 tons per annum. Besides, it is hoped after the war to manufacture sulphate of ammonia on a large scale with by-materials from the complex ores treated.

WORLD PRODUCTION OF ZINC IN METRIC TONS (000's omitted)

This table refers to the zinc contents in ores mined from these countries.

Year	U.S.A.	Australia	Canada	Mexico	Germany	Others	WORLD TOTAL
1930	540.2	121.5	121.4	142.9	138.7		1559
1931	372.2	75.4	107.6	150.5	105.2	Diff. between world Total and these listed	1,208
1932	258.8	117.5	78.1	57.3	75.3		942
1933	348.6	125.7	90.3	89.3	104.4		1194
1934	398.0	139.0	135.4	125.2	131.7		1410
1935	469.8	150.9	145.4	135.9	140.9		1556
1936	522.2	175.2	151.1	150.2	156.5		1702
1937	568.2	206.7	168.0	154.6	165.6		1856
1938	461.6	165.4	173.1	172.2	-		-

WORLD SMELTER PRODUCTION OF ZINC IN METRIC TONS (000's omitted)
(From Primary Zinc only)

Year	U.S.A.	Belgium	Germany	Canada	Australia	Others	WORLD TOTAL
1930	451.8	176.6	97.3	110.2	55.8	Diff. between world Total and those listed	1,394 *
1931	264.9	134.7	45.3	107.6	54.7		995 *
1932	187.9	96.3	42.0	78.1	54.1		781
1933	278.7	137.3	50.9	83.4	54.8		987
1934	329.8	174.9	72.9	122.4	55.5		1,177
1935	381.6	181.7	124.2	135.6	68.8		1,338 *
1936	446.5	195.3	136.4	137.1	71.6		1,467 *
1937	505.2	217.8	163.3	143.8	70.9		1,623 *
1938	406.3	210.0	194.6	156.0	-		1,580

* Estimated, or provisional

(Figures taken from Statistical Year Book of the League of Nations 1938/39.)

ZINC PRODUCTION IN AUSTRALIA

(Zinc Contents of Ores and Concentrates produced.)

A.

Year	In Broken Hill Zinc Concentrates	In Broken Hill Lead Concentr.	In Rosebery Zinc Concentr.	In Rosebery Lead Concentr.	In Other ores treated or exp.	TOTAL
1928	121,154	18,534	-	-	8,175	147,863
1929	134,779	21,268	-	-	8,515	154,562
1930	102,972	16,641	-	-	-	119,613
1931	66,124	8,088	-	-	-	74,212
1932	106,348	9,324	-	-	-	115,672
1933	114,235	9,468	-	-	-	123,703
1934	126,062	10,698	-	-	-	136,760
1935	130,619	11,073	-	-	6,800	148,492
1936	130,035	11,133	-	-	31,246	172,414
1937	136,430	10,519	27,303	1,604	27,600	203,456
1938	152,258	12,680	29,184	1,936	23,721	219,779

B.

EXPORTS FROM AUSTRALIA (From Customs Stats.)

Year	Spelter or Zinc	Zinc in Concentrates and Ore	TOTAL
1928	35,053	122,450	157,503
1929	32,739	74,531	107,270
1930	31,798	88,057	119,855
1931	56,559	43,026	99,584
1932	37,450	30,238	67,688
1933	29,967	66,080	96,047
1934	31,914	31,119	63,033
1935	34,605	70,329	104,934
1936	44,041	86,157	130,934
1937	41,366	86,295	127,661
1938	37,815	93,561	131,376.

A & B. From No 14. Australian Mines & Metals Assoc. Statistics.

REFINED METAL PRODUCED IN TASMANIA, METAL IN ORE & CONCENTRATE EXPORTED FROM AUSTRALIA.

Year	Spelter & Zinc (Risdon Plant)	In Zinc Concntr. & Ores exported	In Lead Concntr.& Silver-Lead Ores Export.	TOTALS
1927	49,155	111,755	579	161,489
1928	50,223	117,858	77	168,158
1929	51,872	69,958	21	121,851
1930	54,901	86,761	396	142,058
1931	53,832	41,917	557	96,306
1932	53,200	31,542	-	84,742
1933	53,956	60,142	586	114,684
1934	54,629	26,963	-	81,592
1935	67,666	54,693	-	122,359
1936	70,509	75,391	-	145,900
1937	69,750	76,990	-	146,740
1938	69,820	93,561	-	163,381

Figures from Aus. Mines & Metals Assoc. Statis. Year Book No. 19

C H A P T E R I I

HISTORICAL.

The Read-Rosebery fields today contain Tasmania's important zinc mines. They also are situated on the West Coast Range some 20 miles north of Lyell. Their history is a chequered one, going back to 1893 when they were opened up by a number of companies which worked the leases for silver lead or copper.

Mt. Read. The two principal companies at Mt. Read were the Hercules Mining Co. with a subscribed capital of £39,050, and the Mt. Read Mining Co., incorporated in London, which had a subscribed capital of £141,944/6/0.

By 1911, the Hercules mine's output had reached 30,864 tons of complex ore returning £107,904 for that year. The Mt. Read Mining Co. spent over £100,000 on its lease for a recovery of only 8,059 tons of ore yielding a monetary return of £8,000. The latter company was forced to suspend operations, and the Government made a geological survey of its lease, which revealed 122,000 tons of available ore and a further 122,000 of probable reserves.

Another mine on the field was the Jupiter, which was forfeited in 1905 after having used £7,000 of capital in development. This mine was worked for copper assaying 8%, but in 1905 zinc blende assaying 42% zinc was located. No estimate of reserves of ore were given by the Government report, as the development undertaken did not justify any definite figure.

The King P.A. Mine was another that produced copper to 1913. The tonnage was 2,340 tons of ore valued at about £6,000. Over £9,000 was spent by the Company in prospecting and developing the property. Again, no reserves were estimated as development was not sufficiently extensive to enable estimation.

The whole field was paralysed by the closing of the Zeehan Smelters in 1913, and those had finally ceased operations after a failure to float in London a new company designed to merge the interests of the Tasmanian Smelting Company, the Hercules Gold and Silver Mining Company and the Primrose Company at Rosebery into one Company. This was expected to eventuate in 1913, but failed to do so.

The Government then made a geological survey of Mt. Read, which revealed large ore reserves of 1,000,000 tons. It was estimated that about £400,000 had been spent on the Read field, and this had failed to establish its as a constant and profitable producer. We might here examine some ofthe causes of failure.

1. Some 200,000 tons of ore had been extracted and receipts totalled only £280,000 giving an average value p.t. of approximately £1/8/-, whereas the average assay value was between £9 and £10 per ton.

2. The reason for this poor sale return was due to the fact that the directors of the Companies had never attempted to find a suitable metallurgical process to treat their sulphide ores. They employed no competent metallurgist to investigate the special nature of their complex ore, but rather confined themselves to making contracts for the sale of the ore as it existed, at a figure to show some sort of profit to allow operations to continue. This resulted in the sale of ore with assay value of between £9 and £10 at £1/8/- per ton to the Tasmanian Smelters in whose hands some 2,200 tons of zinc were hopelessly lost.

3. Failure to amalgamate. The Mt. Read Company had the larger capital with which to carry out research and development and the Hercules had a splendid sample and quantity of ore.

4. A desire to obtain profit quickly and at once and mainly through sale of shares. Profits were sought fromm a rise in share values and hence the need to show good dividends. This policy showed itself in the frantic efforts at pig-rooting after the gossan at the sacrifice of valuable sulphides, because the former was easily treated. Stopes were not properly filled, the leases were being ruined for want of a solid and long-sighted policy of exploitation and the company was starved for capital in a frantic endeavour to distribute as much as possible in dividends.

The Government report on the field made these recommendations:-

1. An immediate amalgamation of all mining companies and a pooling of their resources for the purposes of development and research. As the field was similar in structure and nature of ore this was most desirable.

2. Further, that a metallurgist of ability and experience be enlisted in the service of the new Company.

3. That a thorough scheme of development and exploratory work be undertaken, including a huge diamond drilling programme.

4. An investigation into the question of cheap power. The State Hydro scheme was at this stage not completed.

5. The amalgamated Commny must be provided with a large capital, and the proposition was to be regarded as one big business concern.

6. There must be no feverish rush to see quick returns, but the scheme must be envisaged as a big undertaking demanding time, and looked upon in the nature of a long-term venture.

7. The Rosebery field was to be included, and the two fields regarded as one (Read-Rosebery).

The Rosebery Field.

The other early field which was later associated with Read was Rosebery. The early and most important mines located on this field were the Tasmanian Copper Mining Company's properties, the Primrose Mine, including the old Mt. Black property, and the properties of the Great South Rosebery, North Tasmanian Copper Company, and the Colebrook.

1. The Tasmanian Copper mine was discovered by T. MacDonald in 1893 and was first owned by a gold-mining company In 1899 it was worked for copper, and later it was found that the ore was a zinc-lead sulphide and contained no more copper than the average characteristic ore of that type. The mine was closed in 1911, and the total output to that date was 50,826 tons of zinc-lead sulphide ore assaying, gold .145 ozs. silver 12.3 ozs. Lead 7.9% Zinc 28% and copper .5%. In addition, some 600 tons of zinc lead sulphides were sold as zinc, assaying as high as 41% zinc. The ore was sold to the Tasmanian Smelters till 1907 and then to the Metals Extraction Company at Rosebery. Ore reserves were estimated by the Geological Survey of 1913 as - Total proved ore, 305,000 tons, plus Probable ore, 300,000 tons. Further prospecting was recommended.

2. The Primrose mine was discovered shortly after the Tasmanian Copper Mine. It was prospected till 1905, and let on tribute till 1907, after which the extraction of ore continued till 1913. The total output to this date was 44,569 tons with average assay value of gold .152 Ozs. silver 12.5 ozs, Lead 10%, Zinc 30% and copper .5% Reserves were estimated at 80,000 tons.

The North Tasmanian Copper had some 10,000 tons of proved ore.

As the composition and nature of this field was similar to that of Rosebery, it was recommended that it be worked in conjunction with Mt. Read by the one

company. The difficulties confronting the Rosebery field in 1913 were similar to those at Mt. Read. The whole deadlock was waiting upon an economic and suitable treatment process.

The Tasmanian Copper and the Primrose endeavoured to supply 1000 tons monthly to the Zeehan smelters beginning in 1905. When the Tasmanian Metals Extraction Company was formed in England to treat these zinc-lead sulphide ores by the bi-sulphite process, and the erection of the works at Rosebery was commenced in 1910, it was hoped that the metallurgical difficulties had been solved. The plant was not completed till 1912, and deliveries made under contract in 1907 with the Tasmanian Copper and Primrose commenced. The Extraction Company continued for three months, and then shut down for alterations. In October 1914, work was resumed, and continued until January 1915, when they finally closed. They had not proved a success.

As the Tasmanian Smelters at Zeehan had closed, and now the Tasmanian Metal Extraction Company also, there was no avenue left for the sale of the metal and operations on these two mines ceased. In 1914-15 renewed interest came to the field owing to the principal properties being placed under offer to the Mt. Lyell Mining and Railway Co. Ltd. The officers of the latter Company made an examination of the field, and this was responsible for the pegging of many sections which were considered to be in the line of the lode. The total output of the field to 1913 was 96,890 tons, value £97,600

In 1916, after long negotiations, all the principal properties were acquired by the Mt. Lyell Company and amalgamated under the name of Mt. Read and Rosebery Mines Ltd. This Company hoped for success with a reduction works for which a large supply of electrical power was essential. Conversations were carried on with the

Government, and power schemes at Lake Rollestón and the King River were investigated, but in 1919 the mining properties were turned over to the Electrolytic Zinc Company, with reserves of some 1,800,000 tons carrying zinc 27.3%, Lead 7.4%, Silver 9.6 ozs per ton and gold .127 ozs per ton, which were awaiting a metallurgical process to render treatment economical. Another major economic factor to be solved was that of cheap power with a voltage capacity of 3000 h.p.

The Electrolytic Zinc Company with a paid-up capital of £3,600,000 and an electrolytic plant at Risdon in Tasmania was the Company that could afford to search for a process of separating the complex sulphide ores of the Read-Rosebery district and already had a zinc refinery to treat concentrates when separated to metallic zinc. The old smelters at Zeehan were then purchased for a roasting plant to reduce the sulphur contents of zinc concentrates prior to sending them to Risdon. During the twenties this plant and premises were used for an experimental base and small quantities of the Read-Rosebery ores were mined and sent there for experimentation. The new method of selective floatation which was discovered in 1925 was applied to the sulphides of Read-Rosebery mines with good results and a large reduction plant was then installed at Rosebery on the Emu Bay Railway. By 1931, the whole plant was ready for operations on a large scale, but owing to the depression of metal prices, opening was postponed till 1936. Selective floatation and cheap hydro power from the Government scheme at Tarraleah were responsible for the re-opening of this field.

During the years 1931-36 while the Company was awaiting the upward movement in the zinc and lead market, extensive development, diamond drilling and general preparation was made at the mines for a long-term venture on a large scale, to begin immediately market conditions sufficiently improved. The Company too was

under mutual contract with the other important world producers of zinc to limit production until world stocks had been reduced to a reasonable tonnage, and this retarded the project of an early re-opening.

Production began in 1936, and has continued until the present time.

C H A P T E R I I I

ZINC PRODUCTION.

The zinc industry in Tasmania is highly capitalized, and is controlled by one company, the Electrolytic Zinc Company of Australia Ltd., which has a paid-up capital of £4,000,000. The Company is primarily interested in treatment of zinc ores, but has now acquired its own mines at Rosebery (Tas.) from which one third of its ores are drawn. Broken Hill Zinc concentrates supply the other two-thirds. The production and marketing of zinc may be summarised thus:-

1. Mining at Read-Rosebery.
2. Concentration at Rosebery.
3. Roasting or calcining at Zeehan
4. Transport to Risdon
5. Purchasing of Broken Hill concentrates and transport to Risdon.
6. Risdon Electrolytic treatment
   (a) Electrolysis
   (b) Melting to slab
7. Marketing
   (a) In Australia
   (b) Overseas.

MINING.

The zinc deposits are mined at both Read and Rosebery chiefly by underground workings and with open-cut operations on a limited scale. 90% of the mining is Rill-cut and fill in underground stopes.

Mining costs are for this reason much higher than at Mt. Lyell, but a factor in their favour is that the ores are found at high altitudes and can be mined on the tunnel system, which greatly facilitates ore transport to the reduction works. The chief cost items for ore extraction are:-

		Approx. only
1.	Wages and Superintendence	50%
2.	Stores - General	5%
	Explosives	1.5%
	Timber	14.5%
3.	Repairs - Wages	8%
	Stores	2.5%
4.	Power and Fuel	5.0%
5.	Indirect Expenses	Balance

To this must be added Development Cost, which has the same cost items, and in addition diamond-drilling cost.

From a study of the items above, it is seen that wages have the greatest influence on mining costs, for these are approximately 50% of all costs attributable to this section of the industry. The next biggest factor is that of Stores, of which timber is the principal item. A big factor in underground mining is the cost of timbering and mullocking of the stopes. Filling or mullocking costs are paid away principally in wages. By mullocking is meant the refilling with waste where ore has been extracted

The actual mining of the ore is let on contract to the miners, who earn anything from £12 to £30 per fortnight, and thus mining costs are very sensitive to contract prices. Although these aim at allowing a miner to earn at least 25% above the award rate, they are usually much higher for this field, and thus any study of the relation of award rates to mining costs would not be accurate enough for a helpful study.

There are no major problems, other than those associated with the war, such as a general shortage of supplies and equipment. The grade of ore mined is dist-

inctly uniform in contrast with such propositions as the Mt. Lyell copper body. For this reason, costs are not rising other than by reason of those factors associated with war, and the general rise in the price level.

Concentration.

The next stage is that of milling, which is done at Rosebery in the large modern reduction plant on the main Zeehan-Burnie Railway, and in fairly close proximity to the mines - the furthest distance ore travels is about 5 miles.

The cost of concentrate is divided between mining and milling in the approximate ratio of two-thirds to one-third respectively. The process of concentration is that of selective floatation of the sulphides.

From the Milling Cost Sheet items below, one is able to isolate the various factors affecting costs in this division of the industry.

A. Direct Charges

1. Operating wages
2. Operating Materials
   (a)Roll Shells
   (b)Steel Balls
   (c) Ball mill liners
   (d) Re-agents
   (e) Oil and grease
3. Fuel
4. Power
5. Water
6. Maintenance - Labour
   Stores

B. Indirect Charges

1. Holiday pay
2. Assaying
3. Experimental
4. Overhead.

The biggest factor here is that of operating materials and re-agents, followed by power and operating wages. The consumption of power by the concentrating plant

is fairly heavy, and has considerable bearing on the location of the reduction plant. Electricity, with its cheap carrying costs allows reduction at the place of ore extraction.

Although no figures can be published as to milling costs they are approximately 9/- per ton of crude ore milled. They show a remarkable stability which is mainly due to the fact that the grade of ore is generally the same from month to month, and year to year.

The capacity of the plant is 480 tons per shift of 24 hours, which runs seven days per week for 50 weeks in the year. In comparison with Broken Hill this capacity is not large, but in comparison with the majority of Australian milling plants it is substantial. The economics of zinc reduction is bound up with prices ruling for lead, copper and gold.

Three floats are made of the ore, firstly a copper float, secondly a lead float, and thirdly a zinc float, recovering the concentrates of the metal in each. While it is to the interest of the company to secure the greatest recovery possible, this interest is complicated by the following considerations. See Sheet No. 158. Zinc is penalised for in either the copper or lead concentrates if in excess of 1%. Lead is most valuable in either the copper or lead concentrate and less valuable in the zinc concentrate. Copper going into zinc can now be recovered and sent to Port Kembla for treatment. The lead smelters pay for copper in excess of 1%, but each metal is of more value in its own concentrate. Milling economics is therefore concerned with securing not only the greatest recovery of metal in total concentrates produced, but in that concentrate where it is of the greatest value. The problem then becomes to increase the efficiency of a float for that metal for which it is designed without increasing any penal costs or incurring

any loss of the other valuable metals. From a study of the following table the nature of the problem will be more fully understood.

While it shows a total recovery of 91.6% zinc only 82% is of value, and the remaining portion is a penal cost against production. It may be that the 8.65% zinc for which a penal charge is made in the lead and copper concentrate can be minimized to less than 1%, b ut in so doing, the loss of the other metals would make it less economic than paying the penal charge for excess presence of zinc.

PERCENTAGE MILL RECOVERIES AT ROSEBERY FOR PART YEAR ENDING JULY 1st, 1942 (5 MONTHS.)

Concentrate	Lead %	Zinc %	Iron %	Copper %	Silver %	Gold %
Copper	11.4	2.9	3.75	54	51.2	49
Lead	55.6	5.75	1.2	9.4	18.5	12.5
Zinc	19.8	82	10.0	18.1	16.9	8.65
Residue	Not given, as this is only dumped					
TOTALS	86.8	91.6	15.1	81.45	86.6	70.2

Figures supplied by courtesy of the Mill Supt. N.Z. Co., ROSEBERY.

Transport and destination of the concentrates.

The first transport phase is the conveying of the crude ores from the mines to the Rosebery reduction mill. The Hercules ore from the Mt. Read tunnels are is transported 5 miles over rugged terrain by means of aerial buckets on an endless cable supported by steel towers. Although the initial cost is high, the cost over the period of years is very satisfactory by this device. The Mt. Black ore at Rosebery is brought from the tunnels by electric locos which are fast and cheap to operate by electric power.

The copper concentrate, which is 54% copper, is railed to Burnie and shipped to Port Kembla, where it is smelted, refined and melted into metallic copper. With the copper the greater part of the silver and gold is

recovered.

The lead concentrate is railed to Burnie and thence shipped overseas, at this present time to the United States. This concentrate is 55.6% of lead. The production of these two metals is on too limited a scale to allow profitable treatment by the Company, and is therefore disposed of as indicated.

The third and final float, that of zinc, is sent by rail to Zeehan some eighteen miles for further reduction in the roasting plant there, which reduces the sulphur content by about 50%. It is then railed via Burnie some 290 miles to the Risdon treatment float. This concentrate consists of 82% zinc.

The location of the Zeehan roasters appears puzzling at first. It meansthat the concentrate from Rosebery has to go to Zeehan and then be returned via Rosebery to reach Risdon. This plant was previously the old Zeehan smelters which, because of their already established position, has continued to draw the ores over a route that appears illogicalland uneconomic. From recent information passed through the Company to its shareholders it appears that this plant will soon have to give way to a roasting plant established at the Risdon works, where it is hoped to make use of the sulphur.

<u>The Purchasing of additional Concentrates.</u>

As the Electrolytic Zinc Company is primarily a treatment company, it is concerned with the purchasing of additional zinc concentrates to allow economic treatment of its own ores while concerning itself with the production of electrolytic zinc.

These additional concentrates which form the bulk of its raw materials are purchased from the North Broken Hill, Broken Hill South, and Zinc Corporation Mines at Broken Hill. The existing contract governing the purchase of this concentrate supply was made in 1930

and expires in 1945. The price of the concentrate f.o.b. Port Pirie or other Mainland port is based inter alia on the average price of zinc received each year. While there are other sources of zinc concentrate available in Australia, it was stated by Sir Colin Fraser in the Report to Shareholders of the Electro-lytic Zinc Company Limited at Melbourne on December 2, 1943 that the success of the Electrolytic Zinc Company was obviously very largely bound up with the fortunes of the Companies owning the Broken Hill mines.

C H A P T E R I V

ELECTROLYTIC TREATMENT.

The deciding factor favouring the choice of Risdon, Tasmania as the location of this large treatment plant was firstly, the availability of cheap electric power, which is an essential for the metallurgical process employed in zinc manufacture. The required quantity of power for this plant, which is 45,000 h.p. is made available by the State Hydro Commission for the low price of £2 per h.p. Secondly, Risdon's facilities for interstate and overseas shipping made it ideal for the freighting of concentrates from the mainland and for the exporting of refined electrolytic zinc to overseas and mainland markets. The third factor was the proximity to a big city from which labour could be provided on an appropriate scale (i.e. today over 1,500 employees). A remote position would have probably caused labour shortages with greatly increased labour cost because of scarcity and other labour disutilities.

Costs at the Risdon plant are decided chiefly by the following items:-

1. Price of electrical power
2. Cost of zinc concentrates

3. Price of labour

4. Price of operating materials

5. Extent of repairs and rate of depreciation of plant

6. Value of by-products - sulphuric acid for superphosphate manufacture, value of cadmium recovered.

7. Freighting costs to and from the plant.

Future Source of Zinc Ores.

The Read-Rosebery field has the only zinc deposits of any size known in the State. Reserves are stated at 1,500,000 tons assaying approximately zinc 21% lead 6%, copper .7%, silver 7.3 ozs, gold 1.9 dwts, sulphur 26.6% and iron 16.1% (December, 1942)

Total zinc production for this State for the years 1936 - 41 was 143,231 tons. During this period reserves have not diminished, as each year prospecting and development has located as much as has been extracted. At the present scale of operations, which is approximately 168,000 tons per annum, there is a life for the field of ten years, but geological science indicates that possible reserves of ore are another 1,000,000 tons.

Nevertheless, there is nothing to suggest that this zinciferous body is boundless. On the contrary, geological surveys do not promise any further large deposits of ore at Mt. Read, but at Mt. Black the grade of ore is likely to remain good for many years.

On the mainland there are several producers of zinc concentrates - the Broken Hill companies and the Mt. Isa Silver Lead Company are the most important. At the present time, Broken Hill concentrates alone are purchased, and more could be supplied from them if Risdon's capacity was increased. As the Broken Hill reserves are very extensive and the financial position of the companies operating them never looked brighter than they do today, there is little reason to believe that inadequate supplies of concentrate will be forthcoming to supply the Risdon treatment plant. There is evidence from the Electrolytic

Zinc Company's Directors' Report to Shareholders for the year ending June 1943 that the Company proposes extensive alterations to allow increased treatment and production of zinc. As Australia exports as much zinc concentrates as are treated at Risdon, there is reason to conclude that concentrate supplies from outside of Tasmania should prove more than sufficient to maintain production formany years to come.

The Zinc Industry in Wartime.

West Coast Mines.

Throughout 1942 and 1943 the supply of ore to the concentrating plant was maintained at full capacity This was possible because of transfer of miners from gold-mining centres in other parts of the Commonwealth to the mines at Read and Rosebery.

Development work suffered in the endeavour to keep the supply of ore to the mill at capacity. Labour could not be spared for development, but because of the previous up-to-date policy of the Company, development was still well ahead of present workings. Nevertheless, the near future will suffer in output if the labour is not found to do this necessary developmental work.

Production costs have appreciably risen. Wages increases have been largely responsible. Also all factors entering into costs have shown a strong upward trend due to the general upward trend in our wartime price structure.

Risdon Plant

Except for intermittent periods when the supply of calcine (zinc roasted concentrates) have been reduced through shipping delays, the plant has operated at full capacity.

Due to wartime conditions, the construction programme designed to further increase production has lagged behind schedule. Higher treatment costs have been caused by (a) increases in wages and imposition

of war-time allowances; (b) lower operating efficiency under wartime conditions due to substitutes in operating materials and labour dilution and (c) advances in price of operating materials.

Profits have been reduced for the industry over the years 1942 and 1943 and dividends from 14% to 9% by reason of the increased prices already mentioned, and also because of the fact that price fixation has controlled the sale of zinc below export parity, the normal basis of realization, and the decision of the Company to provide for a reserve fund in respect of mine depreciation (ore depletion)

The demand for zinc continues to increase. Zinc has manifold uses in war-time. Under war conditions, more than two-thirds of the Electrolytic Zinc Company's output is required by the Commonwealth Government. Its distribution is controlled by the Ministry of Munitions, and the supply is authorised only for munitions and essential goods and services.

The Company is selling its product to the Commonwealth Government and its contractors and to others in Australia at a price far below that ruling in any other country. The Chairman of Directors, Sir Colin Fraser, in his Annual Meeting to Shareholders in 1942 and again in 1943, made reference to the increase of costs in the industry, and said that the Company was asking for an increase in the price of its product. The demand for cadmium from the United Kingdom has also increased, because of its use as an alloy in high efficiency bearings in aircraft engines.

The United Kingdom is urgently requesting more Australian zinc. To meet this demand, the Company made a new issue of £400,000 so as to increase output to the United Kingdom and to India. This plant extensions programme is being seriously hampered by labour irregul-

orities and disabilities, plus shortage of materials. Such conditions have brought slow progress and high cost constructions.

Although the mines from the West Coast are unlikely to increase production, the increased output at Risdon will come from Broken Hill ores that were previously exported as concentrate to smelters abroad.

With Great Britain, Canada and the U.S.A. increasing output of smelteries to the maximum, the strong wartime demand for zinc is likely to continue. Markets are in short supply. The great problem for now is not one of consumption, but one of production, but now the factors of production are in short supply. Increased mechanization cannot wholly relieve the situation, for mechanization itself is curtailed by labour restrictions. The industry's war-time problem is how to increase production under war conditions.

The following extract from the report of the Chairman, Sir Colin Fraser, at the Annual Meeting of Shareholders held in Melbourne on December 2, 1943, is very informative:-

"While there is a good prospect that our zinc production will find a market during the current year, the marketing position has changed considerably.

The proportion of our output used locally showed a steady and substantial increase prior to the war, and up to the end of the financial year ended June, 1943. All contracts with the Commonwealth Government for the supply of zinc and zinc base die casting alloy have, however, now been fulfilled, and with the use of zinc for civil requirements still under rigid restrictions, it seems likely that the current year's domestic sales will be smaller than during last year.

Fortunately, from a National point of view, the reserve stocks in the United Kingdom and India are

also satisfactory. His Majesty's Government, has, however, renewed for another year, i.e. to the end of August, 1944, the contract for purchase entered into at the outbreak of war, and this contract, which gives us the right to sell some export zinc in specified permissible markets, together with certain firm purchases made by the United States of America, already ensures disposal of almost our full output for the current financial year.

It is opportune here to make brief comment on the matter of zinc prices, and in particular to show at what exceptionally favorable prices zinc has been made available to the Commonwealth Government for munition manufacture, and also to meet the requirements of Defence contractors and essential industry.

In August, 1939, the price in Australia for zinc - calculated in accordance with our policy on the parity of the London Metal Exchange quotation - was £20/2/6 per ton. Subsequently, in February, 1940, the Australian price was increased to £22 a ton, though we still continued, as a concession, to supply the Government with zinc at £20 per ton. At a later date, this concession price was increased to £21, and still later to £22 - the fixed Australian price. During the war period, our costs have risen by considerably more than is represented by this price increase, and it will be seen, therefore, that we are carrying most of the extra cost on the zinc sold in Australia.

The price of high-grade zinc in Great Britain delivered into buyers' works has, under rigid control, continued static since February, 1940 at the equivalent of £34 Australian currency. This electrolytic zinc is mainly metal purchased by the British Government under the very favorable contracts made at the outset of the war by the United Kingdom Government with our Company

in Australia, and with producers in Canada.

The price of zinc in the United States of America (the largest producer in the world) has long presented a marked contrast to the above-mentioned prices in Australia and the United Kingdom.

The price of g.o.b. zinc (spelter) today in U.S.A. is the equivalent of £57 per long ton Australian currency, with electrolytic zinc at a premium of, say, £7, or £64 per ton. These prices, too, have been fixed for what is known as standard mine production, with substantial premiums paid for zinc produced in excess of standard productions.

Having regard to world prices generally, I doubt if there is a cheaper metal today than Risdon electrolytic zinc as sold for consumption in Australia. While there is some satisfaction in this record, shareholders should be told that there is now very little profit margin on producing this portion of our output, and that we are only able to maintain a reasonable overall profit, because of the larger proportion of our production which is sold in export markets, where higher prices prevail, and where recognition is given to increased costs under war conditions. Full representations have been made to the Prices Commissioner in this connection, and our case is under consideration."

BY-PRODUCTS.

The Rosebery concentrates carry a valuable by-product, cadmium, which is recovered at the Risdon plant. The demand for this product is increasing, the United Kingdom being the present buyer. Cadmium is used mainly for high efficiency bearings in aircraft engines, and because of the increased importance of these, the Company is doing all in its power to increase the exports of this mineral.

Although the Company is primarily concerned with zinc and next in order, lead, silver, copper, gold and cadmium, the sulphur content of the zinc concentrates is also a matter of major importance. The Company is endeavouring to centralize more of its roasting capacity at Risdon. The Rosebery ores are now roasted at Zeehan, and Broken Hill concentrates on the mainland. The result is that although the concentrate is reduced for freighting to Risdon, much of the sulphur is completely lost. At Risdon, the concentrates receive a further roasting, and here the remaining sulphur content is driven off in sulphurous gas from which sulphuric acid is made. Sulphurb acid in turn is essential inter alia for the manufacture of superphosphate and sulphate of ammonia. The Company is equipped to produce a superphosphate to meet the full requirements of Tasmania. The economic geographical range of this relatively low-priced commodity, superphosphate, which is necessarily governed by transport costs, is definitely limited, so there is little prospect of competing with mainland plants. The annual production of this product is about 22,000 tons ~~per annum~~.

The position in regard to sulphate of ammonia is very different. This is a much higher priced product and therefore transport cost is not such an over-powering factor, as with superphosphate. The demand for sulphate of ammonia as a fertilizer for use directly, and also incorporated in mixtures has increased in Australia, and there is every prospect of an accelerated rate of increase. Australia has always heavily imported this product from the United Kingdom and Canada, the annual amount being about 25,000 tons. Economic production of this valuable product demands a large scale plant which would use approximately 30,000 h.p. of electric energy to produce about 50,000 tons. The Electrolytic Zinc Company is hoping to undertake the manufacture of this product on

the scale indicated above immediately at the close of the war.

Cobalt oxide, which is obtained from the Broken Hill ores, is also valuable, although obtained only in small quantities.

Thus it is seen that the economic manufacture of zinc is bound up with several by-products - some of which might even rank equally with the production of the parent commodity.

QUANTITIES AND VALUE OF PRINCIPAL BY- PRODUCTS.

	1939		1940		1941	
Cadmium	Tons	Value	Tons	Value	Tons	Value
From imported concentrates	124.4	£40,094	122.46	£41,148	144.8	£48,622
From Rosebery concentrates	43.34	13,932	49.39	16,594	42.7	14,346
Cobalt Oxide						
From imported concentrates	19.5	£8,961	17.77	£8,177	19.27	£8,869

Gold - in the Rosebery concentrate.
The return for goldis not obtainable, but it has been given on good authority (a high ranking official of the Company) that it is worth 14/- per ton of ore mined.

Silver is shown under Silver-lead.

Superphosphate. Approximately 22,000 to 25,000 tons are produced annually.

ZINC PRODUCTION COSTS.

In June 1934, evidence given by the Electrolytic Zinc Company before the Tariff Board revealed the following position:- "United Kingdom g.o.b. spelter, which could be used as a substitute for high-grade metal for some purposes could be landed in Australia at £19/19/6 c.i.f. and c. The Australian price for high-grade zinc landed in Melbourne, Sydney and Newcastle would be

£21/5/0 per ton, or £1/5/6 per ton above the imported duty-free price of low grade spelter."

At this time, the Company was receiving protection from the Commonwealth Government - Duties of 10% (British Preferential Tariff) and 20% (General Tariff) were placed on zinc bars, blocks and ingots and scrap. Australia was then using between fifteen and twenty thousand tons per annum, chiefly for the manufacture of brass and for galvanised steel sheets and wire products. This protection of the home market allowed the Company to compete overseas with its surplus product at a price often below the home price.

Today the industry is able to supply zinc to the Australian Government for £22 - the fixed Australian price, when the price in Great Britain delivered to buyers' premises is £34 Australian currency, and for the United States, the leading world producer, it is approximately £A64. Although the profit margin is very small at £22 per ton, the Company relies mainly on its exports to show a reasonable profit on its total operation. There is, however, revealed a very strong competitive cost position which places the industry on a superior plane to meet the post-war competition, when overseas marketing will assume considerable importance. This means that although the war has brought a rise in the general price structure, zinc is still able to be produced at approximately the pre-war price as quoted above.

It is known that mining costs have risen at Rosebery, and no doubt Broken Hill concentrates are dearer today than they were in 1934 for similar reasons as apply to the cost of calcine from the Rosebery mines. The treatment plant at Risdon has been the instrument that has enabled the steadying of production costs despite a higher price for its raw materials, wages increases and more expensive operating materials.

When compared with the cost structures of other non-ferrous industries - the position of this Company is a most engiable one and speaks well for the outlook of the industry in the post-war era.

PROFITS OF THE ELECTROLYTIC ZINC CO. LTD.

	1939/1940	1940/1941	1941/1942	1942/1943
Net Profit	£377,728	£332,432	£303,916	£292,765
Taxation	163,396	320,000	299,500	222,000
Depreciation	100,000	125,000	125,000	150,000
Dividend %	14	14	9	9

Australian Press - Taken from Mercury June 30. 1942 & Advocate 1943

QUANTITY AND VALUE OF ZINC PRODUCED FROM ORES MINED IN TASMANIA.

Year	Quantity in Tons	Value in £ sterling	Price £
1919	285	£13,110	
1920	9.3	334	
1921-23	No Production	-	
1924	2748.75	90,485	
1925	3111.69	110,691	
1926	5377.75	183,362	
1927	6326.2	181,242	
1928	7112	188,691	100
1929	6997	185,964	96
1930	943	19,322	65
1931-35	No Production	-	48 - 55
1936	18,769	283,105	56
1937	23,481	525,824	86
1938	25,366	356,452	54
1939	25,021	366,176	57
1940	26,126	711,931	100
1941	24,468	666,768	105

Relative percentages for zinc quantities cannot fairly be based on 1928. Production since 1936 reveals a fairly even rate of output.

Director of Mines Report (Tas) Yr. 1941.

THE OUTLOOK FOR THE ZINC INDUSTRY.

It is necessary to divide the industry for analysis, as it has distinctly two phases (1) Mining and (2) Treatment. The fortunes and interests of each may widen or become closer in the future.

As already stated, the reserves and average grade of ore are most satisfactory. Although the Risdon plant is not wholly dependent upon these mines, they are nevertheless very important. In addition to

zinc, they furnish lead, copper, silver, gold and cadmium and sulphur. The value of the sulphur has previously been indicated. The gold recovery is at present worth 14/- a ton of ore milled, and this is more than sufficient to pay the cost of concentrating the ore at Rosebery in preparation for roasting. The future of these mines is largely bound up with the Risdon plant, but their complex variety of products might help to stabilize otherwise unprofitable operations if zinc prices deteriorated. The mining of ores elsewhere does not come within the bounds of this survey, suffice it to say their cost and supply to the Risdon plant should prove most satisfactory in the future.

Although the production of zinc was once embarrassing the world market, there is nothing to justify the conclusion that because the wartime demand has increased supply that restriction must necessarily follow after the war. On the contrary, those who are best able to forecast envisage a period of great prosperity for the Tasmanian industry. The following is from the report of Sir Colin Fraser to the Shareholders for the year ending 1943:-

"So far as the current year is concerned, and, I believe, for the remaining period of the war, all our metals and products will find a market on terms which should yield in the aggregate revenue comparable with that earned by the Company during the year under review. We anticipate, too, that with the improving war outlook, the Government here will relax its restrictions on the local use of zinc, and in particular, will permit the galvanising of more of the material so urgently required by primary producers, viz., wire, wirenetting and iron and steel sheets, piping, etc. It is unfortunate that owing to war conditions so large a proportion of these essential requirements has had to be put into service

by the farming and general community without the advantage of the excellent protective qualities provided by zinc coating. However, it should now be possible to remedy this disability.

Taking the longer view, and quoting from the statement I made at the annual meeting of Broken Hill South last week, I have no doubt as to the world demand that will develop for lead, and zinc in common with other metals and rawmaterials, after the war. The earlier stage of the transition from war to peacetime conditions will inevitably present problems connected with the disposal of heavy stock-piles of all kinds of materials, mainly in Government hands, including ores, metals and semi-fabricated and fabricated metal products also scrap and salvage metals. There will quickly follow, however, a great and unsatisfied demand, for a long period, of all constructional materials, including metals, in order to meet the needs of post-war reconstruction and development. Australia is fortunate that today her domestic prices for lead and zinc are, like those of iron and steel, the lowest in the world. Assuming that favorable costs of production in Australia for these metals, relative to costs of production overseas, can be maintained in the post-war period, it should obviously prove of very great advantage to our metal manufacturing and engineering industries. With regard to lead and zinc, it will, I believe, be a question as to how and where the required world supplies can be obtained to meet the demand envisaged, as the known undeveloped deposits of lead-zinc ores which can be profitably worked at the present price levels are few and far between.

With the above prospect in view, our first objective must be to complete the extension to our electrolytic zinc plant at Risdon, in order to increase

its capacity, and this we are doing to the extent that our limited manpower resources permit. The plant still ranks as the third largest in the world."

"The cheapness of zinc is its greatest asset, and because of its low price it should be viewed as a dangerous competitor of the other non-ferrous metals rather than as their victim" * (a). Due to the predominantly dissipative and expendable nature of the uses that zinc is put to, secondary production is not a big competitor with primary zinc. In 1930 the United States produced 23% of its zinc from scrap sources as compared with 40% for lead and 43% for copper. * (b)

Reserves of zinc are not well distributed throughout the world, and their diminishing nature may yet cause serious concern. Prior to the present war, most countries, including the United Kingdom, Germany and France were large importers, while few countries outside of Australia and Japan had a substantial exportable surplus.

Australia appears to hold a very favourable position as a zinc producer. Her reserves are comparatively extensive and production costs are the lowest in the world, according to Sir Colin Fraser.

As a producer of zinc concentrates, Australia ranks very high, but as a producer of metallic zinc, output is small. This indicates that smelting accommodation has been provided cheaper elsewhere, principally in Belgium and Germany. The only plant that operates in Australasia is the Risdon works of the Electrolytic Zinc Company, where some 70,000 tons of zinc are

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* (a) "The World's Staples" by Ingalls; page 179
* (b) Figures taken from "World Resources and Industries" by Zimmerman, page 718.

produced annually. The advantages of cheap power and water transport facilities have combined to make it a strong and growing enterprise, with production costs now unrivalled anywhere in the world. The capacity of this plant has increased during the war, and but for wartime difficulties it is reasonable to suppose that production would have doubled.

If the demand for zinc remains firm after the war, it is likely that all zinc concentrates produced in Australasia will find electrolytic smelting accommodation at Risdon and Tasmania will rank among the leading zinc smelter countries of the world.

The prospect that the industry will gain strength from the proposed associated project of producing sulphate of ammonia on a large scale demanding some 30,000 h.p. of electricity and pouring some 50,000 to 60,000 tons of this product per annum is worthy of attention. The Company proposes to cultivate an extensive market not only in Australia, but to develop those potential markets of the East Indies, Pacific Islands and those territories north of Australia which should be easily able to absorb the necessary exportable surplus of approximately 15,000 tons annually.

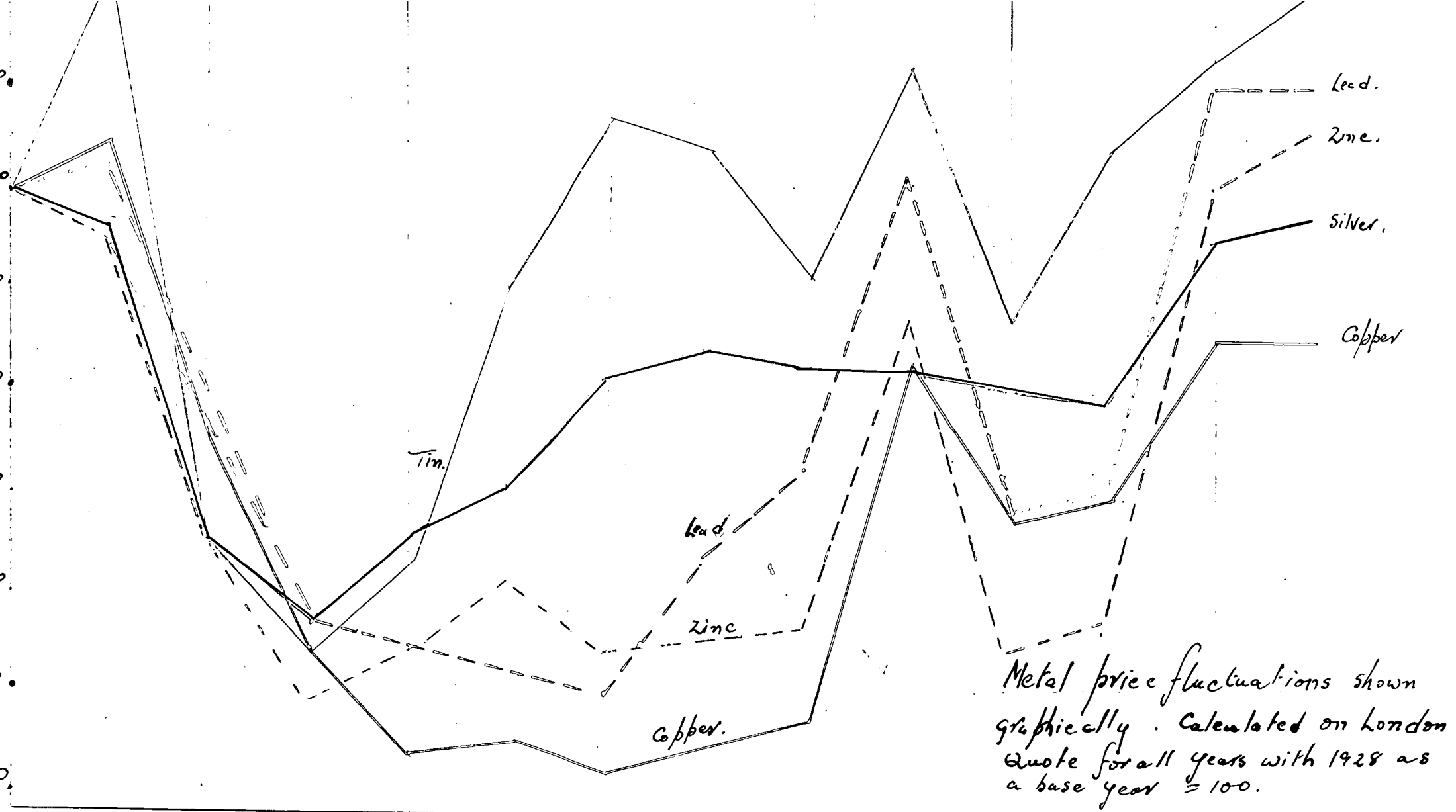
On the whole, the structure of the industry is strong, and a world free-trade policy would redown to the industry's continued prosperity and growth.

METAL PRICES - AVERAGE FOR THE YEARS 1931-1941

(Sterling Prices - London Quote)

Year	Lead soft foreign per ton	Spelter per ton	Silver standard spot per fine oz. in shillings	Tin standard spot per ton
1931	£13. 0. 7	£12. 9. 0	1/2.593	£118. 9. 1
1932	12. 0. 9	13.13.10	1/5.842	135.18.10
1933	11.16. 1	15.14.11	1/6.144	194.13. 4
1934	11. 1. 0	13.15. 6	1/9.208	230. 7. 5
1935	14. 5. 8	14. 0. 0	1/9.951	225.14. 6
1936	16. 7. 9	14. 6.11	1/9.647	208. 6. 6
1937	23. 6. 1	22. 6. 8	1/9.65	242. 6. 7
1938	15. 6. 5	14. 1. 7	1/9.066	189.12. 1
1939	15.13. 7	14.14. 0	1/8.461	226. 5. 6
1940	25. 0. 0	25.15. 0	2/2.048	256.12. 3
1941	25. 0. 0	27. 5. 0	2/1.25	261. 8. 1

Figures obtained from Director for Mines Report (Tas) 1941.


Percentage of 1928 price used as a Relative Index.
110
100
90
80
70
60
50
40
Tin.
Lead
Zinc
Copper.
Lead.
Zinc.
Silver.
Copper
Metal price fluctuations shown graphically. Calculated on London Quote for all years with 1928 as a base year = 100.

S E C T I O N V

GENERAL MINING ECONOMICS.

C H A P T E R I

GENERAL MINING ECONOMICS.

Our object here is to glean from the data collected the cardinal facts and economic principles governing the mining and treatment of minerals, with some scant reference to social and welfare economics arising out of thésbbrief investigation. Our findings will apply to general mining eeonomics, but the purpose is more with the object of providing a guide to the problems that confront the industry in this State.

MINERAL LOCATION AND FREQUENCY.

Minerals are highly localised in occurrence, of uncertain frequency, and of strictly limited availability. Geological phenomena such as volcanic and glacier action are responsible for this. The chief mineral deposits are therefore located in those regions where the earth's surface has been so dislocated by powerful natural forces that only mineral, and sometimes timber resources can be commercially exploited by man. Thus mining fields are generally foundin isolated regions where little or no previous development, industry or population is located.

The frequency of mineral lodes is beset with much uncertainty. Owing to the hidden nature of most minerals, their discovery is largely a matter of chance. Much uncertainty also surrounds the discovery of supplementary or rival deposits. The history of mining fields bears strong testimony to the truth of this paragraph.

The economic availability of minerals reveals a striking contrast to geological availability. Next to oxygen and silicon, aluminium is the most common ingredient of the earth's crust. It constitutes about 8% of the igneous rock, as compared with only 5% for iron and one-hundredth of one percent for copper. Despite this frequent

occurrence of aluminium, the only present commercial source of the metal is from bauxite, which is restricted to a small number of countries, and known deposits of this are smaller than for copper. Mineral resources may be present in that ideal state which metallurgical science is able to treat, but their commercial exploitation may be damned by economic considerations such as distance from markets, or engineering difficulties. Thus the availability of mineral deposits depends to a large extent on technical progress - technique of mineral location, extraction, treatment and transportation. Tasmania has extensive deposits of silver-lead and tin, but the present state of our mineral exploitation technique is not sufficiently ~~far enough~~ advanced to consider them as commercially available. We are, of course, taking the price factor as given, and as a part of the data in our proposition. If by virtue of mineral exhaustion or increased demand price is raised sufficiently, these mineral deposits may become economic. Economic availability then, is also subject to price movements.

GENERAL CONDITIONS AFFECTING THE MINING AND METALLURGICAL INDUSTRY.

1. Water Supply.

An abundant water supply is the first essential in mining and treatment of ores. Fortunately, Tasmania's West Coast region provides this, where are located the State's chief centres of production. The rainfall in this area ranges between eighty and one hundred and sixty inches a year, and for this reason the conservation of water does not present any problem. Water costs are therefore small, but because they are only a small item on cost sheets, their importance is no wise depreciated. Like air to mankind - it is life, but costs nothing, so water is to mining, and for the West Coast region, it costs little. A small supply of this commodity is

required in ore extraction, but it is the concentration and treatment of the crude ores that require such a large supply of water. Lyell's requirements are heavy. That the West Coast generally has a very even distribution of rain as to place and time is another important fact favouring water supply. Here is a typical rainfall for the twelve months for Queenstown:-

January	165 pts	April	200 pts.	July	1018 pts	Oct.	982pts
February	252 "	May	746 "	Aug.	658 "	Nov.	798 "
March	880 "	June	652 "	Sept.	945 "	Dec.	363 "

Some conservation of water is necessary even for the wettest places to cover dry spells, but capital required for such schemes is not large. It is for the production of electricity that the continuous and heavy rain is so essential to Queenstown.

The North Eastern portion of the State has a rainfall averaging 40", but the distribution throughout themonths is not so consistent as in the West. The summer months are dry. For this reason more and bigger schemes of conservation are essential. The tin-mining companies of the North East are, generally speaking, not so large and financially strong as the Western industries, and for this reason such schemes are a heavy financial undertaking for them. Water costs are for them high, because water has often to be brought a long way in comparison with West Coast mines.

It often happens that tin production is seriously affected in the summer months, and for very small mines production ceases. The greatest demand for water on these alluvial mims is required for hydraulic sluicing, as well as mineral concentration. Tasmania's abundant rainfall in the mining areas, which ranges from 40" to 160", is indispensable to the success of the mineral industry.

2. Power

Another essential factor to mining is cheap

power. The first essential often assists the second. Because of the mountainous nature of this State, and the high rainfall, hydro-electric power is made possible. Some of the mines have their own individual hydro-electric power schemes. In addition, the State Hydro Electric Dept. has already installed schemes totalling 144,000 h.p., which represents a mere fraction of the State's hydro-electric resources.

The power is available at low rates, especially if taken in large blocks. The conditions are extremely favourable for large mining and metallurgical companies requiring large blocks of power. The dependence of the industry on cheap power cannot be over-stressed. High power costs have closed many small mines.

The chief consumers of hydro-electric power in this State are:-

	H.P.
Electrolytic Zinc Co., Risdon	45,000
Hobart District	11,000
Carbide Works, Electrona	4,500
Launceston Corporation	6,000
Country Districts	4,120
Railton Cement Co.	3,000
Maximum Demand	62,500

It is readily seen that the mining industries underlined are the principal consumers of electric power. Although it is the treatment plants that are more particularly dependent upon cheap power, mining requirements are also assuming increased importance with increased mechanization. It is the mineral industry, and mainly its treatment phase, that has made possible the development of our Hydro-electric resources on such a scale, and it is this industry that will help to extend its development in the future. We might say that our mineral and hydro-electric industries are interdependent.

3. Timber

The mining fields embrace large areas of timbered country, containing forests of eucalypts, beeches and pines, which are most suitable for general mining and

constructional work, both as regards quantity and quality. This feature aids considerably in making operations profitable.

TRANSPORT (Railway)

The factor of transport looms large because of mineral location, ore bulk, weight of metals location of treatment plants and distance from markets. Some idea of min eral locat ion has been given. This entails transport over regions where railway enterprises can expect little or no support from other industries. The weight of ores and metals necessitates powerful locomotives and costly rolling stock, with high fuel consumption costs. Seldom can good return freights be expected to reduce transport costs. Apart from the goods for the maintenance of the mining communities, there are no return freights. Some companies, such as Mt. Lyell, which smelt their own concentrates convey coke to their plant and return with refined copper, but the conveyance of ores from Rosebery to Risdon is one way freighting. The necessity for specially designed trucks suitable only for similar cargoes accentuates the difficulty of finding return freights for this rolling stock.

Some Russian and American enterprises have found it more economic to have two treatment plants, one at the source of mineral extraction, and the other where fuel resources are available for treatment purposes. Ores are thus carried to the fuel for smelting, and coke and coal is freighted to the mines where another plant is engaged in smelting. By such a device rolling stock is kept fully loaded both ways. This device is most desirable where the refined product is used on the spot, or has to travel in another direction.

Tasmania is fortunate in that her mineral lodes are, generally speaking, reasonably close to the ports, but there is the high cost of railway operation

over difficult and wet terrain with steep grades. Rolling stock on the Emu Bay Railway conveying ores to Burnie for Risdon has to climb about 2,000 feet in 32 miles. This steep grade greatly reduces the load capacity of the locos, with ensuing increased freighting costs.

Shipping

As Australia is a large exporter of metals and mineral concentrates, overseas shipping freight rates are very important. Ores travelling overseas are generally accommodated for at very reasonable prices, except in wartime by reason of return freighting opportunities to the shipping companies, Australia being a large importer of goods from Europe and America. Because of the benefit to be gained from return cargoes from Australia, tramp steamers would freight zinc to England and America from Australia for 18/3 a ton, cheaper than the railroad could handle the same freight from Rosebery to Burnie, a distance of only 75 miles. Of course, these cheap freighting rates apply only to particular seasons of the year, but as minerals are not of a deteriorating nature, waiting, apart from finance, is not detrimental. Thus they are able to take advantage of the cheapest rates offering.

THE LOCATION OF REDUCTION AND OTHER TREATMENT PLANTS

Mineral ores are mined in great quantity, and they are extremely heavy, and their value, especially in the case of the non-ferrous metals, is low relative to their weight. Copper and tin ores carry only a little more than 1% metal in this State, and zinc-lead ores, although carrying 20% zinc and 6% lead, are proportionally lower in value. For non-ferrous ores particularly, the close proximity of reduction plants is important. In this State all ores are concentrated by reduction plants at the mines. Transportation is the prime factor in determining the location of crushing and concentration

mills, with power considerations ranking high.

Smelting, refining and processing plants are determined by several factors. The size of plant with access to re-agents and energy resources is chief. Transportation costs are also influential in pressing the location of smelters as near as is practicable after considering all factors, to the place of reduction. Refining and electric smelting plants are primarily driven to cheap electrical power resources. Thus we have the reason for the choice of Tasmania as the location of copper refining, electrolytic zinc manufacture, and aluminium smelting.

SOME SPECIAL FEATURES OF THE INDUSTRY AND SOCIAL EFFECTS.

The coal mines of the world have often brought their market to them. In attracting large populations and metal industries, the market for coal is often brought to the coal fields. The non-ferrous mineral industry is differently situated. No market is created for its product by the peoples who mine and operate it. Rather must it find a place of realization in areas far remote from where it is extracted. It is particularly a lone industry - operating in areas that are entirely dependent upon it for settlement. With the exception of a little timber, which is mostly absorbed by the mines themselves, the West Coast of Tasmania is directly supported by minerals.

Consequent upon this fact, mining ventures are called upon to make and carry out extensive schemes that would otherwise be shared by other industries and the costs borne by these, and the communities themselves. To reach the isolated regions where minerals are to be exploited, a Company is often forced to undertake a very costly scheme to provide transport. We have such an example in the early days of Mt. Bischoff and Mt. Lyell Mining Companies, not to forget the Zeehan and Read-Rosebery fields. Such ventures often prove too costly for

one company, whereas if a number of industries, such as timber and agriculture, were possible, the cost of access might be borne between them. Again, the company undertaking a venture in an isolated region has often found it imperative to undertake not only the costly erection of its own plant, but the entire planning and cost of erecting a town with the conveniences demanded by modern civilization. This was the case for Mt. Isa in Queensland, and for the Electrolytic Zinc Company at Rosebery.

By this means the transport system and the entire communal life of the field is bound up with the prosperity of the mines, and very much becomes subject to the will of mine ownership. Trains are run to suit the mines, and not the passenger freight. Thus to a very large degree, the contentment of employees' social life is dependent on the mining administration, which is not only the sole capitalist owner, but the sole employer of labour. The prices of rents, fuel and stores are largely determined by the freight, store ownership, and other policies of the company. This is true to a large degree in the case of the Electrolytic Zinc Company at Rosebery, and the Mt. Lyell Company at Queenstown, and to some extent the same applies to Tullah, where the North Mt. Farrell Company owns its own railway and much property. This situation gives the company some negative control over labour. Desired labour can be encouraged by such factors as cheap rent and fuel, lighting and workmen's mess houses and sporting clubs, while undesired labour is more easily distracted by withdrawing such facilities.

The isolated position of these enterprises bring higher disutilities, and consequently the price of labour, as well as living costs and the price structure generally in such regions, is, on the whole, higher than it would be if closer settlement were possible. Higher

labour costs are reflected in higher mining costs, and very much depends upon the companies controlling the field and their administration in social matters just how much these labour costs amount to. The extreme climatic conditions, although outside direct control, can be to a large extent overcome by careful planning and wise investment.

THE EXPENDABLE NATURE OF MINERAL RESOURCES AND FACTORS SPEEDING EXHAUSTION.

Mineral deposits are assets provided by the gift of Nature, and therefore rank with all those economic resources given to man which are termed in Economics "Land" A mine, however, must be distinguished in certain features which make it unique in the Land category. Land in the ordinary sense is not exhausted by the application of capital and labour. It is subject to the principle of diminishing returns, and may become partially exhausted through the application of the above agents, but by the further application of labour and capital scientifically applied it can be regenerated to continue production. It is unexpendable in this sense, and because of its continued usefulness, it is therefore an asset for ever. The use of forest resources, on the other hand, means demolishing assets which will take many years to replace. Nevertheless time can replace them, and science can help to speed the time. Mines might be classed in the third degree category of economic Land resources. They are assets which are subject to final and complete exhaustion through the application of labour and capital. Capital, labour and science may help to conserve our mineral assets, but they can never recondition or replace them.

A mine, therefore, is not only subject to the principle of diminishing returns, it is also subject to the principle of a wasting asset, and because these two principles are at work during the life of a mine,

the economics of ore extraction differs from that of agricultural production. The fact of ore depletion demands a high rate of depreciation on capital invested, which is not always recognised by taxation authorities nor by mining enterprises themselves.

Factors speeding the economic exhaustion of minerals may be due to a number of causes, such as obsolete equipment or a mechanised application of ore extraction, both of which are incapable of extracting the total ore body, the former by reason of its obsolete character may be unfit to work lodes below a certain depth, or to break rock of a specific hardness, and the latter engaged to work on such a scale that small seams of ore are unprofitable, and hence are left, and in both cases, mineral resources are buried, and their renewed commercial exploitation is never likely to again prove economic.

Further factors hastening exhaustion through wasteful exploitation are brought about by companies operating with insufficient capital on lodes demanding a heavy investment to make their exploitation profitable, fierce competition making skimming necessary to survival, or sometimes wasteful operations are continued when the lodes are rich and the necessity to eliminate waste is absent. We have examples of all of these in the history of our fields in this State. The Mt. Read and Renison Bell mines were skimmed by companies with insufficient capital to undertake their proper exploitation with the result that the latter field has never recovered from this early setback, which makes a start prove difficult to any new enterprise. The Magnet silver-lead deposits illustrate an example where rich lodes were wastefully concentrated by means of an inefficient milling plant with the result that the field reached a stage of premature exhaustion.

The division of a field between too many small treatment plants, which are either obsolete or on too small a scale to profitably handle their by-minerals may also be cited.

We might mention a final cause, and that is in the case of a large company endeavouring to take the full advantage of increasing returns, is faced with the problem of a shrinking market. The Electrolytic Zinc Company of Australia Ltd. in the early thirties was in such a position. It had entered into agreement with the zinc producers of the world to restrict output, but its scale of operations had grown to such proportions and it had thus become so inflexible by way of heavy capitalisation that it found it more profitable to continue pouring out zinc and pay the penalty for exceeding its quota than to restrict production and increase production costs. This factor, of course, is aggravated by competition, and arises out of it.

THE NON-EXPENDABLE NATURE OF MINERALS

Minerals are subject to exhaustion from a mining standpoint, but not from a social or manufacturing point of view. The physical sciences state a law to this effect - "Matter can neither be created nor destroyed." The truth of this law is to a large extent realized in commercial mineral resources. The recovery of metals from scrap sources is assuming ever-increasing importance. We have, therefore, always to keep in mind the possibility of producing from resources once consumed, and which are now considered scrap.

THE PRINCIPLE OF INCREASING RETURNS.

Mining and treatment both operate according to this principle, but the rate of increase is more pronounced in treatment than in mining, because the latter is more highly mechanised. Our mineral companies have been greatly limited in their attempt to take advantage of this principle because of the size of their

reserves of ore.

MECHANIZATION IN THE MINERAL INDUSTRY.

Labour still occupies a very important place in the industry. Its position in ore extraction is relatively the highest, and its importance decreases in large-scale mechanised plants, but on the whole labour still maintains a strategic position in the structure of mining and treatment. Labour costs account for percentages ranging from 50-75% in ore extraction and from 25-50% in treatment plants, depending of course, upon the degree of capitalisation is each case. Labour's relative position is gradually declining, due to the steady encroachment of mechanized production, but the rate of this change is slow. Many processes are not suitable to machine operation, and because of ore depletion, the rate of mechanization has been slowed up. Undoubtedly increased mechanization has displaced labour from particular industrial, mining and transport processes, but the growth and scale of mineral enterprises have re-absorbed this displaced labour. Although Mt. Lyell is employing approximately the same number of miners today as in 1922, each unit of labour, with the aid of machinery, is removing approximately seventeen times the former quantity of ore attributed to a unit of labour.

Ore extraction is the most highly mechanized in the case of copper, while treatment plants for zinc and copper are about on a par. The tin industry still has a long way to go, but is handicapped by the scattered nature of its deposits. The rate of mechanization has been largely determined by the extent of reserves and the depth of these. Extensive surface lodes favour a high degree of mechanization in ore extraction and large scale treatment of ores in crushing, concentration, smelting, and likewise in processing, favour the mechanization trend.

THE INSTABILITY OF MINING & DERELICT CAPITAL.

Mining is a most unstable industry. The unpredictability of ore reserves, and general conditions affecting the industry, accentuated by extreme price fluctuations arising out of similar conditions globally are mainly responsible.

The result is that associated with mining enterprises there results a high percentage of what Professor Hayek terms "derelict capital.", which embraces much social capital. One has only to wander over Tasmania's West Coast, and see the large number of abandoned mines where capital in the form of mine development, mining plant and equipment has been sold for scrap or left to sepulchre the corpse of a dead enterprise, to be convinced of this fact.

Derelict capital is not only a feature of dead enterprises and abandoned mining fields, but it is also found in varying degrees on all mining fields. A change of administration, the need for re-organization arising out of competition, a change in mining or treatment technique, or a change in the nature of the ore body, often requires the abandonment of large amounts of costly mining plant which have become useless or are now superfluous. Technical progress is not steady, but generally comes in jerks of varying magnitude. Quick progress often means a higher rate of ejection of much fixed capital from the role of economic production.

Derelict capital is not to be confused with worn-out capital. Mines have a high rate of wear for capital, but the notion of derelict capital is to be associated at all times with capital that, technically speaking, is sound, but which technological progress has made uneconomic. Its value in relation to the object for which it was designed has perished, not by use nor failure, but by progress which has proved it to be undesirable, and there-

fore valueless on its original score.

Derelict capital on mining fields may have a scrap value, or have a use value to another enterprise, but generally speaking, this value is only a small fraction of its original cost. The possibility of "derelict" capital is always a contingent liability which must be accepted by mining companies and communities. The best way of dealing with it is either to have a high rate of depreciation on all capital plant or to build up reserves to meet it.

Any attempt to try and save derelict capital is a policy of throwing good money after bad. Neither monopoly, nor integration, [illegible] is capable of saving it. Rationalistic conduct demands its elimination.

The fear of capital becoming of a derelict nature with mining companies and also in mining societies is most evident from the impermanent atmosphere that surrounds a mining field. Capital is spent sparingly, and plant and buildings are installed in a makeshift fashion. One social consequence is that workers on many small mining fields are insufficiently housed and generally their wants and comforts poorly accommodated. This then re-acts on mining costs, for labour engaged on such terms demands higher wages.

THE IMPORTANCE OF THE MASSIVE LOW-GRADE DEPOSITS

Another feature that the present century discloses is the shift from mining of selective deposits to mass production on the extensive low-grade reserves. The historical portion of this thesis reveals the abandonment of copper and silver lead mining on small selective lodes that have failed because they have been unable to take advantage of cheap reduction. Only in gold and tin mines where the freights to be carried possess a relatively high value in proportion to their weight has selective mining proved a success.

The constant and substantial producers are those that have moved in favour of mass production on extensive lodes, even though the ores carried only a low mineral content. This has been particularly true for Mt. Lyell. The extensive nature of the deposits there has encouraged heavy capitalization, with increased returns Small rich bonanzas are unsuitable for capital investment, as their short working life does not warrant any material investment, and their wealth is quickly exhausted at high cost.

PRICE AND MARKET DIFFICULTIES.

The extreme fluctuating nature in the price of mineral products is seen from the chart on Page a and the table on Page 176. The fluctuations are of such a magnitude that adjustment of production cost to meet these demands a high spirit of enterprise. Failure to completely re-organize has often brought failure to a proposition that may have survived for many years. We have an example of this in the famous Mt. Bischoff mine.

Australia's isolated position as a producer and exporter of minerals places a great strain on the industry. Lead and zinc are very cheap metals and heavy transport costs are sufficient to close a rich field. Fortunately, shipping accommodation favours weight before

bulk, yet nevertheless freighting to Europe is a heavy cost item for them. With copper, the value of the freight is much higher, and this offsets the cost burden to some extent, but with low prices such as prevailed in the early thirties, the cost of freighting was too high in proportion to value returns. Tin is fortunate, in that its value per ton is high with the freight factor far less significant. The desirability of reducing weight in this country by reduction, smelting and refining here is therefore emphasised. The value returns from overseas marketing of concentrates is too low unless the mining costs are particularly small, or the lodes of ore very rich.

C H A P T E R I I

LABOUR IN THE INDUSTRY.

Labour may be classified this wise:-

1. Operating labour
   (a) Highly technical
   (b) Technical
   (c) Non-technical, but possessing some skill
2. Administrative and superintending labour.

Highly technical operating labour is often employed in a dual capacity - of acting as superintendents as well as highly skilled operators. This is particularly true of the small companies where a high ranking technician such as a metallurgist or assayer may, in addition to his duties as an assayer or metallurgical experimentalist, be superintendent to the treatment plant. In the category of highly technical labour, we have such experts as mining engineers, metallurgists, surveyors, electrical experts, geologists, constructional and machine shop engineers. This class of labour is almost without exception employed at a yearly salary, and given staff positions with many ensuing privileges. The salary paid is, generally speaking, considerable, ranging from £500 to £1,500, andin some cases more. Only a

small percentage of labour engaged, ranging from 1% to 5%, would fall in this class.

Secondly, we have the technical division, which bulks the largest of all, and would account for approximately 75% of all labour employed. In this class there are assayers, mechanics, electricians, turners, fitters, plumbers, pipe layers, blacksmiths, carpenters, loco drivers, winch men, timber men, plat men, brace men, hoist operators, miners, time keepers, office staff, mill operators, smelters, and like technicians. Some of this labour isengaged at a salary, such as the assayers, time-keepers, and foremen in all technical departments. These, too, are generally classed as staff, and their social position is accordingly raised, even though their rate of wage is often no higher than one not in this ~~section~~class. They receive holiday and sickness pay, and various other privileges such as better housing with fuel and lighting provided. The salary range is between £400 and £600, while the wage men receive their award, plus overtime.

The third type of labour (non-technical), which is generally classed as labourers, is engaged in various capacities at th emines, mainly as surface hands and in the treatment works. They receive the basic wage rate for their district, and account for about 25% of labour. This group often graduates to the technical class after some experience on the fields.

For companies primarily interested in mining, the strategic position of the technical miner is worthy of some note. They comprise the bulk of all labour engaged for extraction purposes.

Miners engaged in the extraction of the non-ferrous metals generally keep to their own particular class of mining, and seldom does one see a coal miner on these fields. Thus the mobility of labour between coal and heavy minerals, although not restricted by the Unions (A.W.U.), is very uncommon in this State, but between the

non-ferrous industries it is quite common. The degree of skill required for a miner in these industries is generally not so high as that required on the coal fields. The Tasmanian mines recruit their labour from the mining population living on the field, from other mines, and finally from sources other than where mining is carried on. For instance, the Mt. Lyell, Read-Rosebery and Mt. Farrell fields first acquire the bulk of the natural male increase from their own mining population, and secondly, they compete against one another for mine labour. Prior to the war, there was a small stream of miners moving from one field to the other. Many miners enjoy change, as do seasonal workers, such as shearers. Finally, the labour in other districts far removed from the mining centres ~~were~~ was attracted to these fields by reason of the high wages paid. Especially from agricultural areas was this migration most noticeable.

As the life of the miner if on underground work is comparatively short, there is need of a constant supply of labour to be brought to the field. Mining fields use up more labour than they can rear. This has been particularly noticeable during the war, where all the natural male increase has been protected from recruitment, and yet the shortage of labour has become acute. During prosperous times the mobility of labour is high, but during depression is it very low, with ~~other~~ often serious social consequences. The necessity to train more miners is a constant requirement while the fields remain prosperous. Farm and other non-skilled labour when recruited is generally worked into non-skilled underground work until it becomes more or less accustomed to the new atmosphere. As most of the mining is let on contract, new men are constantly being put into contracting parties where others have dropped out for medical or other reasons, and there gradually acquire the necessary skill of the

technical miners. In three months they are skilled machine operators, although the need of regular supervision is required for some years. Thus the fields are constantly resorting to the principle of labour dilution. As the Unions make no restriction on the recruiting of labour, nor do they make any stipulation as to a period of apprenticeship nor to age - miners can be selected from a wide area range and age composition. The only qualification is a sound body, which must pass a medical test, principally as to the state of the lungs. This is only to ensure that the Company is not accepting labour that is almost worn out so far as mining is concerned, and will become a heavy liability as a claimant for occupational diseases compensation. The non-ferrous mines have generally a comparatively high occupational diseases rate, but much lower than quartz gold mines, and much higher than coal mines, althoug the danger from fire and accident is more remote than in the case of coal.

Some further disabilities that confront labour are the isolated position and higher living costs on the fields. This, coupled with risk and danger to health makes the price of the wage higher than would otherwise result. Labour is often deceived by the higher wage rate and is ready to accept it without full consideration of the real cost in terms of a shorter and probably incapacitated life, averaging about ten to fifteen years for underground workers.

Labour is not so strongly organized in this State as are the N.S.W. coal miners. Miners here are members of the Australian Workers Union of the coal Tasmania is not a highly industrialised State, and generally incomes are low, especially in agricultural areas, and mining wages appear high in comparison. Labour on the fields, although not redundant, has generally been most satisfactory, with acute shortages as rare occurrences. During the depressio unemployment resulted on the silver-lead and lead-zinc

fields; for tin the position was relieved by agrigultural districts absorbing some labour at low rates, while for copper, production steadily progressed, and labour was not discharged, although wages suffered a reduction of 10%.

A factor reducing disutility of mining to labour on some of the fields, especially at Mt. Lyell, has been the reversion to open-cutting, but the general attitude toward the alleviation of this disutility is offset by the severe climatic conditions prevailing in this region.

Labour troubles on the fields of this State have been few. There have been no major strikes for many years. This has been a factor helping production costs.

The rate of the wages is determined by the Commonwealth Court of Conciliation and Arbitration. The basic rate plus increased margins for special skills is subject to the cost of living index, and may be changed from time to time. The employees of the Mt. Lyell Company have an agreement with their Company whereby their wage is subject to increased margins as the price of copper rises above £50 per ton. Today all employees of the Company receive 17/- per week extra by reason of this agreement.

All employees of all companies must receive at least the Federal mining Award, while the miners and other technical employees receive in addition a margin for their skill as determined by the Court. Miners on the majority of the fields are engaged on a contract basis, but work only the prescribed hours as determined by arbitration, which is 40 hours per week for underground men and 44 hours for surface employees.

Contracting - a form of piece work in mining.

Mining is an industry in which piece work

is popular with labour. In the majority of the mines mining is let on contract either by the ton or truck of ore broken, or by the foot if driving or rising.

Contracting as a cost against mining is cheaper than a fixed rate per shift. The contract price is fixed between the men, who work in small parties, and the management, and the Miner's Award forms the general basis for reckoning the price at which the contract is let.

For the miners who are prepared to do more work when on contract, the price must allow a wage materially above the award rate, otherwise the men will prefer wages, and will not give that all-out effort.

"When any party of miners or other employees contract to execute any work by foot, yard, ton, fathom, or other similar measurement of volume or weight, the work shall be carried out subject to the following conditions and subject to such conditions being incorporated in the contract -

The contract price shall be fixed at an amount which may reasonably be expected to enable a competent party working fairly as contractors to earn a sum at least 25 per cent above the aggregate of the of the prescribed wages for the respective classification of the members of the party, provided that not less than the minimum rate of such wages shall be paid for the actual time worked."

(Australian Workers Union Federal Mining Award.)

It is not uncommon for miners to earn at Lyell on an average of £16 to £20 per fortnight as against £12, the approximate amount awarded for mining by the Arbitration Court. The miners also have an agreement through their Union with the Management as seen from extract quoted above, that if the men are unable to make award rates at the contract price, they must receive

the award wage for time given. No contractor can earn less than the basic rate. For this, and the reason that they have the opportunity of earning above the rate - contracting is a very acceptable method to both parties whereby labour is engaged in breaking ore.

To the Company, it has the advantage of requiring less superintendance by shift bosses and other officials. The men have theinducement to give the maximum effort of labour when working according to a contract rate. The Company is always able to get more ore per man shift than on a fixed shift rate. This makes it a very valuable device when manpower is scarce.

There is this disadvantage, that there is not the care taken in timbering, and with their own person that is otherwise the case, and consequently more risks are run by the men, and a higher accident rate is generally the case with increased compensation cost in the long run. Another disadvantage when contracts are let on the basis of length driven is that of burying metal in their endeavour to get the maximum footage. If let on the basis of ton extracted or truck filled there is the tendency to include mullock. The first case requires strong supervision, and the latter is generally overcome by imposing a penal charge for ore carrying too much mullock, which is stipulated in the contract.

A further disadvantage is that the disparity in wages and contract pay sometimes leads to friction and agitation by the wage men for higher rates, so as to bring their remuneration more in line with the contractors The Company therefore aims to keep contracts within a reasonable margin of the award. It often happens that some parties work very hard and possess a higher degree of skill than others, which is not always appreciated by other parties, and particularly by the wage men, and sometimes by the management. This often leads to

reduced contract prices for new contracts: Contractors soon learn to keep their quota within moderate limits, otherwise cuts will follow. Many Lyell miners complain that Italian labour ruined contracting at Lyell. Italians quickly cut contract prices, and were satisfied with much less than Australian miners. This caused much discontent and threatening by labour.

There is a further difficulty in that no parties are working identical ground, and contract rates therefore have to differ, often by a considerable margin. It requires keen judgment by the management in making the contract price. In a big mine with many parties at work in greatly differing seams of ore, the one setting the contract with the parties must be thoroughly acquainted by experience and with ability to know what a particular contract will yield at the price quoted, so that all miners will earn approximately the same per fortnight and within reasonable proximity to the award. Of course, all contracts are made in the interests of mining costs.

Again, with those trucking the ore that has been broken underground, there is often discontentment when asked to remove the ore broken by contractors earning perhaps more than one and a half times their wage. The contractors are naturally anxious to urge the truckers to hurry up in order to proceed with their boring or other work that may be waiting on the removal of the broken ore. Truckers and other wage men waiting on contractors thus become dissatisfied, and feel that they should earn extra if required to keep the pace with those contracting. Lyell and Rosebery have overcome this trouble by letting the trucking on contract also. Timbering and mullocking of the stopes is also let on contract, and here again pays are higher.

One big advantage is that labour is generally less truculent when earning above what has been awarded.

It must, however, always be remembered that the awarded rate by the Arbitration Court forms the core of the wage cost structure. A material adjustment in this rate is carried to contract prices, and the total price of labour to the industry.

ADMINISTRATION AND SUPERINTENDENCE.

Administration and superintendence cost is low especially for the big companies (appm ximately 2%) Miners require daily supervision, but not constant supervision, which would be impossible in underground workings. Supervision is much simpler in open-cutting than in underground mining. A shift boss working under a mine manager is generally able to superintend forty miners. Superintendence of technicians, such as blacksmiths, electricians, etc, is comparatively easy. Milling requires expert supervision, assisted by hands possessing a fairly high degree of skill. The same applies to smelting, aonverting and refining, or electrolytic processing.

C H A P T E R I I I

CAPITAL.

Capital is gaining in relative importance with mining companies. The necessity to venture on a large scale gives Capital a very important position in the structure of the industry. The economy to be won from mechanization and the urgent need to take advantage of the principle of increasing returns in the threat of competition makes a large capital not only desirable, but often essential.

In mining, ventures are chancy, and the factor of risk is the odds against winning a fortune. The history of Mt. Bischoff strikingly illustrates the return that a mine can yield, while the futile investments of Heemskirk emphasise the odds. It is, perhaps,

the gambling nature of mining ventures that so often attracts capital to them, and at other times starves them for capital. The chief factor helping a company to get capital is the publicity that a field or company has received. The success of Bischoff brought more capital to other tin fields that promised dividends than could be profitably employed. On the other hand, large successful companies have little difficulty in selling new shares to increase their capital resources.

The particular demand for capital in mining comes from the necessity to undertake heavy investment in mining plant, and because the value of this plant is dependent on, and relative to, the prosperity of the venture the capital sunk is highly illiquid. Once a company is paying good dividends, the possibility of a shareholder selling his investment is relatively simple, but from the standpoint of the industry, mineral companies have a high freezing rate for capital. Mining enterprises bid for liquid capital resources, which they immediately transfer into specific fixed capital resources. The highly frozen nature of Capital in mining enterprises tends to increase the price of Capital to the industry.

A further factor detracting from mining investments is the high rate of risk present. The Law realizes this risk, and protects shareholders whose shares are not fully paid-up, by the No-Liability principle, which may be appropriated by a Company if it registers and advertises as such.

There is always the possibility that capital invested will never be repaid, and because of the low realization value for mining equipment in the event of failure, the risk is further accentuated.

A peculiar feature as a source of supply of capital for mining is from those sources which are particularly interested in holding their assets liquid -

speculators. Their aim is to float mining ventures and sell out their shares as quickly as possible, or to reap quick profits from inflated share values. The Public Company has greatly facilitated the finding of capital for mining enterprises.

One of the main sources of floating large scale ventures today is with the capital resources at the disposal of strong financial companies. After a measure of success seems assured, it is not hard to sell new shares on the market. Often a number of companies will agree to back the venture, and then later unload their shares on the market at a good price.

Return on Capital

Mining dividends often appear high, for instance, the Electrolytic Zinc Co. of Aus. Ltd., has paid 14% for a number of years, and the Mt. Lyell Co. paid similar high dividends for some time. Until 1922 it averaged 12½% for all years since its inception. But we must be careful to allow for two things in dividends, because they are the reward for the use of Capital, and the bearing of risk and anything over the current rate of interest on the capital invested, after a due allowance for risk, is a surplus. Production costs for copper in our earlier analysis of the industry should really have added to them the interest due to shareholders for the amount of Capital invested. When these two items are considered, mining returns for Capital appear greatly reduced, and often inadequate.

Capital tied up in ores or metals for realization (stock in trade to a Mining Company) for a large company might be many thousands, but in comparison with the amount of its fixed capital, its capital in stock is small.

One result of the use of more capital with mining companies has been the increased size and scale

of plants, with the result that the industry has become less adjustable to demand. Because of this inflexibility due to increased overhead costs, the process of reducing output if necessary is very painful. This inflexibility is particularly true in large treatment plants, whereas the mining section of the industry, which employs a high percentage of labour, is able to dismiss its hands without incurring any high carrying costs.

Continuous production is therefore necessary to highly capitalized industries to ensure full economy, otherwise they are likely to prove less economical than the small companies which are less capitalised, and more able to adjust production to demand. Hence the need of large resources upon which operations can be staged, without fear of exhaustion if an industry become highly capitalized.

Enterprise in the sense of innovation, risk assumption and organization, is vitally necessary to the maintenance and strength of mineral production. As deposits become depleted, enterprise must launch out and discover new reserves. The struggle to reduce costs to meet overseas competition demands new organization within our non-ferrous industries. Enterprise has constantly to assume risk and make the necessary change.

A change in scale of operations or a move from small high-grade deposits to extensive low-grade ones, a displacement of labour by more capital, the integration of the industry either horizontally or vertically, or any such re-organization might prove necessary at any stage. Mining in this State particularly calls for the Capitalist - entreprenneur, to get the industry floated and production started, to assume the risk and prove the soundness of a venture. This type of capitalist is rare, for he should be one associated with mines, and possessing an excellent knowledge of them.

He may be an ore buyer, who has become interested because of his touch with market conditions. This type of individual is not the man to float our largest ventures, which are generally undertaken by Mining or Treatment companies but he is the man to start the many small scale enterprises that are too small to attract the large Company, and too big for the average syndicate, or small entreprenneur. This State abounds with such propositions - projects demanding £20 - £50,000 to put them on a good solid mechanised footing where they could meet the ups and downs of price fluctuations. We have such a proposition in the North Mt. Farrell mine, where but for a capitalist-entrepreneur, the field would probably have closed down.

With regard to some of our big propositions, such as aluminium production, requiring £3,000,000 of capital to commence operations on an economic footing - private enterprise has been too slow in attempting production with the result that the Commonwealth and State Governments have assumed the responsibility of finding the capital and carrying the risk associated therewith.

We may ask, is it wise for a Government to assume the function of capitalist and entrepreneur in a risky enterprise like mineral production? In this particular case there are certain features which greatly diminish the risk for a Government. The highly capitalized nature of the undertaking and its dependence for such a large block of Government Hydro electric power, plus the fact that it is likely to enjoy a strongly nationalistic market, and will be regarded as a key industry, are all in the favour of reduced risk. These features provide it with a monopoly position in many respects and the risk is therefore correspondingly reduced.

It has further been estimated that the ideal conditions exist for its establishment here, and there

can be no objection to a Government establishing something which ought to be - and which private enterprise for some reason or other is too diffident to assume. Capital today is, generally speaking, far less venturesome than it was in the last century and there is a tendency to place too high a price on liquidity, with the result that mining, which requires a high degree of illiquidity for capital, is spurned and enterprise languishes. Many economists are becoming alarmed over the timid character of the modern capitalist, and his distaste for risk assumption. It therefore appears that the intervention on the part of Governments to assume risk and become the innovators, risk takers and capitalist owners is a step necessary to the continued maintenance and progress of industry, upon which employment and population depend.

INTEGRATION.

The integration of the mineral industry, both horizontally and vertically, has taken place to some extent in Tasmania. The Electrolytic Zinc Co., primarily a treatment company, purchased its own mines at Read and Rosebery, and is now stretching out to control other industries that once purchased its products. The Mt. Lyell Company is an example of a Company that not only became integrated vertically by erecting its own power plants, and taking over its own refinery, but it first of all integrated horizontally and purchased the leases of, and absorbed all other mining companies operating on its environs. Zeehan mines, on the other hand, failed to integrate either horizontally or vertically, and they have since failed. The integration of the tin industry is not at present very practicable, owing to the scattered nature of the deposits, but there are cases of neglected opportunities to integrate which have greatly retarded the progress of a field. We might conclude

by saying that integration has strengthened the industry, and more of it is desirable.

THE QUESTION OF TAXATION

It is commonly claimed by mining companies that a policy of high taxation by the State is most detrimental to the industry. In support of their contention, they argue as follows - Mines are wasting assets, and they waste more quickly than most assets. Therefore depreciation is a very high factor, and because of the contingent liability of ore depletion, it is necessary for a mining Company to buildup considerable reserves to meet the contingency, and embark if necessary on a plan of prospecting and development to locate new resources for working. If the taxation authorities by high taxation prevent the accummulation of substantial reserves, then a company must fail if difficult times come, such as occasioned by ore depletion, on the need to re-organize.

High taxation prevents mining capital earning substantial dividends, and this deters investment in mining, which requires plenty of Capital that is willing to accept the element of risk. We must examine these contentions, for they appear a serious charge.

Firstly, taxation, is levied on net profits which are the net income after all expenses, including depreciation have been allowed for. The taxation authorities admit depreciation as a cost against production, and a reasonable percentage of capital is permissable to be debited to this item.

High taxation therefore cannot rob a company from charging legitimate depreciation to Profit and Loss Account. That high taxation prevents the accummulation of big capital reserves is partly true. However, this

is partly decided by the dividend policy of the Company. For instance, the Electrolytic Zinc Company of Aus. Ltd. showed an income for 1942 of £598,972, of which Taxation took £299,500. The Directors of the Company then had the choice of distributing the rest accordingly as they thought fit. They could hold a great deal of it back for reserve purposes to meet contingent liabilities, or they could have paid it out in dividends. Reserves can be provided for at the expense of dividends, but this is not always advisable. Sir Colin Fraser, Chairman of the above Company, said that the policy of reserves before dividends would be unjust to the small investor, who constituted the majority of Company shareholders, both as to number, and total of invested capital. This second contention, therefore, appears to have some foundation.

Thirdly, that high taxation dries up the inducement to invest in mining will now be investigated. As high taxation will be general, therefore all investments must be affected, but perhaps not in the same degree. Investments involving risk will be treated the same as those involving no risk by the taxation machine, and therefore self-interest will drive investors to seek those investments where risk is smallest or nil. Mining involves a high rate of risk, and consequently will be side-stepped. Thus a policy of clipping all profits above a certain figure makes no allowance for risk, and drives Capital away from enterprise in favour of security.

Parliament has, to some extent, recognised the special problems of mining, and its need to build up resources to meet ore depletion, perhaps with the view to preventing Capital from seeking other investment fields, and it has passed a Bill which provides that 20% of the profits of metalliferous mining companies shall be exempt from taxation during the war.

Before leaving taxation, we might examine

another feature which it possesses. The only avenue available to a Company earning big returns is to increase its spending, and mining companies always have a field which calls for spending, and that is prospecting and general mine development. Prospecting can be looked upon as an investment which is capable of reducing profits that will otherwise be swallowed in taxation, and at the same time preparation is made for the future. Such an investment is in the nature of a gamble. It may open up a massive ore body, and it may yield nothing, but in any case, it is better from the Company's point of view than barren taxation. It is doing something for the industry which must sooner or later be undertaken. Is not high taxation therefore causing to be done the very thing that mining requires - the spending of capital in search of new reserves?

This may be so under certain conditions, but it is not true under war conditions, when labour and materials are scarce. Mining companies are unable to obtain the necessary labour and/or materials on which to spend their current incomes before the taxation machine clips them. Mining companies have discovered that, because of the acute shortage of operating factors during this war, that they have been unable to make sufficient allowance for even depreciation - depreciation arising out of idle plant, depreciation for plant working two and three shifts which is normally provided for on the basis of one shift, depreciation through damage caused to plant by inexperienced labour, or depreciation arising out of high cost wartime construction. And as we have previously concluded that mining is likely to be starved for capital if taxation takes that part of dividends which should be the reward of risk, there seems little to commend high taxation.

One further point - high taxation encourages waste and inefficiency. In war, when increased production

is so essential, companies are deprived of their greatest incentive to produce. Why should a mining company prematurely exhaust its reserves only to have the greater part of this return taken by taxation? This is how the industry reasons, and the objection is very serious, if production is likely to be curtailed. Quite a number of small companies, which a sole capitalist or wealthy syndicate owns the mine, have actually adopted this attitude at the present time. They argue - why should we exhaust our reserves for taxation? Although we may not agree with their attitude, nevertheless in economics we must accept what is, and not what ought to be.

S E C T I O N V I

CONCLUSIONS AND RECOMMENDATIONS.

CHAPTER I

CONCLUSIONS AND RECOMMENDATIONS.

The total value of the output of minerals and mineral products in Australian currency in Tasmania during the year ended the 30th of June, 1942, was £3,465,832, for which the Mt. Lyell Mining and Railway Company was responsible for £715,251. The previous year's value for the same period was £3,732,905. From Page No. 211 it will be seen that the value of mineral output has increased by approximately 100% since 1928.

Operations in the period above mentioned gave direct employment to 5,705 men as against 5,921 men employed the previous year. The decline was due to enlistments and diversion of labour from gold production to other war services.

The size of the mineral industry in this State may be judged from the following tables. Mineral income reckoned per capita(approximate only) for the Commonwealth is as follows:-

West Australia	£23.7
Tasmania	£7.8
South Australia	£4.9
New South Wales	£3.9
Queensland	£3.9
Victoria	£0.99

Mineral production in Tasmania from 1880-1941 inclusive has yielded £81,182,913 sterling, as analysed on the following Page No. 209. These values are calculated from the minerals mined in this State, and do not apply to concentrates brought to Tasmania for treatment. Values added to mainland ores treated in Tasmania are not included.

The importance of the industry may be further appreciated by reference to the table on Page 210, which shows mining as the State's chief primary industry, and second only to manufacturing.

TOTAL MINERAL PRODUCTION FOR ALL YEARS FOR TASMANIA 1880 - 1941 INCLUSIVE

Produced by Industries covered in the survey			Approx.% of total mineral value produced
Copper	£26,278,719		
Tin	18,690,021		
Silver and Lead	11,405,379		
Zinc	3,883,457	£60,257,526	75%
Minerals Dependent upon the above Industries			
Gold	£8,780,665		
Cadmium	124,088		
Pyrites	438,834		
Silica	17,410	9,360,997	11.5
Others			
Carbide, Cement and Limestone	6,791,743		
Scheelite & Wolfram	855,073		
Coal	3,084,214		
Osmiridium	656,565		
Iron Ore	31,756		
Nickel	38,850		
Bismuth	26,990		
Shale	23,908		
Unenumerated	65,241	11,564,387	13.5
TOTAL		£81,182,913	100%

CURRENT PRODUCTION - 1941

Copper	£721,985		
Zinc	666,768		
Lead	293,837		
Silver	139,306		
Tin	328,340	2,150,236	70%
By-Products from above industries, or produced in joint supply.			
Pyrites	50,093		
Cadmium	21,086		
Gold	167,289		
Silica	4,094		
Wolfram	42,536	285,038	9.5
Others			
Carbide, Cement and Limestone	476,915		
Coal	85,311		
Scheelite	42,700		
Osmiridium	4,212		
Others	15,637	620,564	20.5
TOTAL		£3,055,838	100%

Compiled from Tas. Mines Director's Annual Reports. Yrs - 1941.

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NET VALUE OF PRODUCTION BY PRIMARY INDUSTRIES FOR TASMANIA IN £A (000's omitted)

(Net value represents the net return to the producer after deducting from the gross value the costs of marketing and of materials used in the process of production.) (★ - Estimated)

Primary Group	1932-3	1933-4	1934-5	1935-6	1936-7	1937-8	1938-9	1939-40	1940-41
Mining	884	1,003	883	1,268	1,976 ★	2,426	2,499	2,889	2,812
Agricultural	1,177	1,624	1,896	1,657	2,009 ★	2,407	3,002	2,349	1,641
Pastoral	950	1,605	1,038	1,489	1,567 ★	1,467	1,445	1,797	1,784
Dairying	442	379	440	535	542 ★	748	656	717	460
Poultry & Bees	315	302	318	309	311 ★	372	428	401	386
Forestry	210	259	326	364	382 ★	431	400	453	516
Fisheries & Trapping	154	229	269	255	275 ★	280	164	226	421
Manufacturing	2,879	3,050	3,158	4,067	4,209	5,445	5,399	6,253	6,292

(Figures taken from "Tasmanian Economy" 1936/37. 1940/41 & 41/42.

The actual and relative value of minerals and mineral products to the State for all years from 1919 to 1941 inclusive is hereunder shown. A sharp upward movement in the price of metals is mainly responsible for the marked acceleration in value returns for recent years.

VALUE OF MINERAL PRODUCTION OVER THE PERIOD 1919-1941. Compiled from 1941 Director of Mines Report for Tas.

Year	Value in £ Sterling	Index percentage of 1928	Composite Price Relative
1919	1,301,090	81	
1920	1,421,104	95	
1921	822,851	51	
1922	1,013,415	64	
1923	1,219,456	76	
1924	1,496,804	94	
1925	1,700,861	106	
1926	1,808,847	113	
1927	1,621,027	102	
1928	1,593,828	100	100
1929	1,790,653	112	103
1930	1,270,114	80	73
1931	894,986	56	53
1932	897,168	56	54
1933	1,053,373	66	63
1934	1,037,351	65	67
1935	1,387,511	87	72
1936	1,979,637	124	69
1937	2,653,822	166	96
1938	2,294,735	144	70
1939	2,520,282	158	78
1940	3,137,330	197	101
1941	3,055,838	191	103

The Composite Price Relative is calculated on the average relative for copper, zinc, lead, tin and silver to indicate the trend of prices only. No weighting of the respective metals is employed.

Tasmania's chief mineral industry has been that of copper, followed by tin, silver-lead and gold respectively. Copper production has been unique in following an upward trend in production, irrespective of price fluctuation. Tin production over the past twenty years has been influenced by price movements, and the same can be said for silver lead. Gold production is now dependent upon the production of copper from Lyell, and composite zinc ore from Read-Rosebery. Zinc mining has been given a new lease of life with the re-opening of Read-Rosebery.

The production of wolfram has been affected by both tin production, with which it is often mined as a joint mineral, and by price movements. Minerals like osmiridium are extremely sensitive to price, and so is gold-washing and tin-scratching. Here no capital is at stake, the mining is pursued by primitive methods. Production is only induced to proceed while price is satisfactory, because overhead costs are nil.

Copper and zinc are the most heavily capitalized industries in the State, and thus show the least inclination to be affected by price fluctuations. The silver-lead and tin industries are in the hands of a number of small companies whose production costs are high and whose capital resources, are, generally, speaking, meagre. For this reason, when prices move down to or below production costs, operations cease or slow up until prices return to allow a favourable margin over production costs. Operations are here more easily adjusted to price movements, and the industries are more flexible than those heavily capitalised. The suddenness of closing depends mainly upon the amount of fixed capital at stake, the cost of re-starting against that of keeping going, and the financial position of the company at the time, together with the outlook for the market generally.

A number of minerals such as cadmium and pyrites are by-products, and their production depends upon the demand for other minerals. The value of the State's mineral production over the years shows a general upward trend except for the years 1931-32. Copper, lead, silver zinc and gold have been the principal metals to contribute to this increase. The future of our mineral income will depend very largely upon those mentioned, together with tin, and the possibility of exploiting the newly discovered bauxite deposits, manganese and dolomite, and other rarer minerals not at present being mined in

any quantity, such as asbestos.

That the post-war period is likely to see a decline in copper and gold production for this State is to be expected for reasons analysed earlier. To replace their contribution to the State's annual mineral returns, the only present possibilities are bauxite, dolomite, asbestos and iron, which is doubtful, and which the post-war markets are likely to require.

The mining industry's prosperity and future will largely be decided by the economic availability of its mineral resources. Its mineral resources consist of these:-

1. Reserves known, and being exploited
2. Reserves of minerals known, but not being exploited.
3. Reserves of minerals not yet discovered.

From the most reliable data it must be accepted that the reserves of present worked deposits of copper are nearing their end, for silver-lead from galena, the same, for tin and wolfram about seven to ten years, and for zinc and lead sulphides fifteen or more years. With copper, gold would seriously decline.

Reserves of minerals known, but not yet exploited are for copper practically nil, for silver-lead of doubtful character, and zinc-lead more promising. Tin has the huge pyritic reserves of Renison Bell, a doubtful source at present. The large deposits of iron, bauxite and dolomite known, but not being worked, appear the most promising, particularly the two former, the demand for which will increase with all light metals.

That new discoveries will be a factor that will largely decide the future of the mineral extraction industry, is evident after a study of each particular mineral. That new discoveries are likely to prove extensive lodes of minerals from which light metals can be manufactured, gives the greatest hope to the survival

of the industry at its present value to the State. There are indications from geological surveys made that Tasmania possesses many varieties of minerals, but reserves for the majority have so far proved very limited. Recent examination has revealed very promising reserves of bauxite.

That the future for the industry will be largely influenced by factors Nos. 2 and 3 and more particularly No. 3 (new discoveries) is easily understood. On this conclusion it seems evident that consideration will have to be given to the pyritic tin question, and to bauxite, iron, asbestos, dolomite and to those other complex deposits such as copper nickel and the low-grade silver-lead reserves.

That factors 1 and 2 can not prevent the decline that is likely to come after the war is evident because many of No. 1 category (present producers) will be uneconomic under normal trade conditions. Therefore the discovery of rich ores of those minerals now becoming depleted, and of new minerals which will assume demand is imperative to maintain the present rate of mineral extraction.

From the supply angle it is ascertained that the future production of the following must decline@-

1. Copper
2. Tin
3. Silver-lead (galena)

if new deposits are not found. Thesethhree account for the following value in the mineral wealth for the year 1941:-

Copper	£721,985
Tin	328,340
Silver	139,306
Lead	293,837
Total	£1,483,468, or as a percentage,

approximately 50% out of a total mineral return of £3,055,838.

It has already been suggested that if the world returns to free trade after the war, competition will force our copper and tin industries into the extra-marginal cost category. The present cost of production for copper and tin is so high that it ismost difficult to see how either industry will adjust itself to any deterioration in price. Tin has one card to play in the pyritic field, but it is not likely that the industry will become sufficiently established during these favourable years, owing to manpower shortage, to enable it to meet the post-war strain to reduce costs.

It can readily be seen that least one-third of the present mineral wealth from this state is likely to seriously decline in the post-war period. In fact, the whole problem of high cost for tin, copper and silver-lead from galena, arises directly out of the limited and poor resources on which their respective industries are established. Their dominant problem, although in some instances aggravated by such factors as high wages to labour, insufficient mechanization, absence of integration low capitalization, and even high marketing costs for concentrates, is in the last analysis a problem relating to reserves. The only channel of hope for these particular industries appears therefore in the finding of new deposits which can be more economically exploited.

CHAPTER II

CONCLUSIONS AND RECOMMENDATIONS (Continued)

The problem now becomes one of mineral location. How is this to be solved? It is generally agreed that the primitive prospector's day is done. The majority of our surface mineral lodes have been discovered. The task is now to bring to light those that are hidden, and which no prospector's pick will locate. This problem must receive the assistance of science and capital. Science will not be lacking if the necessary capital is made available. Who is going to provide the capital? Will private enterprise find the needed resources? This is very doubtful. Certainly the large companies operating on fast-diminishing reserves are willing to spend substantial sums in the chancy venture of mineral location. But it is ridiculous to expect them to undertake a geological survey of 29,000 square miles. They have their shareholders' capital to answer for, and therefore they must not exceed a certain degree of risk. They might spend large sums for years and feel that it is useless to proceed any further, as the Mt. Lyell Company is feeling after its large and recent survey. Can we then expect capital from other private sources to volunteer for use in copper or tin prospecting when both those industries are struggling to survive? It is useless to consider such a proposal.

Are we then to adopt the attitude that the mining industry is a declining one, and urge with some economists the need of directing capital and labour resources away from mining and prospecting to industrial and tertiary enterprise? Surely such a recommendation is too premature, when thousands of square miles of our country is virgin territory. The mining industry can also argue - why refuse us help when all other primary

industries are receiving every Government assistance, and many of them substantial loans (e.g. the wheat and dairying industries.)

The following table gives the loan figures from State and Federal Government sources, together with the repayment moneys paid by mining companies:-

STATEMENT OF LOANS UNDER THE AID TO MINING ACT, 1927.

Year	Expenditure	Repayments.
1935	£10,697. 6. 0	£387.14. 9
1936	13,269.16. 5	2,364.18. 4
1937	5,886. 7. 1	3,491. 9. 2
1938	5,274. 3. 7	4,218.19.10
1939	3,380. 4.11	1,107. 3. 2
1940	4,984. 8. 9	1,543. 9.11
1941	1,022.12. 6	924.11. 7
TOTALS	£44,514.19. 3	£14,038. 6. 9

Of these totals, £27,628/9/7 was loaned from and £8,184.10.5 was repaid to Federal Funds, while Mining Trust, and other funds supplied £16,886/9/8 and were repaid £5,853/16/4. (Figures taken from the Director of Mines Report, 1941.)

The industry in this State has received since 1935 £44,514/19/3 by way of Federal and State assistance. Approximately half of this was made available in advances to mining companies, some £1,584 was spent on prospecting £7,000 in constructing roads and tracks to known and potential mineral areas, and £1,237 on metallurgical investigation. During the same period, the industry repaid £14,038/6/9, which means that the average yearly cost of Government assistance to mining in this State was a little over £4,000per year. In the same period, the mining companies have handed over annually well over £500,000 in direct taxation, besides indirect taxation, and the high taxable income they have paid away in wages and salaries. On the whole, Government assistance in

the mining industry has been meagre. Too little capital has been spent yet to judge whether it has reached its hey-day or not. Who is competent to say how much wealth lies within our precincts? There is not one scientist who stakes his reputation on estimating our potential mineral wealth.

The course to be adopted first of all demands scienfific investigation. This will require capital. As the State stands to win if mineral resources of value are discovered, the State must undertake the survey and become the scientific prospector in search of commercial deposits. Private enterprise may be reckoned on assisting after a certain stage has been reached. More roads and tracks, in which this State is so deplorably lacking, will encourage private enterprise to shoulder this responsibility The plan here proposed is not the demolishing of large sums of public money that may have been more gainfully employed elseqhere, but rather a conservative proposition financed to a very large extent by the industry it is designed to assist.

Every industry has its difficulties, some are faced with orderly marketing problems, and there are many more too numerous to mention here; butone of the mining industries chief worries in this State is the location of payable deposits. Mines are wasting resources, and waste more quickly than most resources, therefore there is always the problem of exhaustion and the location of supplementary and new deposits to which the industry can transfer its capital and labour.

In view of these conclusions, we recommend the following:-

1. The inauguration of a permanent Mineral Production Committee, or Commission, with definite constitution and specific powers. This Committee could constitute the following personnel :- the State geologist,

the Director of Mines, two independent mining experts chosen by Parliament, and two representatives selected by the Mining Companies, one from the heavily capitalized industries, and one representing the numerous small companies. The constitution of the Commission should be flexible enough to meet the needs of the industry it is designed to assist, and this Commission should be responsible to Parliament. The powers and status of the Commission to be passed by Act of Parliament. The Committee to be financed partly by the mining companies, and partly by a Parliamentary Annual Grant.

2. The Committee to be assisted by the staff of the Mines Department, and in addition, to possess a staff of its own, consisting of highly technical experts such as geologists, surveyors, chemists and metallurgists and at least one mining engineer.

3. This Committee, which will be primarily interested in mining, will also investigate problems in treatment, in so far as mining ventures are depending for their success on a solution of treatment difficulties. It could avail itself of certain experts for a period, by negotiation with mining companies possessing the technical skill required.

4. 25% or more of all taxation moneys collected from mining enterprises to be handed over to the Production Committee, and placed to the credit of a Mineral Pool Fund, which would be controlled by the Committee.

5. The Production Committee to undertake from its inception a complete general geological survey of the State's entire mineral resources. This survey to be undertaken by at least three geologists of world experience, either acting separately or jointly. These experts to be given substantial assistance from a number of junior technicians.

6. The policy of making further specific geological surveys by eminent geologists employed by the State Government to follow up all favourable indications revealed in the general survey.

7. The preparation of a carefully compiled and detailed report by the State Geologist, together with a report by a highly qualified mining engineer on all mineral resources located. The most promising of these bulletins could then be advertised and brought to the attention of capitalists. These areas should then be pegged by the Crown. Those interested could then approach the Production Committee or the Mines Department for further details, and if satisfied, they could be given access to the leases only after signing a declaration to the effect that operations will be commenced on a specified scale. The approval of the Production Committee should be necessary for all permits.

8. The Production Committee to have power to grant loans on a substantial scale on the basis of certain arrangements, such a £ for £ basis. This would encourage the spending of private capital on these prospective propositions. If a Committee recommends a proposition, it should be willing to lend money for the purpose of doing what it recommends. Such loans to be made available on easy terms with discounts for early redemption. The Committee could stipulate the amount of labour to be engaged for the size of the loan, if it thought such a measure desirable, and likely to ensure employment and active development.

9. The use of Pool resources by the companies operating to be made available upon application, for prospecting and development. Such prospecting should be guided by scientific data and advice provided by the geological surveys and the technical advice available to the Committee. Then all companies wishing to prospect,

and seeking the use of Pool resources, must first be approved by the Production Committee.

10. Legislation by the State Government to make it impossible for private interests to withhold from production by loading (asking exorbitant prices for leases) or other means, deposits that could be usefully exploited by companies willing to operate, and which would ultimately redound to the prosperity and income of the State. The Production Committee could well act as arbitrators in setting a reasonable price for the sale of a lease to a company that can give assurance that production will be undertaken.

11. Free and abundant technical advice to all mining companies, irrespective of their financial position, by the technical staff attached to the Production Committee.

12. A special reduction in taxation in proportion to the amount of income spent in scientific investigation and research by mining companies, if such was spent at the approval of the Production Committee.

13. The use of Pool resources to stimulate mineral industries considered important to the State's prosperity, or to step up production of any particular industry or particular units operating in that industry.

14. The adoption by the Government of the policy of rewarding by monetary consideration for the discovery of new mineral deposits of commercial value. This is designed to stimulate private prospecting, which has done so much for the industry in the past. Such monetary consideration should be substantial. Approval of the payment for the reward should be given by the Production Committee.

15. There should be no taxation for newly-floated mining companies for at least three years. This is designed to give investors a chance of recovering their

capital and the company power to accummlate bigger reserves.

16. The opening up of Tasmania's Western and South-Western districts by roads, with the idea of encouraging prospecting and settlement. These roads should be intended to serve those fields that the geological surveys have indicated as promising distinct possibilities.

At the present time, the whole of the Western district is served by only one railway, and no roads exist between the north and south (i.e. between Rosebery and the North West Coast), while the country south of Queenstown is completely inaccessible. The whole of these regions under review are mountainous, very wet and consequently very heavily timbered. Such obstacles even deter primitive prospecting and make surveys often too general to be of much value. The timber from these regions is most suitable for paper-pulping purposes, and as the supplies to the Paper Mills at Burnie are already exhausting sources on the neighbouring areas, it is believed that the timber project would assist in making these roads well worth the cost. It is therefore urged that the Government of this State regard the provision of roads in these inaccessible regions as a post-war measure directed to assist the mineral industry among other things, and imperative to a survival of a high rate of ore extraction.

It is believed that the above measures, if adopted, would ensure a proper share of capital and science being devoted to mining, and would greatly assist in solving the problem of sufficient resources, to allow the continued maintenance and growth of the industry.

CHAPTER III

THE OUTLOOK FOR MINERAL SMELTING IN TASMANIA.

Besides assisting this State to maintain, and, if possible, improve its scale of mining minerals which are subject to the possibility of exhaustion, it should be recognised that Tasmania possesses unique facilities for the treatment of ores. The great potential hydro-electric resources, which could provide approximately one million horse power of electricity at a price that no energy power plant in Australasia could compete with, is a factor that is likely to mean a great deal to the future of this State. Mineral treatment plants require power resources on a very large scale, and as electricity is now assuming new importance as a means of reducing mineral ores to metals, Tasmania possesses a lever which is already exerting some pressure in attracting large mineral treatment industries, whose capitalization of plant runs into millions, and whose power requirements are heavy. As coal costs must increase with depletion of the principal coal resources, electricity produced from water resources, in which this State so fortunately abounds, must, in the long run, be a powerful inducement to the establishment of treatment plants here.

Tasmanian cheap hydro-electric power and potential hydro-electric resources has already attracted the establishment of important treatment industries, such as copper refining at Queenstown, and zinc from Broken Hill at Risdon, and soon it is hoped to see established the £3,000,000 plant for aluminium production, ores for which will most likely come from Mainland bauxite deposits Tasmania has an added advantage in the possession of good harbours which are available for interstate and overseas shipping facilities.

It is possible, therefore, that this State will yet build up a considerable reduction, electric

smelting and refining, and processing industries, that will draw their raw materials from ores in all parts of Australasia, including such deposits as the copper-nickel ores of New Caledonia, and the iron ores of the mainland for conversion by means of the electric blast furnace to high-grade steels. The perfection of electric blast furnaces for steel manufacture would make Tasmania what coal has made New South Wales, a strong industrial State. This would mean the shipping of Whyalla pig iron straight to a Tasmanian port, where electricity could be provided cheaply to a large steel plant.

Though present facts and figures do not promise very much for the future of mineral wealth to be mined here, and decline is foreshadowed, all the evidence is to the contrary for mineral treatment and metal manufacture. The importance of this phase of the industry is likely to absorb a far greater portion of the population, and yield bigger returns to capital and greater prosperity to the State than is likely to result from our former proposals. We may conclude by saying that these treatment plants will possibly be strengthened by extensive by-product industries dependent upon cheap electrical power, such as the sulphate of ammonia project proposed by the Electrolytic Zinc Company of Australia Limited.

SOME RECOMMENDATIONS WITH A VIEW TO MAKING THIS STATE THE HOME OF MINERAL TREATMENT.

1. An extensive advertising campaign to bring the advantages of Tasmania before the notice of industrial companies likely to be interested.
2. Government assistance to private companies willing to establish treatment plants in the State if their projects are judged sound.
3. The offering of every facility and assistance by the Government to companies contemplating building treatment plants (e.g. helping them to obtain control of appropriate factory sites.)

4. More Government projects on the lines of the Ingot Aluminium Company, which is an enterprise to have £3,000,000 of capital provided, and controlled by the Commonwealth and State Governments on the basis of 50 : 50.

Private enterprise, with its present strong hold over the Australian heavy non-ferrous industries, may become anxious at the prospect of Government enterprises assuming such proportions, and consequently more eager to buy up the advantages offering in Tasmania as they prove available, rather than let Government enterprises appropriate them and become strong competitors.

The immediate project appears in preparing the necessary power resources that will soon be engaged. This calls for a material expansion in Hydro-electric production, for this is the great magnet which will draw to us a strong industrial structure.

END.

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