

REPORT ON PROPOSED RESTORATION OF SYPHON
AT SITE OF OLD NO. 6 SYPHON MT. CAMERON WATER
RACE

Introduction

The township of Gladstone came into being in the late seventies of last century, as a result of the discoveries of alluvial tin ore in adjacent districts and the north-eastern portion of the State generally. It has remained in existence due mainly, if not solely, to the resulting tin-mining industry which has persisted right up till the present day. Any factors affecting the tin-mining directly affects the population and prosperity of the township.

Certain factors more or less peculiar to the district have been apparent throughout its history. These are:

- (1) **Water-supply.** The topography of the district is such that the tin deposits are situated above the main streams (Ringarooma and Great Mussel Roe Rivers) and these streams have very flat grades. Further, it is impossible to obtain an adequate supply of water, owing to the absence of large creeks &c., near the deposits. Thus, in order to obtain water supplies, it was necessary to either instal pumping plants to raise water from the rivers, or cut long races to bring the water by gravity from a distance. Both methods were employed and involved considerable capital outlay, while the cost of the water when pumped was high.
- (2) The tin deposits vary somewhat in nature and extent, and it cannot be said that large areas of tin-bearing ground of uniform and payable grade exist.
- (3) The above two factors, viz. difficulty of obtaining water-supplies (local supplies only lasting a few months per year during the wet season) and the nature of the ground when conjoined made the working of the ground by companies extremely difficult and in nearly all cases, unprofitable.

The field has always been, and is now, one only suitable for individual miners and small co-operative parties.

Even to permit of such working however, a cheap supply of water was necessary and this has been provided by the Mt. Cameron Water Race.

History of the Mount Cameron Water Race

The question of a water supply for tin-mining in north-eastern districts was discussed as long ago as 1884. Three schemes were considered namely, bringing water from the Ringarooma, Boobyalla, and Great Mussel Roe rivers. As far as the Gladstone district was concerned the latter appeared the best scheme. A start had already been made by the Mt. Cameron Hydraulic Tin Mining Co. Ltd., to construct a race from the Mussel Roe river to their leases at Gladstone. This company exhausted their capital before completing the race and offered to sell it to the State Government. A select Committee was appointed in 1885 to consider the matter and recommended that the unfinished race be purchased and completed at a cost not exceeding £18,000. The purchase was authorised in 1887 and the race was completed.

When completed, the race was so situated that it could command the greater part of the ground (and enable such to be worked), between the Ringarooma River and the Mussel Roe River as far north as the Aberfoyle mine. Certain ground, viz. that near the Garfield, Tamar and Esk mines, was above the race, and so could not be worked unless water was pumped from the race. It will be noted that only ground on the western and northern sides of the Ringarooma River could be worked from the race, i.e. without constructing inverted syphons across the river.

In 1921, some of the local residents stated that the deposits below the northern part of the race on the east bank of river were worked out and asked that the water be taken across to the western or Gladstone side of the river. The proposal to deviate the race was referred to the Parliamentary Standing Committee on Public Works who recommended the deviation. In accordance with this, the Nos. 4, 5 and 6 syphons were removed, (No. 4 being replaced) thus rendering the race between the Edina and Aberfoyle mines quite useless.

A syphon was then put across the Ringarooma River to the west bank and the race cut as far north-west as the Alhambra Creek, while a branch was extended westerly towards the Purdue mine.

In 1927 a cement syphon was put in at the site of the old No. 5 syphon to enable water to be supplied to the Garfield Company, thus taking the water along portion of the old race along the eastern side of the river. In fact this enabled water to run as far as the head of the old No. 6 syphon and as soon as the Garfield Company ceased operations, several places were worked between the Edina and the Lochaber mines.

About the same time, a request was made for the extension of the race on the western bank from Alhambra Creek to Native Lass Plain dam. After investigation this was decided upon and the extension was completed in 1929.

Very little advantage has been taken of the above extension, and now another request is being made for the restoration of No. 6 syphon so that the water on the eastern bank can be taken to the northern end of the race.

Objects of the Present Investigation

As a result of the latest request, it was decided that an investigation should be made by an officer of the Mines Department, of the ground that would be commanded by the portion of the race which would be brought into operation if the syphon were renewed. The investigation was to include:

- (i) Mapping old workings. This was carried out and all workings except a few very shallow surface workings, are shown on the attached plan.
 - (ii) Testing all exposures of drift)
 - (iii) Investigating new or untried areas.)
- Only a limited amount of work was carried out along these lines. To undertake this properly, it would be necessary to employ a party of men for a period of 6 to 12 months. By using the results of previous boring campaigns especially that of H. Reach in 1917, it was possible to obtain valuable information and obviate a considerable amount of testing.

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- (iv) Facilities for working. These were noted during the progress of the survey.
 - (v) Though not included in the above, the important factor of the geological structure of the district, was investigated. This gave valuable information as to the courses of the "deep leads", of the "runs" of tin ore, and the possibilities of extensions of known deposits.

Topography

The highest country is the Mt. Cameron range, a short range with an east-west trend and rising to heights of 1800 feet above sea-level. The southern and eastern foothills are bounded by the valley of the Ringarooma River. The country south south-east of the Ringarooma River forms the extreme northern foothills of the Blue Tier. To the north of Mt. Cameron there is a dissected plain (the Great Northern Plain). At Gladstone and along the foot of Mt. Cameron, this plain has an altitude of nearly 300 feet above the sea, but it slopes gently towards the coast in a general north-westerly direction. The north-eastern boundary of this plain is formed by the low Ringarooma Tier and the south-easterly continuation of same as represented by the country along the Cape Portland road between Foster's gate and Gladstone.

The district is drained by the Ringarooma River and its tributaries. From Gladstone to the north-west the river runs approximately along the junction of the plain with the foothills of Mt. Cameron, but in some places a remnant of the plain is left on the southern bank of the river. The country immediately to the east is drained by the Mussell Roe River.

Geology

Cambro-Ordovician (Slates &c.)

The oldest rocks within the district are the slates and quartzites of Cambro-Ordovician age. They outcrop along the Cape Portland road; north of the Lochaber mine; along the north bank of the Ringarooma River from the Lochaber to near the Canary mine; in Aberfoyle Hill; ~~xxxxxxxxxxxxxxxx~~
~~xxxxxxxxxxxxxxxxxxxxxxxx~~; in the south-eastern corner of the Aberfoyle workings; and on the hills north of Stinking Creek. From these outcrops and from information obtained by the past boring, it is found that these rocks form the bedrock of the greater part of the district.

Devonian (Granite)

Granite outcrops to a slight extent only being restricted to the vicinity of the Canary workings. It also forms the bottom in the Canary, Roy, and the greater part of the Aberfoyle workings, while it is reported as a result of boring to form the bedrock of part of the country in the vicinity of the Macgregor mine. This granite is a small extension from the main body of granite forming the Mt. Cameron range. The junction with the slates and quartzites is south of the Ringarooma River and is generally parallel to it. The granite is intrusive into the slates &c., a good exposure showing the nature of the contact existing in one of the tailraces from the eastern part of the Aberfoyle workings. In common with other granitic rocks in Tasmania, it is regarded as being of Devonian age.

Mesozoic (Diabase)

Diabase outcrops immediately north-west of Aberfoyle Hill, the exposures being partly on crown land and partly on Foster's property. On the south-east side, the diabase is apparently intrusive into the Cambro-Ordovician slates. To the north north-west, it is overlain in the sands, gravels &c. of the Great Northern Plain. The diabase extends under the latter in a general north-easterly direction as it is seen to form the bottom in that part of the Macgregor workings that was worked by Mallison & party, and is also reported in Carey's bore-holes north of Beltz workings. In this direction it probably connects with the diabase on Ringarooma Tier and the low hills on Foster's property on both sides of the Cape Portland road. The diabase is identical with that so prominent in other parts of the State and is therefore of Mesozoic age.

Tertiary

The Great Northern Plain represents a tract of country occupied by gravels, grits, sands, clays, &c. The greater number of the tin mines have operated on portions of these deposits and with the large number of bore-holes put down, have yielded good sections of the strata. The soil for the most part is sandy or gritty (the grit comprising the quartz shed from granite) excepting where the peaty soil of swamps occurs. Below this there may be one to three feet of brownish cement, the sand or grit having been cemented by a small amount of oxide of iron. Below this, there are alternating layers of sand, grit, clay, carbonaceous beds, gravels &c. The sand is a white quartz sand often containing clayey material, but generally suggesting sea sand. The grits are composed of sub-angular to rounded pieces of quartz derived from the weathering of granite. The clay or pug is white, yellow or grey in colour and is generally interbedded with the grits. Carbonaceous beds are fairly common in the gutters in the bedrock. The presence of a small amount of carbonaceous material in the sands give brown sands, and in the clays give black carbonaceous clays. Boreholes report the presence of carbonaceous silt and lignite, the former apparently being a mixture of fine sand and clay with much carbonaceous material, while the latter is nearly pure carbonaceous matter (logs, leaf beds &c.). Gravel beds with rounded pebbles are practically absent, although a few thin layers do occur in some places, but angular gravels (or wash) are rather plentiful and occur chiefly in the deeper gutters either on the bottom or some distance above it. In the Lochaber mine, however, the bottom wash appears more rounded and this, together with the high tin content, rather points to fluvial (river) origin.

The beds generally suggest deposition in shallow water under rapidly changing conditions. The sand rather suggests marine origin, while the carbonaceous beds suggest brackish or more likely freshwater lagoonal and swampy conditions. Generally it may be assumed that the beds were deposits under estuarine conditions, but alternations of fresh water or swampy conditions. The greater prevalence of sand in the Macgregor area rather supports this as it would be closer to the mouth of the estuary.

These beds were deposited during a subsidence of the land. Such a subsidence is known to have taken place in many parts of the State and fresh water beds were laid down in river valleys, lakes &c. in Lower Tertiary times. These beds were later covered with basalt flows. Although in the Gladstone district, the beds were mainly of estuarine origin and are not covered with basalt, they were certainly deposited during the same subsidence and thus are to be regarded as of Lower Tertiary age.

Upper Tertiary to Pleistocene.

After the basalt flows the lower Tertiary subsidence ceased, and there may have even been some elevation of the land. A re-arrangement of the drainage systems occurred and the Ringarooma River in establishing its course on the eastern side of its filled-in valley apparently found a low saddle and left its old valley to enter that of the Mussel Roe River and the system including the Lochaber and Scotia leads. It then established its course on the south-western side of the valley it invaded and eventually corroded its course to the present position along the foothills of Mt. Cameron. In doing so, it probably re-distributed some of the upper layers of the lower Tertiary sediments and probably also formed some of the thin beds of gravels (with well-rounded pebbles of quartz) now found on the surface in some places, e.g. near the Scotia, Doone &c. While cutting down its course, periods of stand-still were reached and terraces of gravels were probably formed. These terraces probably include the shallow deposits at the south end of the Scotia and in the small workings south of the Doone mine, the typical beds being reddish-brown gravels with rounded pebbles scattered irregularly through a fine matrix of clayey sand.

Pleistocene.

By the Pleistocene period, the Ringarooma River had established its present course. Glacial deposits do not occur in the Gladstone district, but the shingle beds in the Ringarooma River probably represent (as they do at Ringarooma in the tributary streams heading towards Mt. Victoria) the deposits formed during the Pleistocene epoch.

Recent.

The Ringarooma River has a very flat grade, and alluvial deposits have been forming along its course probably continuously since the Pleistocene. They are more extensive in the numerous large bends of the river, and numerous alterations of course are apparent in such localities.

Since mining began, the river has become filled with tailings which have also spread over the alluvial flats.

Economic Geology.

The source of the alluvial tin ore is the primary deposits in the granite and the intruded slates near the granite contact. Several of these exist near Gladstone and include the greisen deposits of the Fly-by-Night Creek, the quartz reefs near the township, the greisenised granite of Harden's Ravine, and the Murray's lode above the Ringarooma River. Others may exist on Mt. Cameron and the foothills of the Blue Tier, while others may have been entirely removed by denudation.

The tin ore from the above primary deposits was washed down by the rivers and creeks which existed in the past and was included in the deposits formed from these streams. It is evident from the above description of the geology that there has been considerable alteration of the drainage system from time to time. As the leads and tin deposits generally were connected with the streams, some discussion of the geological history of them, is necessary.

The Gladstone district existed as a land surface as far back at least as the middle Mesozoic.

By Lower Tertiary times or before the commencement of the period of the depression of the land, a drainage system was established. The creeks and rivers of this system, would contain gravels and tin ore derived from the primary deposits in the granite. As subsidence occurred these gravels would be buried beneath other sediments deposited by the streams, and a system of deep leads formed. Apparently however, the surface of the land was only slightly above sea-level and the subsidence caused the sea to invade the greater part of the district including the lower portions of the valleys, and to form a large estuary.

The waters of the estuary appear to have destroyed the stream gravels and redistributed them and their tin ore content. In a few places e.g. the Lochaber mine, the stream gravels appear to have escaped destruction and are preserved as leads. In most places however the gravels were removed, and sands, clays, silts etc. with angular gravels were deposited in their place.

During the sedimentation accompanying the subsidence, the unflooded portions of the streams continued to bring down tin ore and this became mixed with the sediments forming. The position of the shore line, the depth of water, currents etc. altered from time to time and thus there was a very irregular distribution of the tin ore.

As already described above, the Ringarooma River left its former valley after the basalt flows and entered the valley or valleys in the Gladstone district. It probably meandered over the already formed sediments for some time, forming gravels and redistributing the sediments and their tin ore to some extent.

Eventually it established itself on the southern side of the estuary and began to corrode its course. During periods of stillstand terrace gravels were formed which were partly destroyed later, but remnants of which are still left.

Still later its course had been corroded as deep as possible and gravels etc. began to be formed in its bed.

Thus there are in the Gladstone districts a number of types of deposit including:

- (1) Remnants of old river deposits or leads, e.g. bottom gravels of Lochaber Mine.
- (2) Bottom gravels (angular wash) of the estuarine deposits, e.g. Scotia lead. Though not strictly correct, these are referred to as leads, because they occur in the gutters of the old valleys.
- (3) Estuarine deposits. These include all the upper layers of the Great Northern Plain from the Lochaber and Scotia as far as the Macgregor and Aberfoyle.
- (4) Any gravels on the surface of the Great Northern Plain and sediments redistributed by the Ringarooma River. Some of the surface gravels on the north-

western part of the Scotia, Newhaven, Lochaber, and near the Doone and Canary mines were probably formed in this way.

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- (5) Terrace gravels in the valley of the present Ringarooma River. These include some of the pebbly beds or gravels at the south-end of the Scotia mine and in the small workings south of the Doone mine.
- (6) Ringarooma River gravels, shingle etc. These are restricted to the present river bed or old courses in the alluvial flats. Such occurred at the Scotia flat, G. Watt's workings south of the Doone, Princess flat, Black Duck etc., but these have been partly or wholly worked out, and the present report is not greatly concerned with these.

Tracing the Leads

The attached plan shows all the workings and many bore-holes. The latter were put down by the Government (Griffin 1902, and Roach 1917) and by numerous companies, individuals etc. who kindly made available the results obtained. This information enabled some of the leads to be traced throughout a part of their courses and also suggested possible continuations. These are shown on the plan, but it must be remembered that while representing the most probable positions, they may not be very accurate.

Lochaber lead

This lead has been followed through the workings and passes beyond them in a north-westerly direction. Private bores have proved it to extend at least 15 chains in that direction. The wide and deep (114 feet) gutter at No. 27 bore on the Government No. 5 line almost certainly represents the further continuation. A trace to a little tin ore was found in Nos. 27, 28 and 29 bores but was not payable. The same gutter has been picked up in the bores (Carey's) on sections 9704, 9705 and 9706, near Stinking Creek. These bores indicate a bend to the north with the gutter becoming narrow. It must then bend to the west to have an outlet in the vicinity of Boobyalla. It is obvious that while the lead continues beyond the Lochaber mine the values become unpayable before the No. 5 line is reached. Boring would be necessary to determine how far payable value extend down the lead. As regards this lead above the Lochaber mine, it has been removed by denudation, and the only deposit that can be tentatively connected with it, is the short length of lead in the Empress mine. No portion of the headwaters of any existing stream can be connected with this lead, as it has apparently been entirely removed by denudation.

Scotia Lead

This has been followed in the northern part of the Scotia mine where it has a sharp bend to the north-east. Mr. Ryan's three lines of bore-holes and Roach's No. 3 line prove that the lead bends again to the north and has a general northerly trend. The only outlet for this lead is the 110 foot gutter at bore 20 the Government No. 5 line. On the plan the lead is shown as trending northerly towards that bore, but it is probable that it takes a wide bend to the north-east and passes through the deep ground near Mallinson's workings (see description of Mallinson's

workings) before reaching No. 20 bore. The lead will then probably junction with the Lochaber lead before reaching the bores near Stinking Creek. As regards values, these are given below in the description of the Scotia mine. Payable values were obtained in some of the holes, but not in all. As in the case of the Lochaber lead the values become unpayable before reaching the No. 5 line of bores.

The Scotia lead represents the deposits in a stream that was the ancestor of the present Mt. Cameron Creek or one of its tributaries. Other leads connected with the Scotia. On the plan there are shown two leads junctioning with the Scotia - one trending from the Newhaven and the other winding along the No. 5 line of bores. The former is somewhat problematical but the deep ground about the Newhaven and separated from the Scotia by high bottom, suggests the presence of a lead. The other is probably the best interpretation of the numerous depressions or gutters shown along the No. 5 line. These leads must enter the Scotia lead, as they have no outlet otherwise, the high bottom along the road to the Macgregor as proved by the boring campaign of the Alluvial Tin Company preventing any outlet in that direction. The Alhambra and possibly one of the heads of Mt. Cameron or Sextus Creeks would be the ancestral streams of these leads.

Doone Lead

The workings in the vicinity of the Doone mine and the boring campaign of Roach in 1917 have proved the existence of a gutter or lead in this locality. This lead was mined in the old Doone workings, and was proved by bores to extend to the east being situated north of Murray and Richard's workings and those of P. Cross. Murray and Richard's workings were situated on a small tributary nearly parallel to the other lead, or else a loop of the lead. It is difficult to know to which period of sedimentation to assign this lead. It is most likely of the same age as the Lochaber and Scotia leads, although there is a slight possibility that it may have been formed by the Ringarooma at some period of still-stand while establishing its present valley.

Black Duck Lead.

The deep ground at Wainwright's and Richardson's workings and the existence of a lead at the latter strongly suggest a lead between the two workings. Its extension to the south or south-east has been eroded by the Ringarooma River but it probably represents the continuation of the Doone lead or another formed by the ancestor of Deep Creek. On the plan this lead has been shown as continuing through the Macgregor, but there is no evidence for or against this and it is doubtful if this interpretation is correct.

Macgregor Lead

The Government No. 6 line indicates deep ground at the south-west end and a depression must exist between here and Aberfoyle Hill to the south. The ground is also deepening to the north-west of Beltz workings and may be part of this lead or more likely a tributary one. As stated above, this lead is shown as continuous with that of the Black Duck, but this may not be the correct interpretation.

Aberfoyle Lead

The deep ground at Curnow's face of the Aberfoyle mine and the dip of the bedrock in the northern part of the Canary workings strongly suggests an east-west lead in this vicinity. It is also stated that private bores have verified the presence of this lead. It is shown as trending north of the eastern Aberfoyle workings, but there is a slight possibility that it passes between the Sea Shell and the eastern Aberfoyle workings.

The Mine Workings

Lochaber Mine

Leases 7413/M, of 20 acres, and 10841/M of 19 acres, both in the name of E.R. Groves.

The mine workings are situated on 7413/M and the country to the south and east, but have not progressed as far as 10841/M.

The deposit worked is that of the Lochaber lead. It was found on the bank above the Fig and Whistle Creek and was then followed and worked in a general westerly direction. In the central part of the workings the gutter bends to the north-west and passes out of the workings in the direction of 10841/M. The upper layers of the deposit have been sluiced on the south-west side of the gutter. The ground has a maximum depth of 65 to 70 feet in the vicinity of the present face. A generalized section is as follows, the bedrock being slate:

- 3' Surface grit and cement
- 14' Quartz grits with pieces of quartz up to 1" (In places gravels occupy the upper part of this layer).
- 12' White clay with fine quartz grit.
- 8' Alternating layers of clay and quartz grit.
- 30' Coarse gravels with pebbles becoming coarser at bottom, the bottom wash containing rounded and sub-angular pebbles up to 10". (On the sides of the gutter these gravels are not so thick, but give place to clays, carbonaceous clays and quartz grits).

The coarse gravels near the bottom are the richest in tin ore, those immediately above the bottom being exceptionally rich and yielding dish prospects of many pounds per cubic yard. The upper layers contain cassiterite in lesser quantities but still appreciable as may be judged by the extensive area worked beyond the confines of the gutter.

The tin ore is fine in grain that from the bottom, wash being the coarser and ranging in grain size up to 1/32 inch. It is composed of grains of black, brown,

ruby, and resin colour, the general appearance being a dark brown. The upper layers of drift contain gold which is recovered with the tin ore to the amount of 2 ozs. per ton of ore. It is fine in grain and has not been separated from the tin ore until recently, when the low price of tin and high price of gold has made its extraction more desirable and profitable.

Little or no records exist in connection with the working of this mine. It was apparently included within the property of the Imperial Tin Mining Co. Reg. during the eighties, it was reported in 1885 that the Company was getting 2 to 4 tons per week. Since then it appears to have been leased and worked by individuals. There are no official records of production during past workings. In 1901, Twelvetrees stated that the former production was 0.5 tons per month. During the early part of this year, Standage and party began operations and obtained 1.64 tons of tin ore.

As regards the extension of this mine, it can be said that the lead or gutter will continue to the north-west. It has been proved to exist near No. 27 bore of No. 5 line of Government bores, some 50 chains to the north-west. As to how far payable tin ore will occur down the lead is another question and one which cannot be answered except by a boring campaign. The bore-holes ahead of the workings are private ones and the values are not available. Nos. 27, 28 and 29 holes on the Government line gave trace of tin, little tin (not payable), and little tin in surface wash respectively, so that payable values do not appear to extend that far. It is certain however that the tin-bearing gravels will continue some distance beyond the present face.

This mine is being worked with water from the Mt. Cameron Water Race. The only possible alternative scheme would be to pump water from the Ringarooma River which is 25 chains south of the present face. The tail race is cut at the lowest possible level and ends in a tunnel cut through the low ridge separating the workings from the valley of the Pig and Whistle Creek. As the lead falls to the north-west, it is necessary to elevate the material, and the present operators are elevating it 29 feet with an hydraulic elevator. The water for the elevator is taken direct from a small intake near the head of the old No. 6 syphon. Water is also run into a dam on lease 10841/M and is stored and used for nozzle water.

If the present workings continue and a full face of material obtained it would be advisable to treat the upper drifts separately as an overburden face. This method would lessen the amount of elevation necessary.

Mallinson's Workings and Deep Ground to West

These workings are situated in the south-east part of former lease 9678/M 15 chains south-west of the Lochaber workings, but are not held under lease at present.

A working some 5 chains long and half a chain wide was opened up in a general westerly direction at the head of a small gully falling into the Ringarooma River. The depth ranged up to 12 feet at the western end and it is stated that 2 tons of tin ore were won. The upper layers consist of fine sandy clay and fine sand,

with granitic quartz grits beneath. The lower layers are not visible, but judging by the forkings they contained numerous pebbles and boulders (up to 2 feet of white reef quartz), the bedrock being slate.

At the head of the workings the bottom sloped to the west and the ground could not be worked. In 1916, H. Roach put down 5 boreholes, 4 being immediately west of the face and the other 10 chains further west. The depths ranged from 42 to 66 feet, but only one hole (No. 2 with a depth of 56 feet) was bottomed. Thus there exists deep ground in this vicinity, and the ground worked was part of the terrace on the eastern side of the deeper channel. The bores proved the presence of alternating layers of drift, gravel and pug with decomposed timber and pyrite present in the bottom layers. This deep ground most likely represents the continuation of the Scotia Lead with a large bend to the east. The only alternative is that it represents an independent north-west trending lead between the Lochaber and Scotia leads, but this is unlikely because it has not been located on the fall to the Ringarooma River.

The bore holes yielded only traces of tin ore but it is unfortunate that they were not bottomed or that Roach's recommendation for several lines of bores was not carried out.

Until the depth and value of the ground is known it is useless to discuss working facilities except to state that the ground could be worked by water from the Scotia branch of the Mt. Cameron Water race.

Scotia Mine

The face of this mine and the ground ahead of it is included in lease 10857/M of 20 acres held by T. Stanley, the remainder of the workings not being leased.

This mine was formerly one of the most productive in the district, and approximately 35 acres of ground have been worked out. It was one of the earliest found, the Scotia Tin Mining Company being formed in 1881. Little or no information is available in connection with the earlier workings. In 1891, the Scotia Company and J.W. Brown were working six faces on what is now the southern part of the workings. These workings were 10 to 15 feet deep and the slate bottom was generally flat with a gentle slope to the north-west. These workings were apparently payable but later the production decreased. In 1901, however, deeper ground was found in the northern part of the workings, and the mine under Mr. Galloway became the leading producer. The deposit eventually assumed the form of a deep lead with a narrow gutter towards the face. Active mining was carried on until 1905, but the production dwindled in 1906, and 1908 when it appears to have stopped. 1907

The northern part of the workings have therefore, been on the Scotia lead, while the southern part was partly on the lead, but also largely on the lead deposits resorted and redistributed by the Ringarooma River when eroding its present course across the Scotia Lead.

The lead consists of alternating layers of clayey sand and granitic quartz sand. Gravels are absent except in the surface layers where rounded quartz pebbles are present on the western side. These gravels however have probably been formed subsequent to the lead. On the sides of the gutter the bottom "wash" consists of angular quartz pebbles, associated with brownish sandy clay. As far as can be seen from unworked portions of the lead, lignitic clayey sand fills the gutter, while in places large

boulders (up to 5 feet) of quartz with rounded edges rest directly on the bottom (slates and quartzites). Roach's No. 1 bore into the bottom layers near the face shows 17 feet of gravel, wash and small wash. At the face, the depth of material above the gutter is approximately 50 feet, while the bores ahead show ground at least 72 feet deep.

The production from the mine is not known with any certainty. According to local hearsay the Scotia Company produced 500 tons and J. Galloway 500 tons. No records of the workings of the company are available but from 1901 (when the deeper ground was discovered until 1908, departmental records show a production of 185.35 tons, the greatest yield being 94 tons during 1904.

As regards the continuation of the lead this has been determined to a large extent by bore-holes. Mr. C.E. Ryan bored 3 east-west lines ahead of the face, there being 12 holes in the Nos. 1 and 2 lines, and 4 holes in No. 3 line - a total of 28 bore holes. In 1917, Mr. H. Roach put down 13 holes as part of a Government boring campaign. One hole was in the bottom wash near the face; the No. 2 line continued easterly from Mr. Ryan's No. 2 line, while the No. 3 line was 10 chains ahead of Mr. Ryan's No. 3 line, the positions of both sets of bore holes being shown on the attached plan. These boring campaigns prove that the gutter continues in a direction west of north somewhere Nos. 6 (68.5'), 21 (68'), and 28 (68') of Mr. Ryan's bores and No. 13 (72' unbottomed) of Mr. Roach's bore-holes. Its further course is not definite, but it is tentatively shown as passing near No. 21 hole of the Government No. 5 line to the north-west. It is probable, however, that it bends towards Mallison's workings and may then cross the No. 5 line at either No. 15 or No. 21 bore.

As regards values, Mr. Roach's campaign showed a value of 0.42 lbs. per cub. yd. in No. 1 bore in the workings, and "nil", "traces", and "little tin" in the other holes. However none of the other holes were in the gutter except possibly No. 13 and that was not bottomed. It appears from the boring that the upper layers contain little or no tin ore. Mr. Ryan's holes were closer and crossed the lead at close intervals (40 feet) and gave higher results. On No. 1 line bore No. 11 gave 1.78, bore 8 gave 1.028 and bore 9 gave 0.87 lbs. per cub. yd., while the remainder yielded from traces up to 0.33 lbs. per cub. yd. On No. 2 line, bores 19, 21, 22 and 23 gave respectively 0.317, 0.121, 0.04 and 0.443 lbs. per cubic yd. On No. 3 line, bore No. 28 gave 0.524 lbs. per cub. yd. Excepting for No. 11 which appears to be in a parallel gutter or a bed of the main gutter, the values were obtained in or about the main gutter. Thus the possibility of extending the existing workings depends upon the existence of a narrow width of payable ground following the gutter of the Scotia lead. Some of the holes suggest payable values while others do not and it would appear that a boring campaign with closely spaced holes in and near the gutter is necessary to determine if any extent of payable ground exists.

The mine could only be worked with water from the

Mt. Cameron Water Race (either from the Scotia branch race or by delivery by an inverted syphon from the race on the Gladstone side of the river) or pumped from the Ringarooma River. The existing workings were worked with a tail race going through a tunnel to the south-west into the Ringarooma River. This became long and owing to the fall of the gutter to the north, it was necessary to use hydraulic elevators near the face in order to bottom the lead. It is probable that a considerable advantage would be gained by bringing in a new tail race from the river to east of the mine. This would necessitate a tunnel some 15 chains in length, but the tail race would be shorter and might avoid elevators for some time, or would at least lessen the height necessary to elevate the material.

In addition to the deep ground of the Scotia lead, some of the shallow ground at the southern and western sides of the worked-out ground may contain sufficient values to enable it to be worked. Thus on the fall to Newhaven Creek, on the western side of the workings H. Roach put down 24 bore-holes. The ground ranged in depth from 4 - 9.5 feet, and the values from a little tin ore to 1 lb. per cub. yd. Two holes had value of 1 lb. per yd., six others had values between 0.5 and 1 lb. per cub. yd., seven others had values between 0.25 and 0.5 lb. per cub. yd., and five more between 0.1 and 0.25 lbs. per cub. yd. With a water supply some at least of this shallow ground would be profitably worked.

Newhaven Mine

(This name is given to the old Scotia workings at the head of Newhaven Creek, and north of the main Scotia face). The ground is unleased at present but a small part of the workings is included in the Scotia lease (10857/M).

The deposit is generally similar to that of the Scotia lead in that it consists chiefly of sandy clay, clayey sand, and granitic quartz drift. A typical section is:

- 2' Soil etc.
- 2' Sandy clay
- 10' Granitic quartz drift
 - { White clayey sand (fine).
- 6' { Gravels
 - { Clay
- 3' Dark brown sand with some angular quartz pebbles.
Slate bottom

In a few places gravels with well rounded quartz pebbles occur at the surface.

The ground is for the most part 25 to 30 feet deep and bottom is generally visible, but in some places holes suggest the use of elevators that have worked deeper ground. The general appearance does not suggest a gutter, but one may be present. A high bump of bottom in one of the heads of Newhaven Creek, separates this ground from the deep ground of the Scotia lead. Numerous private bore-holes have been put down ahead of the N.W. part of the workings and are stated to have proved 30 to 40 foot ground. On the plan a lead is shown trending to the north-west, but its presence and course are somewhat problematical.

The tin ore is mostly fine, but pieces up to one-sixteenth inch also occur. The coarser tin ore is dark coloured, and the finer contains red, brown and a considerable amount of fine yellow.

The production from this face was probably not separated from that of the main workings, and no records exist. In 1901, Mr. Twelvetrees stated that Mr. Galloway has obtained 5 tons of ore from the workings.

The deposits extend to the north and north-west in the direction of the No. 5 line of Government bores. According to Twelvetrees (1901) the shafts ahead of the workings did not prove payable ground but it is stated that they were not bottomed. The private boreholes immediately ahead of the faces are also said to have given poor results. No tin values were obtained in the Nos. 1 to 14 Government bores, so that on the whole it does not appear that any extent of payable ground exists ahead of the workings.

Water from the Doone or the Scotia branch races is the only possible water supply. The tail race would have to be brought in from Newhaven Creek. Eventually elevators would be necessary to treat the bottom layers.

Doone Mine.

(Lease 9711/M and adjacent forfeited leases). This mine is situated one mile west of the Scotia mine and includes several workings. The most westerly are those of the Doone syndicate, the central being those of Richards and Murray, and the most eastern those of P. Cross and others.

The deposit worked consists of one or two leads or gutters. The main gutter was worked in the old Doone mine and judging by the bores appears to be north of, and parallel to, the workings of Richards and Murray. The bores have proved it to exist still further east where the small workings (really tail races only) just reached the edge of the gutter without being able to bottom same. Richards and Murray's workings were on an almost parallel tributary or a loop of the main lead.

The material is for the most part a granitic quartz grit containing in places a considerable amount of muscovite. Irregular and thin layers of pebble beds are interbedded with the grits. Larger sub-angular pebbles and boulders are found on the bottom where also the tin ore is concentrated. The depth of ground worked ranged up to 30 feet, with a slate bottom.

There are no records of the production from the Doone workings. The mine was worked as long ago as 1885, and was also actively worked between 1893 and 1898. Richards and Murray began their workings in 1917 and continued for some years. Since the water was diverted in 1922 there has been no opportunity to work the mine, although it was held under lease at the present time.

This lead comes to the surface at the western end of the Doone workings and cannot be traced further as it has been removed by denudation. Roach's boreholes (1917) prove its extension to the east of Richards and Murray's workings. The other workings were merely tail-races brought in to work the ground, and while they reached the edge of the ground, they did not bottom the gutter. The lead will continue further east, but it has not been traced in that direction.

The values as revealed by Roach's boring are not encouraging as only Nos. 4 (0.2 lbs./yd. though possibly not bottomed), 10 (0.495 lb./yd.), 12 (0.23 lb./yd.)

21 (0.26 lb./yd.), and 22 (0.25 lb./yd. - afterwards proved not to have been bottomed) gave appreciable values, the remaining 31 bores have given "nil", "traces", and "colours". The question of boring this ground, however, is rather difficult as the values are apparently confined to the gutter and the gutter is narrow, so that bores would need to be in the gutter to give reliable values. If the bores which gave values Nos. 12, 21, and 22 have been proved to have been in or near the gutter (No. 22 actually finished on a boulder 5 feet above bottom) and have been worked away with results probably better than the bores indicated. Nos. 4 and 10 are in deep ground indicating the nearness of the gutter. While the remaining bores to the east do not indicate payable results it is worthy of note that private holes have been put down and the ground has apparently been leased by G.S. Mallison as a result.

This ground can only be worked by water from the Doone branch of the Mt. Cameron race. At least four small dams exist in the vicinity all of which could be used in connection with the working of the mine. The problem of bringing in a tail race sufficiently deep to bottom the gutter and to avoid elevating the material is not an easy one. Three tailraces were used for the old Doone workings, while Richards and Murray had one race which did not however bottom the main gutter. The other two attempts were not sufficiently deep to bottom the gutter. A much deeper race than any of these will be necessary. It is suggested that the gully which heads near the south-east corner of lease 9711/M should be bored in order to ascertain if this offers a cheaper means of obtaining a suitable race rather than deepening one of the others, the bottom of which is already in slate.

Workings south of the Doone mine

Five small workings exist between the Doone and the river. These range in depth up to 12 feet and have generally exposed the same kind of material. The ground consists of gravels composed of water-worn pebbles in a fine reddish grit. It is generally similar to that at the south end of the Scotia and probably represents the remnant of a terrace of the Ringarooma River. The smallness of the workings suggest the absence of payable wash in anything except small quantities.

G. Watt's Workings

These are situated on the east bank of the river and 30 chains south of the Doone mine. These are situated in the alluvial flat of the river and are stated to have contained shingle. Twelvrees (1916) states that nice tin ore was won from here until the ground became too heavy some 30 or 40 feet down. The deposit represents the shingle and alluvial deposits of the Ringarooma River. Work has not been carried on for many years and the workings are filled with water. This deposit cannot be worked without elevating the material.

Working North of Doone Mine

A small working exists about 10 chains north of the Doone. The deposit consists of layers of gravel with rounded pebbles interbedded with grits composed of quartz and feldspar. The beds dip to the centre and represent the infilling of a valley 1 to 2 chains wide. The lead has a bearing of 315° and is some 30 to 50 feet lower than the Doone. It does not appear to have any connection with the Doone lead, but has probably been formed by one of the tributaries of the Ringarooma River, e.g. the small creek shown on the plan.

Black Duck (Barnes & O'Neil)

This working is situated on the east bank of the river immediately west of the Black Duck Lagoon. The ground worked occupied a flat some 10 feet above the water level in the lagoons. The workings are now filled with water, but in the banks can be seen fine and coarse gravels and some sandy beds. The deposit represents gravels &c. formed by the Ringarooma River, and a total depth of 20 feet was worked. Work ceased about 1899 and has not been resumed since. No record of production is available, but it was stated that men made wages until the price of tin fell.

The flat has a small extension to the north and a greater one to the south. No idea can be given of the tin values, because although the ground was bored by Roach in 1917, the plan and results appear to have been lost.

The ground, being at and below river level, cannot be worked without the use of elevators. A water supply could be obtained by pumping from the river or from the Mt. Cameron race.

Wainwright's working

This working is situated in the north-east part of the forfeited lease 9998/M. The working is a long and narrow one and opened up a face about 30 feet deep, but only a small quantity of the deep ground was worked. A section of the ground is as follows:

1' Soil
 2' Cement
 5' Sandy clay becoming gritty and gravelly.
 5' Yellow sand
 Granitic quartz grit approaching a fine
 At least 10' gravel. A few thin pebble beds with
 rounded and angular pebbles of quartz & quartzite
 No bottom exposed.

The ground is generally similar to that of the Great Northern Plain deposits. It probably represents the infilling of a valley or a lead. Its extension to the south-east has been denuded and it is possible that it may have been connected with the Doone lead. To the north-west it probably continues to Richardson's workings. The ground has not been bored by the Government, and while the line of private bores shown on the plan should have intersected the lead, the results are not known.

These workings were carried out by Wainwright about 1906, but the results are not known. It is stated that, with a good supply of water, the ground could be worked.

It is difficult to tell, owing to the fallen-in state of the workings, whether the ground was bottomed at the face. In any case, even if it was bottomed, the tail race is as low as possible and elevation would be necessary before the workings had progressed very far. The mine was worked with water from the Mt. Cameron race.

Richardson's Workings

These are situated on the east bank of the Ringarooma River, near the southern boundary of forfeited lease 9997/M. The workings are roughly circular in shape being 5 to 6 chains long, 5 chains wide and 50 feet deep at the face. A typical section of the ground is:

1' - 2'	Soil
1' - 3'	Cement
30' - 40'	Fine grits and gravels, and pebble beds. The grits and gravels contain much granitic quartz and small quartz pebbles, with some felspar and pieces of granite.
10' - 15'	Sand, sandy clay (micaceous) passing up into a pebbly bed.
1' - 3'	Coarse wash with pebbles of quartz and quartzite. Slate bottom.

The high reef (slate) is showing in a tail race on the southern side, while it also outcrops on the northern side of the creek, north of the workings. It is evident that the deposit represents a lead or infilling of a valley. Although differing in section from Wainwrights, it is composed generally of the same material and apparently represents the continuation of the same lead. The extension to the west has been eroded away by the river. The question of values has been discussed above in connection with Wainwright's workings.

The tail race was brought in from the level of the lagoon and apparently bottomed the deposit as far as the workings proceeded. In any further work to the east, it would be necessary to elevate the material. The mine was worked with water from the Mt. Cameron race, using the Black Duck Dam and a small dam above the workings.

Faces North of Richardson's Working

Four small workings exist on the steep eastern bank of the long lagoon parallel to the Ringarooma River. The bottoms of these workings are 20 to 30 feet above the lagoon and consist of slates and quartzites in the three southern ones and granite in the northern one. The material consists of coarse and fine gravels with granitic quartz grit and fine sand, forming a deposit 20 to 25 feet deep. In 1917, Roach put down five bore-holes in a north-south line, 1 to 2 chains east of the southern workings. These proved ground to exist with a depth of 25 to 30 feet and composed of wash, gravels and sands as described above. The workings and the bores prove the deposit to be a horizontal deposit on a level bottom resembling a terrace deposit. While suggesting a terrace of the river, the fact that these deposits are continuous with those of the Canary, Beltz, and other workings suggest that they are deposits of the Great Northern Plain. The values in the bore holes were only a "little tin", and this coupled with the small extent of the workings strongly suggest that the ground does not contain payable values in this vicinity.

Canary Workings

These include a group of three workings south-west of the Government No. 1 Reservoir and immediately south of the track to the Macgregor and Aberfoyle Mines. The eastern face is the largest and was known as the Roy face. The workings are situated on the eastern bank of the alluvial flat now covered with the Macgregor and Beltz tailings, and the north bank of the small west flowing creek which enters the flat. The ground is 20 to 30 feet deep and has a soft granite bottom. The material consists of alternating layers of fine gravels and grits, coarse sand, fine sand, and gravels. The gravels or pebble beds are restricted to the upper 10 feet and consist of rounded pebbles of quartz &c. The fine gravels predominate and consist largely of granitic

quartz. Scattered pebbles and thin irregular pebble beds occur in the fine gravels. Excepting the gravels near the surface, the material suggests deposition under marine or estuarine conditions, the sediments being derived from granitic land surfaces. The deposit forms part of the Great Northern Plain and extends to the north and west.

No boring has been carried out in this vicinity and the workings are old and the faces fallen-in, so that no opportunities offer for testing. Twelvetees in 1901 stated that the ground contained a little fine tin ore, but that work was unremunerative. The extent of the Roy face suggests that some at least was payable or nearly so.

These deposits could be worked with water from the No.1 Government Reservoir, but the pressure would not greatly exceed the depth of the face. The tail races are as low as possible and if work progressed, it would be necessary sooner or later to elevate the material.

Workings between the Canary and Beltz Workings

Three small workings occur close together in this vicinity. The easternmost is in the south-western part of lease 7169/M and was worked by Taylor about 1916. The other two are south-west of the above, one being on either side of the small creek, and were formerly worked by Chinaman.

The workings are 10 to 20 feet deep and the deposits opened up are those of the Great Northern Plain. In these workings however the upper layers include 10 feet of gravels, which are not so common further to the north-west. Sand and fine grits and gravels underlie the gravels.

No boring has been carried out near this locality. The small extent of the workings rather indicates the unpayable nature of the ground. The ground could be worked with water from the No.1 Government Reservoir.

Beltz Workings

These workings are situated on forfeited leases 7037/M, 7038/M and 7092/M. The ground formed part of the level surface of the Great Northern Plain. The workings range from 8 to 10 feet in depth, but the tailraces especially that at the south-west end are much deeper. The ground worked consisted of:

1'	Soil
1' - 2'	Cement
1' - 3'	Sand
3' - 5"	Fine gravels passing into
1.5' - 3'	Wash

Pebbles are not numerous, but occasionally a thin bed occurs beneath the cement, while a few pebbles in the fine gravels form the wash. The bottom worked to was a fine sand, and the tail races show sands, fine gravels and pebble beds to extend to depths of 10' - 20' without bedrock being exposed.

These workings were commenced by H. Beltz about 1911 and carried on by him for a number of years, when operations were continued by Messrs. Ogilvie and Packett until the water

supply was cut off in 1922.

In 1917, Roach put down 39 bore-holes in this vicinity. Of these 23 holes were arranged in 3 lines ahead of the face at that time. Since then 19 of these holes have been worked away, the ground having had values between 0.50 and 1.30 lbs. per cub. yd. Of the holes that have not been worked away six are left on the western side, while a line of six exist on the eastern side. Those on the west side have values ranging from 0.11 to 0.39 lbs. per cub. yd. with an average value of 0.27 lbs. The line on the east has values from 0.10 to 0.34 lbs. with an average of 0.2 lbs. per cub yd. Another line of 10 holes was sunk 10 chains north-west of the face, and proved ground 9 to 12 feet deep on a sand bottom, with only a trace of tin ore. However a line of six holes put down by Mr. Carey at right angles to Roach's line, gave depths (to solid bedrock of weathered diabase) of 24, 25, 25, 26, 25 and 47 feet (thus indicating deep ground to the north-west) and an average value of 0.5 lbs. per cub. yd. (figures supplied by Mr. Carey). This line extends to a distance of 11 chains from the face.

This ground extends to the north and west as far as Foster's private property and also into the latter.

The mine was worked with water from the No.1 Government Reservoir a long pipe column being laid from the latter and was worked up till the time the water was cut off. The tail races bottomed the ground, i.e. to the sand bottom below which it is stated that values do not exist, and will continue to do so for some distance, the soft sand greatly assisting the cutting of these races. If the workings progressed, it would ultimately be necessary to use elevators. Elevators would be needed much sooner if the ground be worked down to the solid bedrock.

Macgregor Mine

The workings of this mine are south-west of Beltz working and there is only a very narrow strip of ground between the two. The ground has not been leased during the last year or so, but two applications for lease have recently been made.

The ground has been worked to a depth of 16 feet, the bottom for the most part being a fine sea sand. In the older workings, the ground consisted of 1' soil, 2' cement, 8' to 13' sand (somewhat clayey) with fine gravel and a few thin pebble beds. In the most southern tailrace the sand forming the bottom gives place to at least 6 feet of laminated clay stained black and red at the top but becoming white towards the bottom. Going west from the old workings into the more recent ones of Mallison & party the sand bottom is also replaced by what was described as a clay bottom but which is found to consist of a boulder clay containing numerous boulders of completely weathered diabase, and also in places of a bedrock of completely weathered diabase. This diabase represents the north-eastern extension of that which outcrops along the east bank of the river to the north-west of Aberfoyle Hill. In the southern end of the old workings and in the more recent ones, the sand, clay and boulder clay contain numerous boulders of a sugary quartzite up to five feet in length. These boulders as well as those of diabase were derived from Aberfoyle Hill (a solid hill of quartzites, slates and diabase, and not a made hill as reported previously) and the deposits represent those formed on the beach of Aberfoyle Hill which arose as an island out of the former sea of estuary.

The ground below the workings was tested by a

Government line of 4 bores in 1902. The deepest bore was 58 feet and the shallowest 10 feet below the working. There is some doubt as to the numbering of the bores but in any case, the depths indicate a gutter between Aberfoyle Hill and Carey's line of bores to the north. In addition to this line, Roach put down 127 bores in 1917 to the south and west of the workings. Mallison's workings approached some of the bore-holes, but none have been worked out. Of the 25 holes to the south of the workings, only one gave any appreciable value (0.45 lbs) the remaining results being a trace or nil. Of the 102 holes to the west of the workings, four holes gave over 1 lb., six gave between 0.5 and 1.0 lb., 14 gave between 0.25 and 0.50 lbs., and 26 gave between 0.1 and 0.25 lbs., per cub. yd. The values are not distributed in any regular way, except that the holes with the above values exist immediately to the west of the workings.

Good prospects can be washed from the face of Mallison's workings and from material out of shafts west of the face. The tin ore is restricted to the bottom three feet of "wash" and sometimes the coarse sand above. It is fine in grain and is generally brown in appearance due to a mixture of black, ruby and amber ore, and assays up to 74.5% tin. Pleonaste is present in pieces up to $\frac{3}{8}$ " or $\frac{1}{4}$ ", but there is no gold associated with the tin ore.

Mallison's workings are stated to have yielded 37 tons of tin ore. It is also stated that this gave a return of about $1\frac{1}{2}$ lbs. per cub. yd., while one "run" of 14 tons was from ground averaging 3 lbs. per cub. yd.

The old Macgregor workings were carried out by means of the numerous tail-races on the eastern side. In the workings of Mallison and others, a power plant was used for elevating and for a nozzle pump.

It would appear however that elevating was not absolutely necessary and that a tail race could have been brought in at a sufficient depth. Some of the ground ahead of the workings could certainly be worked with tail races, but eventually elevators would be necessary. Water from the Mt. Cameron Race is the only means of working this mine.

Aberfoyle Mine

The workings of this mine are situated on abandoned leases some 50 chains south of the Macgregor Mine. The ground has been worked since the early eighties by various individuals, companies, &c. The Aberfoyle Company held and worked the ground for many years, while You Hen and others held and worked adjacent ground, two of these old workings being known as the Sea-Shell and the Boomerang respectively. In 1906, the New Aberfoyle company began active operations and was succeeded by the Aberroe Tin Mining Co. N.L. in 1909 (the company does not appear to have been registered however until 1912). Work continued until 1916 the workings being extensive and connecting up the old faces with the result that there are now three main workings. These will be described as the Eastern, the Main, and the Western or Curnow's workings.

The Eastern workings are 20 chains long and up to 8 chains in width, and cover some 10-12 acres. Tail races were brought in from the eastern and south-western sides. The depth ranges from 10 to 20 feet and averages 12 to 15 feet. The average section is:

1'	-	3'	Sandy soil
0'	-	3'	Cement
5'	-	6'	Sandy beds (sands, fine gravels and clays)
1'	-	6'	Wash (water-worn pebbly beds).

The bedrock is visible everywhere excepting the northern end and the central tail race on the eastern side where sea sand extends down to tail race level. The bedrock is soft, weathered granite except at the south-eastern corner where the Cambro-Ordovician slates and quartzites occur. This ground generally represents a terrace and while some of it represents a continuation of the deposits of the Great Northern Plain, some of the southern portions may have been formed by the Ringarooma River.

The main workings are roughly 27 chains long (north to south) and 10 chains wide with an irregular extension to the west, and embrace the old Sea Shell and Boomerang faces. They are shallowest (6 to 8 feet) in the Sea Shell and deepest (35 feet) in the narrow workings on the west, but the greater part of the workings have a depth of 10 to 15 feet. The ground below the soil and cement consists of fine gravels, clays and sands with generally a few feet of gravels (with rounded pebbles) on the bottom. The bottom consists of the soft weathered granite bedrock which is everywhere exposed except in the old Sea Shell workings and the main tail race at the north-eastern corner, sea sand occurring to the greatest depth reached in the latter. In the northern part of the Sea Shell the bedrock dips sharply to the north and is suggestive of deep ground (the Aberfoyle lead) under or just north of these workings.

The irregular workings on the western side show much deeper ground. In the deep tail race, the ground is 35 feet deep, and beneath the soil and cement there is about 20 feet of sand, overlying dark laminated clay beds. The lowest bed consists of several feet of gravels (with round sub-angular pebbles) or dark sandy beds containing similar pebbles. Similar, but shallower ground occurs in the workings to the south-west. The occurrence suggests a lead or filled-in gutter trending to the north-east and passing between the Sea-Shell and Curnows workings.

The western or Curnow's workings cover about 5 acres and are 50 feet deep. A section on the south side shows:

1'	soil
6'	Fine gravels
2'	Coarse sand
4'	Fine gravels becoming pebbly at bottom
10'	Fine sand
20'	Not visible (probably sand passing down into clays)
10'	Black laminated clays and clays with pieces of the laminated clay and sub-angular pebbles. Stained brown yellow sand.
	No bottom visible.

On the north side, two feet of angular wash are visible beneath the black clay, then sand and grits, with no bottom showing. In the western part of the workings, granite bottom is showing and rises towards the north. A short distance north of the workings the slates of Aberfoyle Hill outcrop at the surface. This deep ground apparently forms part of a lead with a general W.S.W. - E.S.E. trend, and forms part of the Aberfoyle lead referred to above. The direction

in which this lead is falling is not determinable. The deep ground in the western part of the main workings is a tributary of the Aberfoyle lead. The tin ore from the bottom of Curnow's workings is stated to be coarse in grain size, thus indicating a different source to other deposits on the Great Northern Plain. This deep ground can only be worked by tail races from the western end and it would appear that they had bottomed the ground as far as possible so that elevators would shortly be needed.

There is no record of production from these workings until 1906. From 1906 till 1916, the New Aberfoyle and the Aberroe companies produced 129.3 tons of tin ore, the greatest annual production being 22 tons in 1910. From figures supplied by the company, the values of the ground treated were:

1909	0.8 lbs./cub. yd.		
1910	0.80 "	"	"
1914	0.535"	"	"
1915	0.580"	"	"
1916	0.617"	"	"

There has been no Government bores put down near these workings and the results of private bores are not known, so that it cannot be stated whether any payable ground still exists.

The ground was mainly worked by water brought in from the Boobyalla River and across the Ringarooma River by an inverted syphon. It has also been worked by water from the Mt. Cameron race. Races are cut round both the west and east sides of Aberfoyle Hill. A good storage dam exists on 1059/W at the eastern end of Aberfoyle Hill.

Private Property (John Foster, 625 acres. Lot 115)

This property occurs to the west and north of the Macgregor workings and occupies portion of the Great Northern Plain. Until the passing of the Mining Act, 1929 this property was not available for mining, as it was alienated prior to 1893 and the owner would not permit mining operations. There has therefore been no mining on it, but a few old prospecting shafts exist.

The same class of country (sandy soil with fine gravel and sands beneath) continues from the Macgregor mine west and north-west into the southern part of the property. Two shafts near the southern portion showed on the dump material similar to the Macgregor, and which yielded in dish prospects results of approximately 0.5 lb./ cub. yd., the tin ore being similar to the Macgregor. Another shaft further west gave smaller results, but the prospect showed two colours of gold. Another shaft still further west and near the edge of the plain was in nearly pure sand and gave a poor prospect. It will be noted that some of Roach's bores within 10 chains of the boundary gave results up to 1 lb. per cub-yd. while Carey's bores further north-east are stated to have averaged 0.5 lbs. per cub. yd. It thus appears likely that some payable ground exists on the southern part of Foster's block. Farther prospecting and boring would of course be necessary to determine the position, extent and value of such ground. As workings progressed from the Macgregor, they would indicate the position of such ground. If worked from the Macgregor or eastern side, it would be necessary to elevate the material.

Tailraces brought in from the river on the west would bottom the ground for a certain distance, but it would be necessary to locate them so that the hard diabase would be avoided and thus eliminate costly excavation. Water from the Mt. Cameron Race could be used to work this ground, the Aberfoyle part of the race being very close to the ground.

In the centre of the block, two other old shafts exist. The surface in the vicinity contains numerous pieces of hard siliceous conglomerate, but one of the shafts prove these to be "floaters". The conglomerate has therefore either been formed in situ by silicification or shed from an adjacent island in the old estuary. One hole is over 20 feet deep and the other appears to have been partly filled in. The dump of the latter contains pieces of chalcedony, agate &c. (all pointing to silicification) as well as pieces of tin ore up to $\frac{1}{8}$ inch diameter. Thus the conditions here are somewhat different to those at the Macgregor and adjacent parts of the plain. Further prospecting is therefore warranted. This ground would have to be worked by tail races from the west, cut along the courses of the open creek valleys (mainly a line of lagoons) in this locality. It could be worked by water from the Mt. Cameron race or possibly by the old low level race (172/87W) though the pressure head would be lower in the latter case.

Private property (500 acres A.C. Ayton, Pur.).

This property was purchased in 1912 and so has always been available for mining but only a small amount of prospecting has been carried out on it. This work was confined to the extreme western corner adjacent to Foster's property, and is situated on the northern bank of Stinking Creek near the ford on the old track.

The prospecting shafts were sunk in the floor of the creek valley and also on the higher ground to the north. A shallow excavation also exists in the valley floor, the material having been cradled or boxed. The excavation shows coarse gravels with water-worn pebbles up to 6" diameter. Prospects yielded fine tin ore like that of the Great Northern Plain only somewhat coarser. It is possible that these gravels are recent ones formed along the creek.

The shafts on the bank show sea-sand, and in one case granitic quartz gravel. From the pebbles on the dump, some gravels must occur beneath the sand. The prospects vary some being of a payable nature. Solid bedrock was not reached anywhere. This ground has always been considered as the extension of the Lochaber lead. No doubt the continuation of this lead/somewhere near this area, but the gutter, if it still exists, must be 50 to 100 feet below the surface and the bottom wash is not available.

Summary of Information of Ground

The above descriptions show that a considerable amount of boring and testing has been carried out in the vicinity of the old workings and also in the district generally. This boring has shown that payable ground exists in the vicinity of the Macgregor and Beltz workings, Doone mine and Scotia mines. The largest area is near the Macgregor and Beltz workings where many bores have been put down. This ground could be readily worked the only slight disadvantage being that eventually it will be necessary to use elevators.

At the Doone mine, only one payable hole remains, but owing to the narrowness of the gutter, other payable ground may have been missed because of the spacing of the bores.

At the Scotia, some payable holes occur in the lead ahead of the face, but altogether it does not appear that it would be possible to work the whole of the lead at the present prices. Shallow but payable ground also occurs on the western side, but is only suitable for an individual or party.

At the Lochaber, the bottom wash is rich and may continue so for some time. The recent attempt to work the lead does not appear to have been successful, but with a more plentiful water-supply or other means of elevating, the position might be different.

The Aberfoyle ground has not been tested by boring so it is impossible to state if any payable ground exists there.

In addition to the above there is the possibility of payable ground existing on Foster's and Ayton's private property, which require testing to prove or disprove same.

Apart from actual proved ground tin ore can be won from old workings by fossickers who with a water supply treat old bottom, tail races, edgings and even virgin ground.

Thus if water supplies were available per medium of the Mt. Cameron race, tin ore could be won at several places within the district, the best place being the Macgregor country. It will be noted that leases are held at the Scotia, Lochaber, and Doone mines while applications have been made for two leases at the Macgregor.

While it may be stated that payable ground exists, the information is not sufficient to state the area and value of such ground. In order to obtain such information it would be necessary to conduct a boring campaign extending over a period of approximately six months. Such a campaign could be designed to advantage as the result of the present survey.

In general it may be stated that the possible extent of ground is greater and the ground deeper than that under other portions of the race. Thus there is more scope for extensive mining operations than in many other parts of the district.

General Discussion

The question of replacing the syphon suggests an enquiry as to (1) What the position was before it was removed, (2) Why was the payable ground not being worked before its removal, and (3) What circumstances have altered in the

meantime.

- (1) There was very little working being carried out before the removal of the syphon. Thus water was last used at the Doone in February, 1920; at Scotia Flat in February, 1921; at Newhaven in July, 1921; and at Beltz workings in May, 1922.
- (2) It is difficult to state the reason that the payable ground was not being worked prior to the removal of the syphon. One possible reason was the large fall in the price of tin from 1918 (£329) till 1922 (£159). Another one was the disinclination of mines to work at distances from their homes in the township if payable ground nearer home was available. It will be noted however that Beltz workings were being worked by Packett and Ogilvie right up till the time of removal of the syphon.
- (3) Certain circumstances have altered since 1922. The price of tin is now lower than it was in 1922, but against this the charge for water on the royalty basis has been reduced from 25 to 15 per cent, the charge under fixed scale being the same as previously.

The miners have gradually accumulated large stocks of pipes &c. so that when combined in small parties they can install long pipe lines and are thus in a much better position to treat ground such as that on the Great Northern Plain.

The Mining Act of 1929 has considerably altered the position by making private property available for mining purposes. Thus Foster's private property to the north-west of the Macgregor and Beltz workings becomes available for mining.

The question of replacing the No. 6 syphon depends principally on the area and value of the tin ground which can be treated by water from the race. The latter factor has been discussed above in the light of all available information. From the economic view-point the ground should of course contain sufficient tin ore to reimburse the Mt. Cameron Board for the expenditure involved plus interest and working costs.

The State Mining Engineer's estimate of a syphon of 15 inches diameter and 16 gauge iron is £660. The Board receives a royalty of 15% and the present price of tin ore is £80 per ton, the royalty being reckoned on a net return of approximately £75 per ton. Thus one ton of ore yields the Board £11.25. Using the round figure of £11, the ground would need to yield 60 tons to reimburse the capital expenditure. To cover the interest a yearly output of 3 tons would be necessary while it is impossible to calculate the output necessary to cover the proportion of management &c. chargeable to that portion of the race if operated. Assuming the capital expenditure to be returnable over a period of 15 years, it would be necessary to win at least 7 tons a year for 15 years to provide for the capital and interest. This implies that a production of at least 105 tons would be required. Such a quantity could be obtained from 10 acres of ground 12 feet deep with a value of 1 lb. per cub. yd., or 20 acres of 12 feet ground averaging 0.5 lbs. or 40 acres of 12 foot ground averaging 0.25 lbs. per cub. yd. With the information available it is impossible to state whether such areas exist and a further boring campaign would be necessary to determine this matter.

There is another aspect other than the strictly economic one. Gladstone is almost solely dependent on tin-mining and if ground and the water to work same, are not available, portion of the population will be without means of earning a livelihood and might become a charge on the State. Under such circumstances it might be advisable to undertake the capital expenditure without requiring return of same as a result of the working of the ground. Thus a smaller area of payable ground need only exist and such would be more likely to occur and possibly need not be verified by a boring campaign.

Instead of replacing the syphon another proposal has been made viz. to build a sod wall 10 feet high along the syphon site and cut a low level race along the fall to Stinking Creek to deliver the water into the No.1 Government dam or the Black Duck dam. This race would serve all mines except the Scotia and Doone. Its approximate cost would be £500 (£100 a mile for 3 miles of race, and £200 for the sod wall), but a survey would be necessary before an accurate estimate could be made. Unless it were found that the difference in cost was large, it would be preferable to replace the syphon instead of building the wall and cutting a new race. With the syphon, all the existing races could be used, and water delivered to all parts of the district.

The question of replacing the syphon is also connected with a number of other problems which should be decided in accordance with the general policy of the Mt. Cameron Water Race Board:

- (1) If the syphon be replaced, and several workings commence, the Board will probably have water running through a much greater length of race than ever before. This will entail losses due to wetting of greater length of race, greater evaporation, greater leakage &c. This would be a distinct disadvantage when the water-supply is low in the dry periods.
- (2) If during any period particularly that when the rainfall is low, the water supply is not sufficient to provide an adequate supply to water-users under existing portions of the race, it does not seem the correct procedure to make further extensions of race the effect of which would be to make the supply more inadequate than at present. This position might be partly relieved by users moving from their present locations to others under the new extension, but this does not greatly affect the principle involved. This matter could be remedied by insisting that all ground under certain portions or extensions of the race should be worked out before supplies to other portions of extensions will be considered. This might be difficult to carry out, but is a very desirable objective
- (3) Since the Nos. 5 and 6 syphons were removed, the No.5 has been replaced by a cement one (18" diam.) which will allow 18 sluice heads to flow through. By extending this at the intake and a maximum of 21 sluice heads would flow through. It is therefore obvious that it is useless to put in a syphon at the No.6 site to take more than this quantity. The minimum size of syphon would be determined by the water to be used beyond it. It is difficult to anticipate this, but with 3 or 4 mines working it would be necessary to have the full quantity available (18 to 21 sluice heads). This includes water for the Lochaber, as such water would

probably be taken from the Scotia branch race in order to avoid the long pipe column necessary if taken from the head of the No.6 syphon. The ground under this portion of the race is deeper than that on the western side of the river, and as in most places elevation will be necessary at present or when the workings progress a relatively short distance, it is essential that an adequate water supply should be made available. Thus the question of the size of the syphon is important and consideration should be given as to whether it should not be such as to enable the maximum quantity of water coming through the No.5 syphon to be carried.

It is worthy of note that from 1891 to 1931, excepting 1923-25, the production of tin ore by water from the Mt. Cameron race has been 2,722 tons or approximately 2% of the total production for the State or 2.76% of the production for the same period.

Conclusions and Recommendations

The above descriptions have shown that there is some tin-bearing ground on the Great Northern Plain that could be worked if a water supply were available. It is therefore rather unfortunate that the water-supply was cut off by the removal of the Nos. 5 and 6 syphons in 1922. As the No. 5 syphon has since been replaced, it is evident that consideration should be given to the replacement of the No. 6 syphon.

If it is desired to consider the replacement from the strictly economic point of view then it is recommended that a systematic boring campaign be carried out in order to determine the extent and value of the tin-bearing ground. Such information would enable calculations to be made as to whether there is a sufficient ore to repay capital expenditure, interest, and costs of management and upkeep of race. Such a campaign could be laid out to advantage as a result of the recent survey. The boring campaign would occupy 3 to 6 months and would cost up to £300.

If it is not desired to consider the proposition from the strictly economic viewpoint, but rather from the point of view that the replacement of the syphon will tend to keep the local residents engaged in tin-mining, then it may not be necessary to undertake the boring. If boring is not carried out, the outlay which would have been incurred in same will form a large proportion of the cost of the syphon.

The size of the proposed syphon deserves special consideration and as large a one as possible (to take up to 18 sluice heads) should be installed. This is necessary because the ground ranges up to 16 feet in the Macgregor country, or up to 70 feet if the leads of the Lochaber and Scotia mines are considered, and more especially because the ground will have to be elevated either now or when work progresses a short distance beyond the existing working faces.

As regards the proposition of the sod wall and a new race, it is recommended that a level survey be made and estimates prepared before such a proposition should be considered. In any case the cost of such a scheme would not fall far short of that of a 16 inch syphon, and it would not serve the Scotia, Newhaven or Doone mines. If the cost is, as suggested above, close to that of a syphon, it is recommended that the syphon should be installed as it would be more satisfactory and would serve all mines that might possibly be worked.

The general question of the water-supply and the advisability of adding a further length of race from which water will have to be supplied, is one that should be considered by the Mt. Cameron Water Race Board.

P.B. Nye
GOVERNMENT GEOLOGIST.

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4/7/32.