SULPHIDE DEPOSITS SUITABLE FOR THE PRODUCTION OF SULPHUR OR SULPHURIC ACID.

A. - Introduction.

Although Tasmania does not contain deposits of native sulphur, it does possess several large sulphide deposits. These are of such a nature that they can be used for the production of sulphur or, what is more probable, for the manufacture of sulphuric acid. The following information has been compiled from departmental information and reports, companies' reports &c.

Pyrite occurs at the Mt. Lyell Mine and also at the Chester Mine. Zinc-lead sulphide ores consisting of an intimate mixture of galena and sphalerite and pyrite occur in the Mt. Read and Rosebery districts. Pyrrhotite and marcasite containing cassiterite occur at Mt. Bischoff and Renison Bell and form large low grade tin deposits which may possibly be used for their sulphur content in the future. The pyrite from the Mt. Lyell and Chester Mines has been exported in considerable quantities for the manufacture of sulphuric acid. The Electrolytic Zinc Company have been using concentrated ores from the Read-Rosebery deposits for the production of electrolytic zinc and during the process some of the unoxidised sulphide particles are used to supply dioxide for manufacture of sulphuric acid and then superphosphate.

B. - Pyritic Deposits.

1. Chester Pyritic Deposit. This deposit is situated on the eastern fall of Mt. Kershaw, 7½ miles to the north of the township of Rosebery in the West Coast district. Transport facilities are good, the mine being connected by one mile of narrow-gauge tramway with Chester siding. The latter is situated on the Emu Bay Railway - 63 miles from the seaport of Burnie on the North Coast. This railway also connects the field with Zeehan and also the port of Strahan or Macquarie Harbour.

The ore-body occurs in sheared porphyries, chloritic schists and quartz-sericite schists which form the margin of an intrusive series of porphyries of Devonian age. The formation of the ore body was connected with the intrusions of the porphyries.

The predominant mineral constituent of the ore-body is pyrite; accessary minerals are chalcopyrite, galena, sphalerite, haematite, and limonite. Associated gangue minerals are pyrophyllite, barite, calcite, dolomite, chlorite and talc. The ore-bodies consist essentially of pyrite in schistose and siliceous gangue - mostly pyrophyllite and quartz.

The pyrite deposits are typically lenticular in form, coinciding in strike and dip with the planes of schistosity of the enclosing rock. The strike varies from 10° to 20°, east of north; the dip is 60° to 65° in a south-easterly direction. The thickness of the lenses varies from 20 to 280 feet, their horizontal length on the surface at the main workings has been proved to exceed 600 feet, and may be continuous with the south-west workings 1500 feet distant. The

extent and value of the ore-body has been proved by diamond drilling to a depth of 300 feet below the outcrop.

The ore-body is not homogeneous throughout, but contains lenses of varying composition from those with less 10 per cent sulphur to those with over 30 per cent sulphur.

The deposit was worked by the Mount Lyell Mining and Railway Coy. the pyrite being shipped to Melbourne for manufacturing sulphuric acid in their superphosphate works. The outcrop was favourably situated for working by open cut and adits and these methods were adopted.

The estimate of probable ore down to the depth at which drilling has been carried out is 2,856,000 metric tons containing over 20 per cent sulphur. Below this depth there are large possible reserves. The reserves of sulphides containing over 35 per cent sulphur form a small proportion of the above but cannot be expressed in figures.

The total quantity of ore sent to the sulphuric acid works up till 30th September, 1933, is given as 36,223 tons with an average of 37.25 per cent sulphur, the total number of units of sulphur being 1,349,412. Fuller particulars of this deposit and the working thereof are given in Tasmanian Geological Survey Bulletin No.28.

2. <u>The Mount Lyell Pyritic Deposits</u>. The Mt. Lyell Group of mines is situated in the vicinity of the townships of Queenstown and Gormanston in the West Coast district of Tasmania. Queenstown is connected by railway with the port of Strahan on Macquarie Harbour, which is connected by Government Railway with Zeehan and thence by the Emu Bay Line with the Railway system of the State and the port of Burnie on the north coast.

The ore-bodies of the Mt. Lyell occur in a series of schistose rocks at or near their junction with conglomerates (West Coast Range series). The contact has a general north and south trend the schists being on the western side. The schists probably represent sheared and altered porphyries of Devonian age, the formation of the ore body being connected with the intrusion of these porphyries.

The deposits are of two types, (1) mineralised bands of schist &c.
and (2) Lens-shaped bodies of very pure sulphide ores.

(a) <u>Mt. Lyell & South Lyell Ore-bodies</u>. These two deposits consist almost entirely of pyrite containing copper, gold and silver. The Mt. Lyell ore-body is described by J.W. Gregory as being "irregularly boat-shaped in form consisting of an elliptical mass, which tapers gradually downward and is then cut off below with a rounded base". The length at the outcrop was 800 feet and the width 200 feet. It has been worked to a depth of several hundred feet by a large open-cut and to still greater depths by underground workings, the depth of the deposit being about 730. The South Lyell deposits probably represent the faulted extension

of the Mt. Lyell deposit at depth. The ores of the deposit are of remarkable uniformity and purity. They consist almost entirely of iron pyrites containing copper, gold and silver. There is a little galena and less sphalerite present. The only important minerals forming gangue are quartz and barite.

The average composition of the ore it was considered payable to extract in 1902 was:-

Iron	40.30	per cent
Silica	4.42	" "
Barium sulphate	2.50	" "
Copper	2.35	" "
Alumina	2.04	" "
Sulphur	46.50	" "

Small shoots of richer ore (as regards copper, gold, silver) occurred but were soon extracted. They were more silicious and the copper minerals were bornite and chalcopyrite. The average analysis of these ores was:-

Iron	24.75	per cent
Silica	30.69	" "
Barium sulphate	1.48	" "
Copper	5.33	" "
Alumina	6.30	" "
Sulphur	30.00	" "

Other rich and small shoots contained tetrahedrite, redruthite, argentite and were also found and extracted.

The estimate of reserves by Mr. R.M. Murray, General Manager, at 30th September, 1925, were 1,624,998 tons and only a very small quantity has since been mined so that the reserve may be taken as 1,620,000 tons approx. in the Mt. Lyell & South Lyell ore-bodies.

The material varies in quality from footwall to hanging wall, that on the latter being the purer pyrite. The following approximate analysis may be taken as an average of the whole reserve:-

Copper	0.5	per cent
Gold	0.04	ozs.
Silver	1.5	"
Iron	38.0	per cent
Sulphur	44.0	" "
Lead	1.5	" "
Zinc	2.0	" "
Arsenic	0.3	" "
Insoluble (including SiO_2, Al_2O_3 & $BaSO_4$)	13.7	" "

The ore from the Mt. Lyell mine, together with that from other neighbouring mines, e.g. the North Mt. Lyell has been smelted since 1896 by the Mt. Lyell Mining and Railway Company for the production of blister copper containing gold and silver.

In addition large amounts of the pyrite from the Mt. Lyell mine itself have been exported to Melbourne and utilised in the Company's Sulphuric Acid and Superphosphate plant for the manufacture of these materials, thus taking advantage of the sulphur content of the ore.

(b). North Lyell, Comstock & Other Ore-Bodies. These bodies generally consist of bornite, chalcopyrite and pyrite in schist, quartzite &c. They are now being mined and treated by the Mt. Lyell M. & R. Company for their copper content. The concentration of the ores includes flotation and a pyrite product is obtained. This product is now being utilised for the manufacture of Sulphuric Acid in Victoria.

(c). Low-grade Tin-bearing Pyritic Deposits. Large deposits of pyritic minerals containing cassiterite occur at several localities in Tasmania. The principal ones are those at Mt. Bischoff and Renison Bell.

(1) Mt. Bischoff Mt. Bischoff is the locality of the well known tin mine of that name. It is situated at Waratah in north-western Tasmania which township is connected by a branch line, 10 miles in length, with the Emu Bay Railway at Guildford 38 miles from Burnie. Various types of lodes and ore bodies occur within this mine, and have, and are being, worked for their tin content. One type consists of bodies of pyritic minerals containing small amounts of cassiterite. These ore-bodies represent replacements of dolomites which were formed by alteration of ultra-basic intrusive rocks. The pyritic mineral is mainly phyrrhotite, but large amounts of marcasite probably formed from the phyrrhotite are also found. The pyrite in the ore at present being treated is recovered on concentrating tables and then calcined prior to further treatment for its content of cassiterite. The sulphide dioxide from the calcination is not utilised at present.

In the treatment of the whole of the whole of these pyritic deposits, the possibility of the utilization of the sulphur as well as the tin content of the ore must be taken into consideration.

(2) Renison Bell. Numerous pyritic lodes occur in the vicinity of Renison Bell. These lodes consist of pyrrhotite, pyrite &c. and carry a small content of tin and have been regarded as low-grade tin deposits. Many of the lodes are composed of dense pyrite or pyrrhotite or a mixture of both.

Up till the present very little attention has been paid to these as a source of sulphur but recently some 500 tons has been mined and shipped for use in sulphuric acid manufacture, the sulphur content being approx. 35 per cent.

The reserves are not known with any degree of accuracy, but are large.

If the ores with 35% sulphur can be used in the manufactures of sulphuric acid, then the reserves at Renison Bell are probably the largest in the State and could be largely extracted by quarrying.

(3) The Read Rosebery Zinc Lead Sulphide Deposits. These deposits occur in an area embracing Mt. Read and the township of Rosebery in the West Coast district of Tasmania.

The Emu Bay Railway from Burnie (a seaport on the North Coast) to Zeehan passes through Rosebery (71 miles from Burnie). A road four miles in length connects Williamsford with Rosebery. Williamsford is also connected by the North East Dundas tramway

(two foot gauge) from Zeehan. Zeehan is connected by the Government Railway with Strahan on Macquarie Harbour.

The area in which the ores occur is composed of Ordovician and Cambro-Ordovician strata consisting of slates, breccias and quartzites. These are intruded by porphyries of Devonian age and along their contact, the porphyries are sheared and altered and have been converted into quartz-sericite and chloritic schists.

The ore-bodies occur in association with sedimentary zeoliths occurring in the sheared porphyries. The ores are chiefly those of zinc and lead and are referred to as Zinc-lead sulphide deposits. The deposits are considered to be genetically associated with the intrusions of Devonian porphyries.

The ore is generally very fine grained and consists of an intimate mixture of sphalerite, pyrite, galena &c. but veins of coarsely crystalline minerals also occur. The ore is typically banded due to the occurrence of alternating bands of varying composition. The boundary between ore and country rock is sharp.

The average zinc lead sulphide ore has the following mineralogical composition:-

Zinc blende	35.2 per cent
Pyrite	31.0 " "
Galena	7.3 " "
Quartz	7.8 " "
Silicate of Alumina	6.7 " "
Calcite, Ankerite & dolomite	3.2 " "
Barite	2.5 " "
Chalcopyrite	0.9 " "
Rhodochrosite	2.2 " "
Tetrahedrite & Bournonite	0.2 to 0.4 per cent
Silver	8.5 oz. per ton
Gold	2.12 dwt. per ton
Arsenopyrite	0.7 per cent
Orthoclase and Albite	1.6 " "

Although a great part of the ore-bodies contains over 80% sulphides yet on the average they contain approximately 76% sulphide and 24% gangue. The chemical composition of the average zinc-lead sulphide is:-

Sulphur	28.7 per cent
Zinc	21.3 " "
Iron	16.9 " "
Silica	9.5 " "
Lead	6.4 " "
Alumina	6.1 " "
Copper	0.5 " "
Magnesia	0.5 " "
Lime	0.3 " "
Silver	8.5 ozs. per ton
Gold	2.12 dwts. per ton

The ore occurs in two areas, viz. Rosebery and Mt. Read. At Rosebery there is one large tabular ore-body containing several almost continuous lens along a length of 2200 feet, which has been proved to a vertical depth of 800 feet at certain places. At Mt. Read there are a number of separate lenticular ore-bodies in the Hercules and Mt. Read mines.

In June, 1927 the ore reserves were estimated at a minimum of 1,400, 000 tons. The development work since that time has added considerably to these reserves and the amount of 2,000,000 tons could probably be taken as a conservative figure.

Up till recent years attempts were made to mine, and in some cases treat the ores from the numerous mines separately, but these ventures were almost entirely unsuccessful. The production of zinc lead ore during this period amounted to 295,737 tons, with a value of £383,416.

The first attempt to amalgamate interests was made by the Mt. Lyell M. & R. Coy. who included the Hercules, Tasmanian Copper and Primrose Mines with others under the title of the Mt. Read and Rosebery Mines Ltd. Later the Electrolytic Zinc Coy. took over these properties and are now operating thereon. The ore was mined and then transported by rail to the treatment plant at Zeehan. It was then treated in order to effect as complete a separation of the zinc and lead portions as possible. The argentiferous galena is shipped to the lead smelters at Pt. Pirie, South Australia. The zinc concentrates are roasted and the calcined material (approx. 6% sulphur) shipped to Risdon. The sulphur dioxide from this process is not utilized at present for sulphuric acid manufacture. A treatment plant was later erected at Rosebery, but owing to the low metal prices, operations were not commenced.

The calcines from Zeehan and those from Broken Hill, N.S.W., (which at present form the bulk of the supply) are then used for the production of electrolytic zinc. They are first roasted to further reduce the sulphur content (6%) and then dissolved in the acid solution from the cells. The undissolved and suspended material is removed from the solutions in two stages. The coarser material is removed first and consists mainly of unoxidised zinc sulphide. This product is further utilized in the manufacture of sulphuric acid and subsequently superphosphate, and also of electrolytic zinc. It is dried and then roasted in Herreshoff furnaces, the sulphur dioxide gas being used in the sulphuric acid plant, while the calcined material is taken back into the main process for the manufacture of electrolytic zinc.

Part of the sulphur of zinc-lead sulphide ores, both from Tasmania and Broken Hill is thus being used in the manufacture of sulphuric acid and Superphosphate. The ores, however, represent a large reserve of sulphur and a much greater proportion might possibly be used. The products produced in the concentration of the ore are a galena concentrate and a sphalerite concentrate, while by slight additional treatment a pyrite concentrate could also be obtained. The sphalerite concentrate has to be calcined and the greater part of its sulphur could be used in sulphuric acid manufacture. The ore reserves (2,000,000 tons) contain 704,000 tons of sphalerite which represents a sulphur reserve of 232,320 tons. The pyrite concentrate if obtained would also represent a valuable source of sulphur. The ore contains 620,000 tons of pyrite which represents a reserve of 330,460 tons of sulphur. The company's proposal is to treat 500 tons of ore a day and this would yield a maximum production of pyrite of 150 tons a day while in practice the production would be somewhat less than this figure.

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