UR1920-1922/22-31

REPORT

on

THE RENISON BELL AND CENTRAL RENISON BELL TIN MINES

INTRODUCTION

Since the discovery of tin ore at Renison Bell in 1890 many official examinations of the deposits have been made, and the results of these works have been recorded in publications issued by the Department of Mines. These reports have proved of great value to operators as aids in the design of the mines and treatment plants. In the later publications attention was drawn to the fact that the mines were being rapidly depleted of their reserves of rich free-milling material and that provision should be made for the treatment of the sulphidic ore.

Up to the present time operations have been confined almost exclusively to the excavating and mining of the richer ore contained within the zone of oxidation. At the Renison Bell mine a small calcining plant was erected for the purpose of converting the concentrated sulphide ore into the oxide condition thereby liberating the contained tin oxide and enabling a complete separation to be made by means of mechanical appliances but only the richest of such material could be treated at a profit. Unfortunately the depletion of the rich oxidised ore and the commencement of operations on the sulphide material synchronised with the collapse of the tin marked and the company was compelled to temporarily close this section of the treatment plant.

The richer portions of the ore-bodies having been removed the Companies have now reached a stage in their operations at which a complete change in policy is imperative. Successful operation depends on the solution of the sulphidic ore problem.

In this report the various ways of dealing with the question at issue will be discussed.

The writer presents here a new interpretation of the origin of the ore-bodies and the structural relationship existing between them and the associated rock formations. The various workings have been fully described in other publications, therefore, there is no need to add to the volume of this report on that account. Attention will be confined to descriptions of the ore-bodies and their future development and exploitation; but no details will be given in regard to particular ore-bodies as there is a similarity in the nature of them all and the remarks to be made will apply generally.

AREA, SITUATION, ETC.

The Central Renison Bell property consists of three mineral sections held under leases 7783-M of 20 acres, 8495-M of 39 acres and 1215-M of 36 acres, by H.E., H.J., and C.A. Brock. Each of these sections adjoins on the north-east side part of the Renison Bell Company's consolidated lease 5865-M of 318 acres.

Renison Bell township is situated 9 miles from Zeehan and 78 miles from Burnie.

ACCESS AND TRANSPORTATION

The Emu Bay Company's railway passes through the centre of both properties. The mines are, therefore, easily accessible, and every facility is provided by the Emu Bay Company for the rapid transport of the products of mining to the markets.

GEOLOGY

Summary

With the exception of unconsolidated Quaternary Gravels the sedimentary rocks of this area consist of slates, sandstones, quartzites grits and breccias with intercalated beds of volcanic ash, the whole belonging to the Dundas series of the Cambro-Ordovician. Intrusive into these sedimentaries are igneous rocks of four kinds and ages. First there are representatives of the porphyroid suite so prominent in the neighbouring Rosebery district. These are not extensive and have no bearing on the formation of the ore-deposits. The recognisable components are phenocrysts of quartz and felspar in a ground mass of chlorite with the ilmenite alteration product leucoxene. The next are rocks of basic constitution ranging from gabbro to serpentine forming part of the great belt of basic rocks that outcrops in large masses from Heazlewood to Dundas. They were intruded in early Devonian time and represent the basic differentiate of the stock magma of which the closely following granite forms the complementary acidic part. Associated with this basic intrusive are ores of nickel and also osmiridium and gold. Interest is directed particularly to the granitic or acidic rocks in so far as this investigation is concerned because these intrusives are responsible for the deposits of tin and silver lead found in the district. This group of rocks is represented at Renison Bell by dykes of quartz felspar porphyry and aplite.

Another igneous rock type, separated by a long period of time from the last-mentioned, occurs in this area. This is a diabase probably belonging to the Mesozoic intrusion of this rock so prominent in the eastern half of Tasmania. It occurs here in the form of a narrow dyke extending from the Boulder mine along Dreadnought Hill to Renison Bell township. So far as can be seen this intrusive has not affected the ore-deposits in any way.

STRUCTURAL GEOLOGY IN RELATION TO THE DEPOSITION OF THE ORE

The general direction of dip of the sedimentary rocks is toward the north-east at angles varying from nine to fifteen degrees. In the small area examined the strata have not been compressed into folds, but they have been greatly disturbed and dislocated mainly by the intrusion of igneous rocks and the faulting that has resulted therefrom. They have been completely fractured in two directions: one along a north-west line; the other almost at right angles thereto, a little north of east. The former are lode fissures whose trend lines are roughly parallel to those of the basic and acidic dykes; the latter are fault fissures or slides. As a rule the lode fissures closely follow dykes of dolomitised pyroxenite but they occur also between slates and tuffs and other sedimentary rocks of dissimilar character and in places cut through them. The fault fissures are the older and they have produced a lateral displacement of the strata.

All the important ore-deposits are associated with the thrust faults. Among the most valuable of this type thus far developed are the North workings, Railway ore-bodies, Scott's workings, Big Blows, Summit, and Hetherington workings on the Renison Bell properties, and O'Brien's, Hetherington's, Evenden's and North Workings on the Central Renison Bell properties.. Outside the small area under examination similar conditions apply at the Montana, Dreadnought, Boulder and Federal properties. This may be taken as an established fact.

The rocks adjacent to the thrust zones have been rather highly brecciated especially where a hard rock like quartzite or dolomite has been thrust upon hard slates and tuffs. This brecciation has been favourable to mineralisation, and replacement has been complete in some parts of the dolomite. The ore deposits were formed where these zones are crossed by the mineralising fissures, and the ore-shoots dip with the intersections of the fissures and the fault zones to the east of north. Where the angle of crossing or intersection is oblique the ore-bodies appear to flatten giving rise to the idea of their occurrence in the form of "floors". These so-called "floors" occur on the Central Renison Bell and Boulder properties, and their origin has been the subject of much speculation by resident mining engineers and visiting geologists. A proper understanding of this lode structure would have proved of material assistance to operating engineers. The occurrence is illustrated in the accompanying graphs and sketches. Having given this explanation the writer leaves the details of the effects of these thrust faults on the fissured rocks at each particular mine opening to be worked out by the several operators. Unfortunately, the time at his disposal was insufficient to enable him to give a minute description of the structure at each point.

GEOLOGICAL MAP

On the Geological Map accompanying this report the courses of the faults at surface are indicated by blue lines. Their apparent erratic courses are due to the low dip of the faults to the north and the rapidly changing contours of the hills. The true course is a little north of east. As only ten days were allotted for the examination of these mines an exact location of the lines of faulting in relation to one another and to the mine openings could not be made. The lack of complete mine plans added to the difficulties of the work in this connection. The writer, therefore, desires to point out that the fault lines as indicated on the map should not be followed with meticulous care, but should be regarded rather as a guide to the correct positions of known and undiscovered ore-bodies. Where these lines cross lode fissures rich bodies of tin ore may be safely anticipated. Owing to lack of time and the heavy soil cover some of the faults could not be traced through the properties owned by the Renison Bell Company. For the same reason the details of structure have not been made; nor has any discrimination been shown between the several sedimentary formations.

THE NATURE OF THE ORE BODIES

As already mentioned the largest ore-bodies in the mine are associated with the cross-fractures suggesting that these have influenced the formation of the rich shoots. The loose brecciated rock along these "crush" planes or "breaks" furnished the easiest course

for the passage of solutions, and, as the brecciation
occurred prior to ore-deposition, replacement of favourable
rock and impregnation of metallic minerals in less-
favourable rock may be attributed to this cause.

The ore-bodies occur along strong north-west
fissures which extend right through these into the
neighbouring Montana and Dreadnought-Boulder
properties. They may be classed in two general
divisions, namely;

      (a)   Replacement - Fissure Deposits

      (b)   Fissure Fillings.

The former are the more important, and have
provided the large bulk of the ore thus far mined.
Although this classification of type of ore deposit
is convenient a sharp line of demarcation between
the two cannot be drawn for there are places where
both kinds occur. The former are considered to be
replacements of dolomitised pyroxenites which were
intruded in the form of narrow continuous dykes prior
to the intrusion of the tin-bearing porphyries. A little
doubt was felt as to the origin of this dolomite as
it is in places very narrow, and it is associated
with bands of mangano-siderite, of considerable
size and extent, evidently deposited from mineralising
solutions. Again the course of the dolomite conforms
more or less to the strike of the strata, and
crystalline limestone, possibly of sedimentary origin,
has been exposed in one tunnel. Against this there is
a good deal of evidence in favour of an igneous origin
of thedolomite. Platinum has been detected in two of
the dolomite replaced ore-bodies; microscopic
examination of some of the replaced rock reveals the
presence of partly-altered pyroxenite and suggest
its derivation therefrom. The writer admits that
although the evidence is decidedly in favour of the
igneous origin it is not conclusive. However, so
far as the economic view-point is concerned this
question is of little importance.

The degree of replacement varies with the
distance from the main channels of circulation, that
is: the points of junction between the lode and
fault fissures. Such replacements are made by tin
bearing pyrrhotite and to a lesser extent by tin
bearing pyrite; and where action by mineralising
solutions has been greatest a complete silica-tin
oxide replacement of the dolomite occurs. The pyrite
ore is abundant also at these points, but is, never-
theless, usually found as replacements and impregnations
of slates. In contradistinction pyrrhotite not only
occurs as a replacement mineral of dolomite at such
points, but is, as a rule, the only sulphidic mineral
found in the dolomite away from the fault intersections.
It was thought that the pyrrhotite occurring in dolomite
was formed by the action of sulphuretted hydrogen
on the residual iron of the original pyroxenite in the
process of dolomitisation, but this origin is certainly
not universal as pyrrhotite occurs also in association
with siderite and again as the tin-carrier in the
quartzites of the Big Blow lode and in the slates of
Main lode. It is, nevertheless, a striking fact that
pyrrhotite is almost invariably the particular mineral
form of iron sulphide found as a replacement of dolomite.
This is illustrated in the ore-bodies below the zone
of oxidation, and the information obtained by drilling
is of particular interest in this connection. In
bore hole No. 1 the drill passed through 135 feet of
pyritic slate, 5 feet of pyrrhotite, 10 feet of
siderite, 10 feet of pyrrhotite, 5 feet of siderite,

30 feet of dolomite and again entered pyritic slate.
In No. 2 bore the association is slightly different:
21 feet of pyrrhotite, 5 feet of siderite, 6 feet of
dolomite, $3\frac{1}{2}$ feet of pyritic slate, 7 feet of dolomite,
then pyritic slate again.

The large bodies of marcasite that occur at the
point of intersection of fault and lode fissures
almost certainly represent the first alteration
product of pyrrhotite. It is found usually at the
margin of pyrrhotite bodies that are covered by a few
feet of soil and rock debris. When exposed to the
action of the atmosphere it rapidly oxidises to sulphate
of iron, and under favourable conditions ultimately to
limonite leaving behind a soft friable mass locally
termed "ashes". This residue is the remains of the
skeleton of quartz always found in the pyrrhotite of
these ore-bodies. In some cases the quartz occurs as
a network of perfectly formed acicular crystals; in
other cases it is not well crystallised but is like-
wise of contemporary origin with the associated
pyrrhotite. On the oxidation and removal of the
pyrrhotite the peculiar mosaic of quartz crystals has
the appearance of lattice work. Under pressure of the
fingers the cementing silica breaks and the crystals
becoming detached are found to be almost perfect in
form. The quartz-pyrrhotite ore of this kind is
obviously a replacement product in this case of
dolomite. In some of the large marcasite-pyrrhotite
ore-bodies it is not uncommon to find spherical-
shaped bodies of pyrite from 2 to 6 inches in diameter
standing out in relief from partly replaced dolomite.
Probably these represent a replacement of orbicular
bodies similar to those obtained in the basic rocks
at Magnet. A noticeable feature of some ore-bodies is
that when the brecciated rock is slate it is generally
found that the interstices between the broken rock is
filled with quartz, pyrite and cassiterite, and not
pyrrhotite.

At Scott's workings ore of a different kind occurs
in association with pyrite and quartz fillings of a
fissure between dolomite and black slate. This is a
fine grained tin oxide replacement of an original
pyroxenite, recognisable as such only under the
microscope. It appears at first glance a fine-
grained felspathic sandstone, but the microscope
reveals an abundance of monoclinic pyroxene in some
specimens with also considerable felspar and much
secondary quartz.

It is worthy of note that platinum has been
detected in the dolomite ore-bodies of Renison Bell,
thus providing further evidence of its igneous origin.

Large bodies of manganese-iron oxide occur on the
Central Renison Bell and Renison Bell mines. They
vary in width from 20 to 100 feet and extend in a
north westerly direction for long distances. These
are undoubtedly secondary bodies derived from
mangano-siderite deposits similar to those occurring
with pyrrhotite and dolomite that were cut in boring
underneath the main lode at the Renison Bell mine.
The process of the alteration is as follows:-
meteoric waters attacked the upper portion of the original
carbonate of iron and manganese and converted it into
iron manganese oxide setting free any contained silica.
In so doing the waters lost their dissolved oxygen and
became carbonated in which condition they readily
dissolved ferrous carbonate and some of the contained
silica and transferred it to lower levels. Surface
oxidation having been completed waters charged with

atmospheric oxygen percolated downward, mingled with
the iron solutions previously formed and precipitated
limonite. It has been estimated that the alteration
of siderite to limonite is attended by a contraction
of 27.5 per cent, whence limonite ore-bodies are
often porous and spongy. These mangano-limonite
deposits are porous and vughy and contain incrustations
of silica. Crystals of quartz deposited from infil-
trating solutions in cavities are common in these ore-
bodies. Noticeable features of the deposits are; the
low tin content of the manganese iron ore or the so-
called "black gossan"; the comparatively rich limonite
or brown gossan, especially where accompanied by much
silica in the form of quartz crystals; and the local-
isation of the rich ore at certain definitely fixed
positions in the ore-bodies.

Referring to the accompanying sketches showing
sections of bore holes with nature of materials and
analyses it will be observed that the mangano-siderite -
from which the black ore is derived - is poor in tin
content, while the associated pyrrhotite and pyrite
especially where accompanied by much quartz are
comparatively rich. Doubtless the association of these
sulphides of iron with the carbonate of iron and manganese
was similar to that found in drilling Main ore-body
below the zone of oxidation. Probably the mangano-
siderite bodies represent replacements of dolomite.
The presence of the tin-rich brown gossan in association
with the black gossan ore-bodies is easily explained.
Pyrrhotite and pyrite associated with the siderite
were the tin carriers. They are readily attacked by
meteric waters and are thereby converted into limonite
(brown gossan) setting free the contained tin oxide.
Oxidation of these sulphides followed closely that of
the associated siderite (carbonate of iron) and the
medium of this transformation found an easy way of
access through the channels thus provided.

The reason why the manganese-iron oxide
(black gossan) ore-bodies are poor in tin content is
that they were derived from siderite which was
deposited from acqueous solutions during the waning
period of mineralisation and after the great bulk of
the tin oxide ore had been deposited.

A reference to the records of bore holes Nos.
2, 3, and 4 will show that pyrite and pyrrhotite are
not everywhere tin-bearing. The reason for the
localisation of the rich ore in them at fault inter-
sections has already been explained as due to the
easy access for solutions of high temperature at
these points; and the paucity of the lodes in
metallic minerals of commercial value - other than
those of lead and zinc - beyond the faults is due to
the circulation there of the solutions of lower
temperature only.

In an earlier publication reference was made
to the association of one of the ore-bodies with a
socalled "red" rock. Megascopically this rock appears
to be a jasperised felspathic sandstone or a tuff,
but this identification should be received with
hesitation as the writer has no means of making an
exact determination. Its association with the ore-
body referred to is due to its position on one of
the lines of thrust faulting, and for no other reason.

EVIDENCE OF SELECTIVE REPLACEMENT

Replacement and impregnation along fissures
are fairly uniform in the sedimentary rocks (sand-

stones, quartzites, grits and slates) producing
tabular deposits parallel to the fissure. Where
the rock formations differ in physical character
and chemical composition ore deposition extends
out from the fissure in particular rocks, such as
dolomite, for considerable distances, but leaves
adjacent sediments largely unaffected. This
selective replacement is due in part to physical and
in part to chemical differences in the rocks. Where
fault fissures intersect lode fissures access for
solutions is far greater and replacement conditions
are far more favourable, the resultant deposits
forming boomerang-shaped "chimneys" that follow the
intersection of the ore fissures and the fault
fissures. In the deposits in slate and other
siliceous or argillaceous sediments the reason for
this selective deposition seems to be largely
physical. In these rocks the fissures are harrow
and in places closed up and are relatively impervious
to solutions, consequently it is natural to find that
the ore-bearing solutions have not been so active and
did not extend so far into the wall-rock.

MINING DEVELOPMENT

Nowadays it is the object of every reputable
Mining Engineer to eliminate as far as possible the
element of chance from any mining under-taking and to
consider the proposition of the exploitation of the
ore-deposits from a purely business point of view.
In the early days of its development it was suggested
that leaseholders of mineral areas in this small field
should amalgamate their interests and form one or at
the most two, operating companies. If this advice had
been followed Renison Bell would have enjoyed a far
more prosperous career and the mine or mines would
still have been in active operation. Instead a
number of small under-capitalised companies were
formed each to develop the portions of the ore-bodies
contained within the boundaries of its leases. Each
mine that showed any promise was equipped with a mill-
ing and concentrating plant, in some cases before
development works warranted such expenditure.

An important advantage in placing these mines
under the control of one company is that all expendi-
ture at the beginning of operations can be applied to
exploration under-ground so that any particular mine
may be abandoned at any stage of development without
incurring undue loss. Not only would the cost of
supervision and control be greatly reduced but one
large treatment plant only would be required and the
water supply would be concentrated at one power station
at a comparatively small cost. In the case of the
mines under consideration three of the richest ore-
bodies occur along boundary lines between the proper-
ties. Each mine had to provide lines of transport
and full equipment to operate on the particular portion
lying within its boundaries.

Not one mine on the field possessed at any time
reserves of oxidised ore material sufficient to warrant
the erection of more than five heads of stampers and
the necessary concentrating machinery. The Renison
Bell Company for instance, erected a 20 head milling
plant and could not keep it in operation. Moreover,
provision had to be made for a more continuous and
larger water-supply for power and treatment purposes,
and during the summer months an auxiliary steam
plant was required to augment the power when supplies
of water were low.

The only disadvantage in having a central milling and concentrating plant to treat the product of all the mines is the cost of transport; but such would prove small in comparison with the Great cost of equipping a number of small mines with the necessary machinery for this purpose.

So far as the future development of the mines is concerned an amalgamation of interests is an imperative necessity in order to obtain successfull results. It is of no use making an attempt to carry on operations under existing conditions for the grade of the ore is too low and the available supply too small to keep a large plant in continuous operation for any consider-able length of time. Large ore-bodies are known on the Renison Bell property, but only one or two have been developed by mine openings, of any considerable extent and a great deal of work is required in order to bring the mine to the productive stage.

EXPLORATION

Future exploratory works should be based on the information given in this report. In the past a considerable amount of useless work was performed owing to the failure of operators to appreciate the significance of geologic structure. The unproductive cross-cut openings on the Central Renison Bell property in particular are monuments to this incapacity. If from a main centrally situated cross-cut the lode fissures had been followed in both directions the several faults would have been intersected in succession exposing rich ore bodies of tin at these points. In the past a gossan boulder at the surface provided sufficient inducement to commence a cross-cut to see what lay hidden underneath, and no serious attempt was made to explore the lode fissures along their course. The only solution to operators is the knowledge that they can profit by past mistakes in the design of future works.

PREPARATION FOR MARKET

As already pointed out in the introductory remarks oxidised ore only has thus far been excavated in quantity. There are three reasons for this; the ore at and near the surface is softer and more easily accessible, and consequently the cost of excavation is lower; in oxidised ore the tin oxide component is free and is easily separated from gangue materials by water processes of concentration; the tin content is higher.

Although, doubtless, other bodies of oxidised ore will be found by prospecting on the lode fissures at fault intersections, these will not add much to the permanency of operations. It is on the sulphide bodies that the future of the mines depend. In the first place it should be fully realised that the average tin content of the sulphidic ore - excluding small bonanzas which are of no ultimate moment - is too low to allow of profitable production at normal market rates for tin. Again it should be noted that the exploitable ore occurs in bodies, of no great lateral extent, separated by comparatively barren material of much smaller dimensions. From the fore-going it will be seen that a number of mine openings with all the necessary equipment will be required, thus adding considerably to the cost of mining and transport. From many hundreds of bulk samples it has been estimated that the average tin content of the pyrrhotite ore-

bodies is 0.76 per cent. Sulphide ore of this grade
cannot be prepared in a marketable condition at a
profit to mining companies. In fact pyritic ore
material containing less than one per cent tin cannot
be regarded as of any potential value at the present
market rate; but considered as an ore of sulphur and
iron oxide, or as a source of sulphate of iron as well
there is a possibility of restoring the industry to
its one-time importance.

If the tin content of the sulphidic material
were separated by ordinary mechanical means, the metal-
lurgical problem would prove simple of solution.
Unfortunately, the tin oxide occurs in an extremely
fine state of division and is enclosed in the body of
the pyrite, marcasite or pyrrhotite as the case may be.
This tin oxide when set free by calcination of the
sulphides is so fine that it will pass through a 200
mesh screen, that is, a screen containing 40,000 holes
to the square inch.

With modern plants, in the hands of skilled
operatives to be found only at such places as Renison
Bell, this slime tin can be separated and concentrated
to marketable grade without difficulty. The problem
is to recover the other marketable products of the ore.
Sulphide of iron considered as an ore of sulphyr for
the manufacture of sulphuric acid is valueless for
export if it contains less than 40 per cent sulphur.
Some of the Renison Bell ore cannot be concentrated
to this grade. Moreover, the marcasite variety is
unstable and is liable to spontaneous combustion. One
shipment of such ore from the neighbouring Boulder
property caught fire at Burnie in transit to Melbourne,
and the shipping companies since then have refused to
carry material of this kind. Even if it were possible
to ship the sulphide ore it would be necessary to
erect a plant at the sulphuric acid works in Melbourne
to separate the contained tin oxide after burning.
This confines the utilisation of the sulphyr and
iron content within narrow limits, and makes their
conversion to marketable products at the mines a
matter of necessity. There are two ways in which it
is possible to effect this result:

(1) The conversion of the sulphur constituent
of the gases from the calcining plant to
the elemental condition.

(2) The conversion of the sulphides of iron
to sulphate of iron.

Of these the latter appears the more attractive.
The present market rate of sulphate of iron is £13 per
ton and the demand is strong. If the value of this
material falls it could be converted into the highest
grade iron oxide pigment simply by a process of
reduction.

The other possible product (manganese-iron oxide)
of these mines is worthy of further investigation.
Although the samples of hard material taken from the big
lodes on the Central Renison Bell property contained
manganese in the proportion of five per cent only, the
soft wad-looking ore contains a much larger proportion,
and may prove of commercial value.

PRODUCTION AND RESERVES OF ORE

The total production of tin oxide concentrate
containing over 66 per cent tin from the Renison Bell
Mine exceeds 1,000 tons.

The cost of production is remarkably low taking into consideration the difficulties under which the mining is performed.

Mining, transport and milling of crude material cost in all six to eight shillings per ton, or an average of seven shillings. The average cost of mining and treating sulphidic ore is eight shillings and nine pence per ton. Results such as these require no comment, except that it is doubtful whether operations could be performed to such advantage again.

The output of the Central Renison Bell Mine is not known. It has been roughly estimated at 150 tons of high-grade tin oxide concentrate.

An attempt to estimate the reserves of ore on these mines cannot be made for reasons that are perfectly obvious. Although the quantity of available sulphidic material is undoubtedly very large, the lodes have been nearly depleted of free or oxidised ore-bearing material.

(Sgd.)   A. McIntosh Reid

GOVERNMENT GEOLOGIST

Launceston,
    9th December, 1922.