COPPER IN TASMANIA

The total production of copper ores, matte, and metal in Tasmania amounts to £18,692,495, and exceeds that of any other individual mineral or metal produced within the State. The greater portion of this production has been in the form of blister copper. The principal deposits of copper ores are those near Mount Lyell in the West Coast district. These deposits are worked by the Mount Lyell Mining and Railway Company Limited, who treat their ore locally and produce blister copper, which is then shipped to Port Kembla in South Australia for refining. Works are now being erected at Queenstown (adjacent to Mount Lyell) for the purpose of refining the bullion on the spot.

The Mount Lyell Company's Mine is the only copper mine working at the present time in Australia.

Copper ores also occur at the Jukes-Darwin field in close proximity to Mount Lyell, the Mount Balfour field in North Western Tasmania, and the Scamander district on the East Coast.

THE MINING FIELDS -

1. The Mount Lyell mining field is on the main ridge of the Tasmanian West Coast Range, some 20 to 25 miles from the coast itself. The range consists of a series of mountains of conglomerate, resting upon a base of schists, which are exposed in the valleys between the conglomerate masses.

The schists of the Mount Lyell field are metamorphosed igneous tuffs of Cambro-Ordovician age. The metamorphism has obliterated any signs of bedding except in one or two isolated instances, and no appreciable continuity is observable along the general line of strike, the lithological character of the schists varying within a short distance in any direction. The most common and outstanding types, however, and the ones actually associated with the ore-bodies, are what are termed grey and chloritic schists (Loftus Hills, 1927).

According to R.W. Murray, General Manager of the Mount Lyell Company, the structure of these latter is massive, schistose and nodular, but usually finely laminated near the ore occurrences, frequently becoming fissile. Only in the neighbourhood of the ore-bodies is the foliation disturbed to any great extent, and then not by faulting so much as by numerous folds. The direction of the ore-channels, as a rule, conforms closely to the strike of the schists.

Directly over the schists is a layer of conglomerate, composed of quartz pebbles, white or iron-stained from light-pink to dark red, ranging in size from the grains of a dense sandstone to boulders a foot or more in diameter. This conglomerate, known as the West Coast Range conglomerate, is recognised as belonging to the Silurian period, and as being the basal conglomerate of that system. The conglomerate is not usually ore-bearing, but in the case of the North Lyell Mine the ore appears to have been formed by the metasomatic replacement of the rock on each side of a fault fissure, the sulphide minerals being deposited on both the schist and conglomerate material.

Extensive faulting is a feature of the district, the

relative positions of the schists and conglomerates being sometimes reversed, and it is along the course of what is known as the Great Lyell Fault that the ore-bodies occur, these generally being situated on the contact between the two rocks.

The only mines at present being worked are the Mount Lyell and the North Lyell (the former now only to a very limited extent), both owned by the Mount Lyell Mining and Railway Company Limited.

(a) Mount Lyell Mine - This is situated on the southern side of the connecting saddle between Mts. Owen and Lyell, in a bay formed by the contact of the conglomerates and schists. The ore-body is a pure, massive cupriferous pyrite, with very little gangue, principally quartz and barite, both very finely distributed, and rarely visible to the unaided eye. It carries gold and silver in relatively small amounts compared with the copper content, and is wonderfully free from deleterious elements, containing only about 0.25% arsenic, less than 0.17% antimony, no bismuth, and traces only of selenium and tellurium. Galena and sphalerite are not uncommon, especially in the lower levels, but rarely exceed small amounts.

A typical analysis of the ore is as follows:-

	Per cent.
Iron	42.02
Sulphur	48.77
Silica	2.12
Alumina	1.97
Barite	0.40
Copper	0.73
	Ozs.Per Ton
Silver	1.50
Gold	0.04

The ore-body is lenticular in shape when viewed in plan, its greatest horizontal dimensions being 660 feet by 270 feet, but considered vertically it is rather pipe-like, tapering downwards, its greatest proved vertical depth being 750 feet. It underlays into the hillsides at an angle of about 30 degrees from the vertical, having conglomerate as a footwall and schist as a hanging wall. The pyrites came practically to the surface, the superficial layer of detrital and gossanous matter being slight.

The distribution of metallic contents was irregular, and rapidly diminished with depth. The portion, some 60 feet in width, adjacent to the hanging wall averaged 3 to 8% of copper, but the average shaded off rapidly into the low-grade mass which formed the heart of the body. Several secondary enrichments occurred outside of, but contiguous to, the pyritic mass, and the first 1,500,000 tons smelted averaged 2.85% of copper with 2.67 ozs. of silver and 0.095 ozs of gold per ton.

(b) North Lyell Mine - In this mine the ore is principally a hard quartzite carrying bornite, chalcopyrite, and chalcocite; and, to a less degree, of schistose rock, carrying the same material. The ore occurs along the contact of the schist and conglomerate, and is regarded as a product of replacement and silicification of both these original rocks. The mine is usually considered as containing a number of separate ore-bodies, but these may be more properly looked upon as the richer portions of one large mass, through which the minerals are disseminated irregularly. This occurrence, at the more important levels, has been proved for a length of 1500 feet, and is worked almost continuously over the whole length, the width of the payable ore often exceeding 100 feet, although it occasionally becomes restricted to the extent of practically disconnecting neighbouring stoping areas. The original ore occurrence, which was accidently discovered in 1897 by the cutting of a road, extended right to the surface, but over a small area only, and this has been worked to a depth of 1000 feet, being an almost vertical pipe-like mass.

The present productive occurrences in the mine, however, do not extend upwards above the 500 feet level, at which horizon they were first encountered, and they closely follow the underlay of the conglomerates in an easterly direction; this rock overlies them, and forms the hanging-wall of the stopes, although there is rarely any defined wall, the ore values for the most part dying away until the material being worked becomes merely barren quartzite. A similar condition largely exists on the footwall side, where the ore bearing material dies away into barren schist. Occasionally, however, clean walls are encountered.

The general average is about 6% of copper, but large bunches of nearly pure bornite are sometimes met with assaying up to 50% of copper. Extensive masses, yielding from 12 to 20%, are common, and these rich ores are delivered separately to the reduction works for special treatment.

A typical analysis of the ore in bulk is:-

	Per Cent.
Copper	6.15
Silica	62.7
Iron	9.1
Alumina	7.5
Barite	1.5
	Ozs. Per Ton
Silver	1.3
Gold	0.015

(c) Since the inception of the Mount Lyell Mining and Railway Co. Ltd. to 31st December 1927, 212, 178 tons (fine) of copper, 13,722,813 ozs. (fine) of silver and 389,222 ozs (fine) of gold have been produced. During 1927 the production of blister copper amounted to 5,863 tons containing copper 5,811 tons, silver 101,297 ounces and gold 2,138 ounces, with an approximate value of £383,809. Up to the end of 1927, the Company had paid out by way of dividends the sum of £4,587,411.

2. The Jukes-Darwin mining field constitutes a southerly extension of the Mount Lyell field, consisting of two mountain masses, namely, Mt.Jukes and Mt.Darwin, forming the southern-most portion of the West Coast Range of Tasmania.

The copper ore deposits of this area are confined to similar rock types as those which occur in the Mt.Lyell mining field described above.

The minerals occurring in the ore bodies now under review are pyrite, chalcopyrite, native copper, galena, chalybite, specularite, chlorite, limonite, and quartz, Generally it may be stated that pyrite and chalcopyrite are the most abundant of the metallic minerals present, galena and specularite being very limited in amount. The relative amounts of these minerals present in the different occurrences of ore vary greatly. There is no general type characteristic of the field, for all gradations exist from the occurrences of almost pure chalcopyrite in veins and blebs in chloritic schists ... with very little quartz, down to almost pure quartz with a few disseminated grains of pyrite or chalcopyrite. It must be noted that chalcopyrite is the important copper bearing mineral present, the other two minerals which contain copper being present in totally insignificant proportions.

Gold and silver values are contained in the chalcopyrite, and perhaps also the pyrite, but as the gold values increase with the copper contents, it is most probably associated with the chalcopyrite. No free gold or silver can be seen.

Since a number of the ore occurrences of this field (which contain values in copper, silver and gold sufficient to render them of possible economic value) consist of the mineral chalcopyrite in veins, blebs, and irregular masses in barren rock, the designation of any portion of this sulphide-bearing schist as a payable body is therefore purely arbitrary, being governed solely by the metal contents which render it payable under certain conditions. These conditions of payability may vary from time to time, and, therefore, it is quite possible that what is now regarded as a valueless fahlband, may, under other conditions, assume the character of a valuable ore-body.

The boundaries of these ore-bodies are irregular, being limited in the direction of their width generally by the boundary line separating the schist from hard felsite, the change towards this contact being a gradual one, characterised by a diminution of the sulphides and a corresponding increase in the amount of rock.

This same gradual diminution of the value of the ore-body by the decrease in the relative proportions of sulphide and rock also occurs along the line of strike. In some cases the schist is mineralised for its whole width, but in other instances only a portion of its width is thus effected. In the former case, the mineralisation extends in smaller unimportant veinlets for some distance into the hard adjacent felsite.

It is considered that the present values of the ore deposits of this field will continue to depths which would enable mining to be carried on on a considerable scale. It is rather difficult to gain any conception of the exact value of those deposits which have been more or less opened up, owing to the absence of assays of samples taken systematically. What assays are available, however, give a metallic content which may be regarded as encouraging. The returns from the parcels of ore sent away from the field,

totalling about 30 tons, show the following average values:- Copper=5.38%; silver=6.99 dwt; gold=4.03dwts. per ton.

No copper mining is being done on this field at the present time and no mineral sections are held for that purpose.

3. The Mount Balfour mining field is situated in the north western portion of Tasmania. The prominent topographical features of the region are due to the large extent of country occupied by two physiographical units - on the one hand the Norfolk Range, and on the other hand the broad coastal peneplain. The range rises abruptly to a considerable height above the level of the peneplained surface. In the vicinity of the township of Balfour, and in other parts of the region, there are many smaller hills which are only isolated portions of the peneplain itself, and noticeable only because of the deep dissection of the latter.

The rocks occurring at the surface over almost the whole of this area belong to a great sedimentary group to which the name "Balfour slates and sandstones" has been assigned, and which are considered to be of Cambro-Ordovician age. The rocks belonging to this group are traversed by basic dykes, and they have been invaded by a granite massif which lies partly exposed at the surface along the coast between Sandy Cape and the Pieman River. The majority of the lodes of the field are contained between walls of these older sediments.

There has been extensive rupturing and dislocation of the whole group, and mineral veins occupy the fractures in many places.

The copper ore from almost any portion of the Mt. Balfour mining field has a remarkably constant character. The ore, however, does not represent the whole of any lode. It is to be regarded as that part of the lode whence it has been taken which has been locally enriched during the period of primary deposition in copper-bearing minerals above the other portions of the lode.

The constancy of character in the shoots of copper ore by no means implies a constancy of character in the gangue. The gangue material varies considerably from point to point along any lode, and yet this variation is almost always one of degree only. The minerals represented remian the same, but are present in ever-variable proportions. The usual association of ore-minerals and gangue-minerals forms the normal vein type. It contains the following:- Pyrite, chalcopyrite, quartz, ferri-ferous-dolomite, chlorite, and sericite. Gold and silver appear to be always present in small proportions, but are not known to materially increase the value of the ore at any point. The gold and silver contents of the lodes are, in all probability, due to inclusions of these metals in the pyrites, since assays made of non-cupriferous portions of the lode-matter in all parts of the field have shown their presence. It is noteworthy that the gold content does not appear to rise much above 3 dwt. per ton in those samples which have been obtained from widely separated localities.

The lodes, of which the primary composition has been described, have all suffered some alteration at or near the surface, and as a result have either lost some portion of their primary contents or acquired some new minerals in the place of those of primary origin. The actual surface outcrop of a copper lode may show no copper-bearing minerals whatever. This phenomen is caused by the somewhat ready solubility of the copper ores in surface waters as soon as the sulphides are oxidised to sulphates. The forms in which the copper-bearing seepage waters redeposit their minerals are not quite constant. The new minerals formed are covellite, chalcocite and bornite. Perhaps also some of the chalcopyrite

of secondary origin. Covellite is characteristic of the whole field.

The copper lodes of this district constitute the filling of fissures or fractures in the rocks in which they occur, and are commonly tabular in form, after the manner of those which are usually referred to as "fissure veins". The fissure utilised by the mineralising solutions at the time of ore deposition are planes of fracture and actual dislocation. Where simple fractures have been made in the slates correspondingly simple lodes result. But in a number of different places the crustal fracturing has effected a broad zone. The simple fissure has in such instances been replaced by a broad sheeted zone, and the impregnation with vein matter has followed the course of the many component fractures of the zone. In no case has the relationship between the fracture-zones and the more simple portions of the fissures in which they lie been exposed by underground workings.

In the case of the field here under consideration there is no single mine in which the work of development has proceeded to a depth at which the ore exposed for examination is free from all alteration by secondary processes. It has been, however, indicated that the shoots of ore, which all show evidence of secondary enrichment, will in all probability merge in depth into shoots which contain valuable proportions of chalcopyrite. In other words, it appears probable that chalcocite and covellite will disappear and the unaltered chalcopyrite will remain.

There is no evidence of the existence of any other primary copper-bearing mineral in the lodes, which may, therefore, be expected to provide ore of a simple character. There is a marked general absence of any ingredient which may cause difficulties in the metallurgical treatment of the copper ore, which is likely to be in practically every case of an acidic nature. The quantity of secondarily enriched ore of high grade cannot be guessed at in the present state of development of the field, but there are certainly indications which point to a revenue from this ore, which will materially assist in the opening up of the mines in depth.

No copper is being extracted from the Mt. Balfour mining field at the present time and in the past very little mining has been carried out, the ore exported amounting to only approximately 2000 tons. Several of the parcels of ore sold had an assay value of over 30% of copper, and many parcels contained more than 25%.

4. The copper mining field of Scamander lies in the north eastern portion of Tasmania. The country at Scamander township on the east coast shows a low coastal plain covered with beach sands, evidencing a slight recent uplift above sea level. This gives place at a short distance inland to a raised plain 60 to 100 feet above the sea. The plain rises gradually to the west, and at from 1 to 2 miles inland meets the base of the coastal range, which has a direction of a few degrees west of north, and the peaks of which rise steeply to 600 and 800 feet above sea level. The broad valley of the North Arm of the Scamander Rivers bounds this range on the west. A parallel mountain chain charted as Scamander Tier, exists a mile to the west of the coastal range, and it is on this chain that the copper lodes of the district are to be found. The Tier is a somewhat open, timbered range, about a mile in width, and rising to heights of 900 feet and 1000 feet. It descends somewhat abruptly to the north bank of the Scamander River, west of North Arm.

The rocks of this area comprise sedimentary strata of Cambro-ordovician age consisting of slate and sandstone. The strata have been folded regionally in large anticlines and synclines, but where the arching is on a minor scale and acute, rupturing has followed. The copper ore veins follow the trend of the sedimentary strata, both lodes and strata having a north-westerly strike. The ore channels consist of a group of parallel arsenopyrite quartz-chalcopyrite lodes occupying narrow fissures, but showing replacement zones of mineralised material on each side of the primary fissures. At the old Orieco Mine the lode has been subjected to extensive leaching on its upper parts, and has been worked for secondary ores a little above and down to ground water level.

Several hundred bags of oxidised and secondary sulphide, ores which have been got ready for sending away have been sampled with the following assay results:-

1. Sample supposed to be representative of 500 bags -

Copper	8.4 %
Silver	7.93 ozs. per ton

2. Sample supposed to representative of 400 bags -

Copper	17.8%
Silver	11.5 ozs. per ton.

The work hitherto done on this mine has revealed ore at intervals in the lode for a length of nearly 400 feet. At some of the points (where winzes have been sunk) the ore-concentration is heavier than elsewhere, and there are stretches in the lode where it has not been proved in any other way other than driving the tunnel, so that a little uncertainty exists as to whether separate shoots of ore have been passed through or all the ore belongs to one shoot. The latter is the more probable view. This, conjoined with the extensive leaching which has gone on above the water-level, points to the existence of a lower zone enrichment extending downwards.

signed
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31st May, 1928.