COMMONWEALTH OF AUSTRALIA

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DEPARTMENT OF NATIONAL DEVELOPMENT

# BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS



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1965/183

METALLURGICAL RESEARCH INTO TIN ORE TREATMENT,

NORTH QUEENSLAND.

by

Mineral Industries Research and Testing Services,

Department of Mining and Metallurgy

University of Queensland.

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Records 1965/183

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## Introduction

These reports were made as part of an investigation into tin ore treatment problems in the area of North Queensland to the west of Cairns. The reports have been combined and issued in the Bureau's Record series so as to ensure an adequate dissemination of this information by way of the Bureau's "open file" system. They have not been altered in any way.

The geology of the area will be covered by the Herberton - Mt. Garnet Bulletin, a publication of the Bureau of Mineral Resources in the course of preparation. Reference may also be made to "Lode Tin Deposits of Queensland" by T.H. Connah and F. McIver on pages 379-383 of Volume 3 "Geology of the Australian Ore Deposits" in the Eighth Commonwealth Mining and Metallurgical Congress Publications.

The Summary and Conclusions Section has been placed before the four progress reports for the convenience of those seeking an outline only of the scope results and conclusions of this project.

UNIVERSITY OF QUEENSLAND

DEPARTMENT OF MINING AND METALLURGICAL ENGINEERING

MINERAL INDUSTRIES RESEARCH AND TESTING SERVICE

METALLURGICAL RESEARCH INTO TIN ORE TREATMENT, NORTH QUEENSLAND

CONTRACT C.506697: FILE NO. V.F. 295/5/11

# SUMMARY AND CONCLUSIONS

## 1. INTRODUCTION:

In 1964, an investigation into the treatment problems of several North Queensland tin ores was initiated.

It was generally agreed that the investigation be made to ascertain -

(a) the mineralogical composition and association of the ores; and

(b) their response to various types of treatment.

## 2. ORES FOR INVESTIGATION:

Samples of the following ores, arranged in order of descending grade as received, are as tabulated below. The size (B.S.S.) at which liberation is sensibly complete is also shown.

| | Ore | Sn % | Liberation Size B.S.S. |
|---|---|---|---|
| 1. | Rainbow | 18 | 150 |
| 2. | Bloodwood | 8.54 | 72 |
| 3. | Gilmore No. 2 | 6.1 | 350 |
| 4. | Gilmore No. 1 | 4.51 | 150 |
| 5. | Dover Castle | 2.75 | 100-150 |
| 6. | Lamb | 1.99 | 200-350 |
| 7. | You-and-Me | 1.94 | 150-200 |
| 8. | Lizzie | 0.97 | 72 |
| 9. | Great Southern | 0.80 | 150 |
| 10. | Iona | 0.51 | |

It is pointed out that some cassiterite is available for recovery at sizes coarser than that at which liberation is sensibly complete.

The ores may be classified into four grades -

No. 1 Rainbow ore at 18% Sn is a very high grade ore;

No. 2 to 4 Bloodwood and Gilmore ores are high-grade ores, 8.54 to 4.51% Sn;

No. 5 to 7 Dover Castle, Lamb, and You-and-Me are medium-grade ores, 2.75 to 1.94% Sn; and

No. 8 to 10 Lizzie, Great Southern, and Iona Ores are low-grade ores, containing less than 1% Sn.

## 3. SUMMARISED NOTES ON ORES AND TEST RESULTS:

Full details of the mineralogy of the ores and the test work carried out have been given in Progress Reports Nos. 1, 2, 3, and 4, and these are summarised briefly for the purpose of this final report.

### 3.1 Rainbow Ore

The main heavy mineral present is cassiterite, with minor amounts of pyrite, pyrrhotite, sphalerite and galena.

In the test work, the recovery of tin was carried out in stages. -10 mesh ore was fed to the jig; the jig tailings crushed to -22 mesh for tabling. The table tailings were re-ground for the production of an acceptable tailing.

The jig recovered 58.6% of the tin in a concentrate assaying 72% Sn.

The total recovery of tin was 95.3% in a concentrate assaying 58.9% Sn.

In the re-grind table tailing, 89% of the loss of Sn occurred in the -350 mesh fraction. The total tailings assayed 1.24% Sn.

3.2 Bloodwood Ore

The major heavy minerals present, roughly in order of their abundance, are - cassiterite, pyrrhotite, scheelite, sphalertie, pyrite, galena and chalcopyrite.

Two tests were made on the ore. In No. 1 test, the ore was ground to -52 mesh before tabling and, in No. 2 test, the ore was tabled at -25 mesh and the coarse tailings re-ground. The sulphides present in the concentrate were removed by flotation, with a loss of 1% of the Sn in the flotation product.

In test No. 1, 70.8% of the Sn was recovered in a concentrate assaying 51.0% Sn.

In test No. 2, 71.5% of the Sn was recovered in a concentrate assaying 53.1% Sn.

3.3 Gilmore Ore No. 2

The main heavy minerals present are pyrite, pyrrhotite, arsenopyrite, chalcopyrite and sphalerite. Some cassiterite grains are intimately mixed with light gangue minerals.

The concentration test on this ore was carried out by jigging at -10 mesh, stage crushing to -22 mesh, and tabling the sized products. The table tailing was re-ground and tabled for an acceptable tailing.

The jig recovered 24.1% of the total tin in a concentrate assaying 54.6% Sn and the tables recovered 45.4% of the total tin, making a total recovery of 75.6% in a concentrate assaying 51.7% Sn.

The coarse table concentrates were up-graded by grinding and re-tabling.

Little concentrate was recovered from the -350 mesh ore by tabling.

3.4 Gilmore Ore No. 1

This ore was similar to ore No. 2, but contained a greater proportion of fine material. The heavy minerals present were similar to ore No. 2, but the sizing for liberation was coarser.

No concentration test was made in it.

3.5 Dover Castle Ore

The heavy minerals present are sulphides, including pyrrhotite, pyrite, and chalcopyrite, with minor galena and sphalerite.

A concentration test was made by tabling ore crushed to -20 mesh.

The table tailings were re-ground and tabled. The concentrate was re-ground and floated to remove sulphides and re-tabled to produce a tin concentrate.

The concentrate contained 77.9% of the tin at an assay of 43-44% Sn.

The sulphides assayed 5.23% Sn and contained 7.1% of the total tin.

The tailings averaged 0.47% Sn.

The concentrate was up-graded to 58.4%, with the production of a middling assaying 25.6% Sn.

### 3.6 Lamb Ore

The main heavy minerals present are haematite and cassiterite, with small amounts of pyrrhotite and chalcopyrite.

The ore -22 mesh was tabled in stages. The concentrate was re-ground and re-tabled. The table tailings were re-ground and re-tabled.

The recovery of tin was 74% in a concentrate 48.2% Sn.

### 3.7 You-and-Me Ore

The major heavy minerals present are cassiterite, titan-haematite, ilmenit pyrite, and pyrrhotite, with minor sphalerite arsenopyrite and chalcopyrite.

The ore was tested in a similar manner to the Lamb Ore.

The concentrate assaying 44.4% Sn contained 73.8% of the total tin.

### 3.8 Lizzie Ore

The heavy minerals present are haematite and goethite, with some psilomelane.

The sink-float tests showed large quantities of heavy minerals of sp. gr. greater than 2.9.

Exploratory work only was carried out on this ore and this showed that the recoveries would be poor.

It would appear that some method other than tabling alone is required for this ore.

### 3.9 Great Southern Ore

The main heavy minerals present are earthy haematite and goethite.

The ore, ground to -52 mesh, was tabled. The concentrates were subjected to magnetic concentration and some magnetic material removed.

In the test, 49% of the Sn was recovered in a concentrate assaying 44.3% Sn.

### 3.10 Iona Ore

The sink portion of the sink-float tests contained a high proportion of heavy gangue minerals and, while identification was difficult, they contained iron oxides, manganese minerals and minor sulphides.

## 4. CONCLUSIONS:

Every ore presents its own problems, and this is certainly true with respect to the tin-bearing ores discussed in this and previous reports. Nevertheless, the main problem to be faced in the treatment of these and similar ores is that of the feasibility of their treatment in central, custom mills whose design must take advantage of similarities in the treatment problems while allowing as far as possible for their differences.

In most cases, reasonable recoveries could be obtained at grades which were rather low or "marginal" compared with those generally considered to be acceptable. In some cases, grades were extremely low due to concentrate dilution by heavy gangue minerals; these problems have not been solved in the current test work, and would require intensive study.

Dilution of concentrates by sulphide minerals can be overcome by flotation with little loss of cassiterite.

Obviously, the main difficulty lies in avoiding the over-grinding of ores - a practice which appears to be common (in the interests of the production of higher-grade concentrates), but which invariably, with a friable mineral such as cassiterite, results in "sliming" and the loss of tin.

If any general principle may be laid down, it is that the comminution units used should be such that unnecessary sliming is avoided, and that, in general, comminution should be carried out in stages with associated sizing devices, so that the feed to any gravity concentration step comes as short a size range as possible. Primary grinding should be by rod milling. The sizing device should be a screen where this is economically feasible, and a cyclone for finer size ranges. Concentration processes should take place upon feed as coarse as possible, even to the extent of including machines such as jigs within grinding-sizing circuits.

Shaking tables appear to be the most suitable concentrating machines for intermediate size ranges and, generally, table concentrates should be re-tabled for cleaning, with the cleaner tailings being returned to the rougher table or to re-grinding. The middlings from rougher tabling of the coarsest size range should be re-ground before re-treatment, probably by returning to the primary grinding mill. Generally, the grade of the tailings from the coarsest table also warrants their re-grinding and re-treatment. Coarse concentrates (for example, those from a jig in the grinding circuit and from the coarse table) may themselves require light re-grinding and re-tabling to improve their grade, but this probably will result in a higher recovery than that obtained if the whole ore is ground sufficiently to produce higher grade concentrates immediately.

Although no tests were carried out in verification because of the lack of suitable equipment, there is little doubt that the finest fractions of the ore would respond best to counter-current cycloning and the treatment of the underflow on vanners. Fine material lost from the vanners would be irrecoverable from a practical standpoint.

All of the above observations must be considered in the light of the size at which liberation of the cassiterite is achieved. Some of the ores tested as part of this project displayed satisfactory liberation only at sizes too fine to justify the inclusion of any machine which might recover a coarse concentrate.

The separation of sulphide minerals from gravity concentrates appears to be possible by blotation (recovering a sulphide concentrate), but the occurrence of heavy non-sulphide gangue minerals in other ores presents a very difficult problem. The controlled roasting of iron oxides to render them suitable for magnetic separation would be the obvious approach where the heavy gangue minerals predominate in this form, but the volume of work carried out through the period of the contract precluded the opportunity to investigate this aspect.

As yet, there is no flotation reagent combination available which may be used for the highly selective flotation of cassiterite. Although good recovery can be achieved, many other minerals respond to the reagents in the same way as does cassiterite, and low-grade concentrates result.

The possibility of the volatilisation of tin from low-grade concentrates is perhaps the other most promising line of investigation to be followed as a sequel to the above reports.

The main objects of this present project was the elucidation of the treatment problems presented by certain ores from North Queensland and, in particular, the manner in which available or standard equipment may best be employed to maximum effect in the recovery of tin. Much information about these specific ores is now available as a result of the test work, and the Department of Mining and Metallurgical Engineering is now in a position to offer detailed advice upon their treatment.

The over-riding pressure upon a tin producer in the field is the necessity to produce a concentrate of a certain grade. It is axiomatic that grade and recovery are inversely related, and that if lower-grade concentrates were saleable, recoveries of tin in ore treatment could be improved. It is possible that research into the recovery of tin from lower-grade concentrates by existing methods, or modifications thereof, may prove to be as fruitful a field of research, from the overall viewpoint of the efficient use of material resources, as that of ore concentration.

## 5. ACKNOWLEDGMENTS:

The authors wish to thank the sponsors of this research project for making it financially possible. In their view, it has proved stimulating and has provided a great fund of basic information from which specific advantages will certainly ensue.

UNIVERSITY OF QUEENSLAND

DEPARTMENT OF MINING AND METALLURGICAL ENGINEERING

MINERAL INDUSTRIES RESEARCH AND TESTING SERVICES

METALLURGICAL RESEARCH INTO TIN ORE TREATMENT, NORTH QUEENSLAND

CONTRACT C.506697 : FILE NO. VF. 295/5/11

## 1. INTRODUCTION:

After discussions in early 1964 between the Bureau of Mineral Resources, the Queensland Department of Mines and the Department of Mining and Metallurgical Engineering of the University of Queensland, an investigation has been initiated into the treatment problems and promise of several tin-bearing ores from Northern Queensland. This is covered by a Contract (C.506697) between the Bureau of Mineral Resources and the Mineral Industries Research and Testing Services of the Department of Mining and Metallurgical Engineering.

At the present time, ores are treated in the several "batteries" in the area, but no general survey of ore types, or of the anticipated response of the various ores to different methods of treatment, has been made. Further, because of shortage of capital and/or skilled labour, the operating batteries and treatment plants apply few accurate control or analytical techniques; control sizing and assaying are not carried out on a regular basis. Consequently, little is known about the extent or location in the various flowsheets of the losses of tin incurred during treatment, and the degree of comminution required to give good liberation of each ore has not been investigated microscopically. Indeed, it is generally accepted that, if there is any error in the degree of comminution imposed upon the parcels of ore, it is usually one of over- rather than under-comminution, and that losses of tin are an inescapable consequence.

It was generally agreed, therefore, that samples of several ores should be investigated in order to ascertain (a) their mineralogical composition and association (particularly with reference to the liberation required to give clean concentrates and good recoveries), and (b) their response to various types of treatment.

## 2. SURVEY OF AVAILABLE DATA:

Initially, a detailed survey of data relating to parcels of ore treated and of the concentrates recovered therefrom was made, and the most important of these ores, from the point of view of tonnage and grade, were placed upon a "short list". Other ores, of which there appeared to be no record of recent mining or shipment, were also considered.

Subsequently, Mr. R.O. Archbold of this Department visited the area and inspected all of the operating plants and many of the mines in the area. As a result of his discussions with operating personnel in the district, it was arranged that samples of the following ores should be shipped immediately to the Department for test work:-

1. Gilmore
2. Bloodwood
3. Great Southern
4. Lizzie
5. Lamb
6. You and Me
7. Rainbow

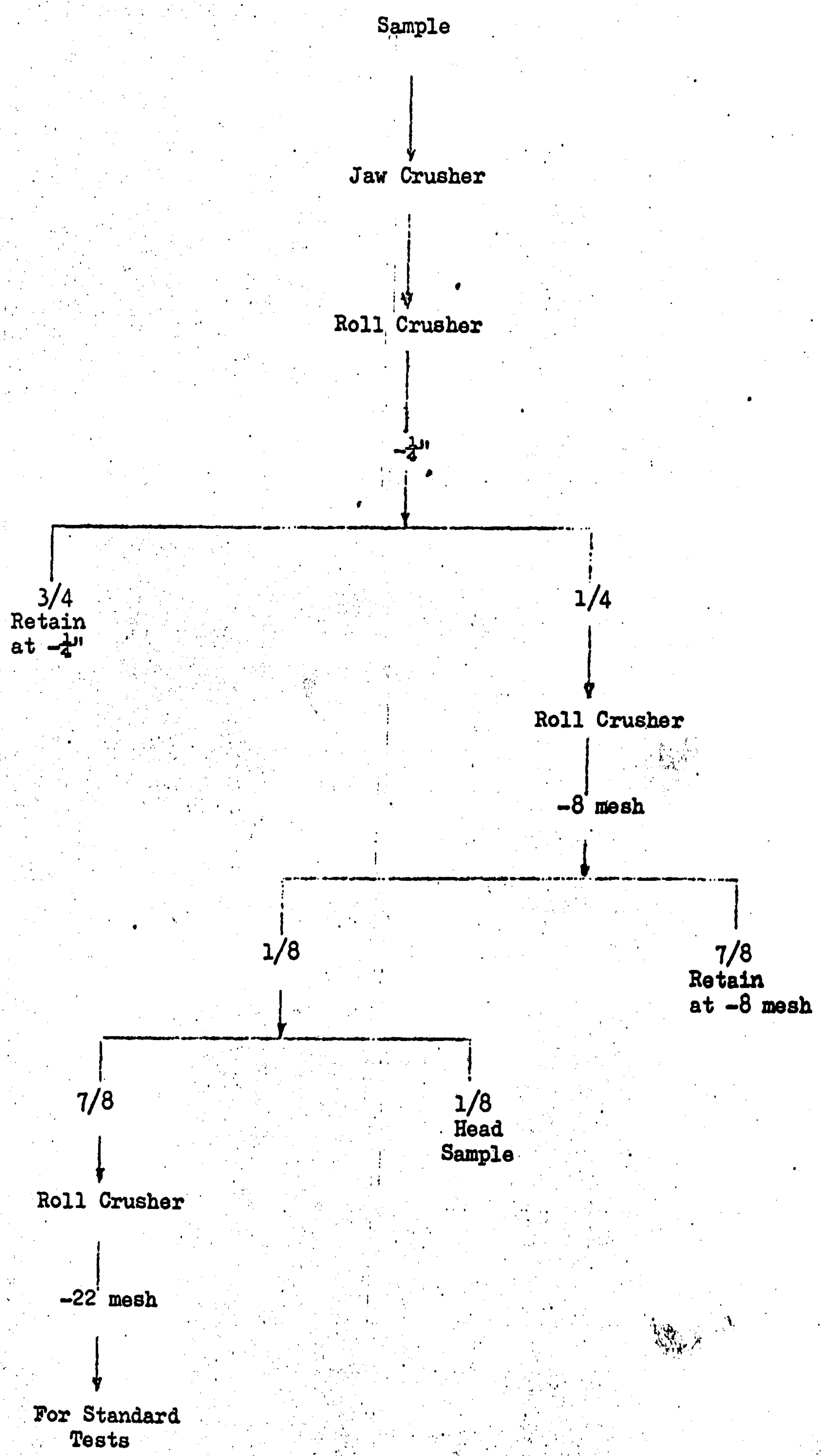
There was considerable delay between arranging for the shipment of these samples and their receipt in Brisbane, but, at the time of writing this report, the last of the seven samples had just been received.

## 3. TEST WORK - GENERAL:

Since all of the ores listed above are at present either treated in a gravity separation plant, or most likely to be treated in such a plant, it was decided that each ore should, in the first instance, be subjected to metallurgical analysis, size-reduction, sizing, mineralogical analysis, and standard small-scale gravity concentration treatment, particularly in order to ascertain liberation of the valuable mineral(s) at various sizes and the grades of concentrate which could be anticipated therefrom.

A portion of each sample has been, or will be, subjected to a virtually standard system of crushing, sampling, sizing, concentration, and mineralogical and metallurgical analysis. The system is shown in Figure 1.

FIGURE 1 - PRELIMINARY ORE TREATMENT FLOWSHEET



Each size fraction produced in the size analysis will be assayed for tin, and selected size fractions will be subjected to standard sink-float or superpanning tests, products of which will be examined microscopically and analysed.

Examination of the results of this system of investigation should give specific information regarding the extent of selective comminution of the tin-bearing minerals, the size at which suitable liberation can be achieved, and the types of other minerals and middlings particles which might be expected to dilute the tin concentrate produced. This basic information will provide pointers to possible larger scale tests, using standard (laboratory-scale) concentrating machines.

4. RESULTS OF TEST WORK:

Each head sample obtained from the "preparation" flowsheet was analysed for tin, and other assays will be performed in the near future. The results of the head assays are shown in Table 1.

The Gilmore ore sample, as received, was found to contain about 40% -¼". In this case only, the sample was screened on ¼", and the two fractions treated separately.

TABLE 1 - HEAD ASSAYS

| | | % Sn | % Mn | % $SiO_2$ |
|---|---|---|---|---|
| 1. | Gilmore +¼" | 3.42 | | |
| | -¼" | 6.22 | | |
| 2. | Bloodwood | 8.54 | 2.2 | 19.9 |
| 3. | Great Southern | 0.80 | | |
| 4. | Lizzie | 0.97 | | |
| 5. | Lamb | 1.99 | | |
| 6. | You-and-Me | 1.94 | | |
| 7. | Rainbow | Not yet assayed. | | |

4.1. BLOODWOOD ORE

4.1.1. Physical and Chemical Testing

The results of the standard screen-and-assay analysis are shown in Table 2.

TABLE 2 - SCREEN-AND-ASSAY ANALYSIS - BLOODWOOD ORE

| Size (mesh) | % Wt | % Sn | Sn Distn. % |
|---|---|---|---|
| +36 | 24.7 | 9.40 | 25.8 |
| 36/52 | 11.3 | 10.18 | 12.6 |
| 52/72 | 8.9 | 12.80 | 12.6 |
| 72/100 | 7.8 | 12.67 | 11.0 |
| 100/150 | 8.3 | 12.51 | 11.5 |
| 150/200 | 6.7 | 11.09 | 8.2 |
| 200/350 | 7.7 | 9.95 | 8.5 |
| -350 | 25.6 | 3.44 | 9.8 |
| | 100.0 | 9.02 (calc.) | 100.0 |

The size fractions +36, 52/72, 100/150 and 200/350 mesh were subjected to sink-float testing in tetra-bromo-ethane (TBE), sp. gr. 2.90, and the products assayed. Samples of selected "sink" products were also mounted, polished, and examined mineragraphically.

The results of the sink-float tests are shown in Table 3.

TABLE 3 - SINK-FLOAT TESTS ON SIZE FRACTIONS - BLOODWOOD ORE

| Size Fraction | Sink % Wt. | Sink Sn % | Float % Wt. | Float Sn % |
|---|---|---|---|---|
| + 36 mesh | 60 | 15.46 | 40 | 0.31 |
| 52/72 | 58 | 21.92 | 42 | 0.21 |
| 100/150 | 56 | 22.32 | 44 | 0.15 |
| 200/350 | 54 | 18.42 | 46 | |

4.1.2. Mineragraphy

The three coarsest samples reported in Table 3 above were mounted and polished, and examined mineragraphically. It is considered that examination of such samples is generally more fruitful than examination of lumps from the original sample, since (a) most of the light, barren gangue has been eliminated, (b) any one mounted sample has a very much higher probability of containing grains of all of the minerals of high specific gravity in the ore than even a suite of lump samples, and (c) such samples are useful in examining the degree of liberation.

Quantitative grain counting has not yet been carried out, but the association of minerals is not very complex. The major heavy minerals present, roughly in order of their abundance, are - cassiterite, pyrrhotite, scheelite, sphalerite (with ex-solution galena and chalcopyrite), pyrite (showing minor marcasite inclusions), galena and chalcopyrite. There appears to be little predominant association of one mineral with another, but liberation of all species is sensibly complete at sizes finer than 72 mesh, (excepting, of course, the fine ex-solution galena and chalcopyrite in the sphalerite).

Assays for tungsten, iron and sulphur, as well as for tin, will be carried out on gravity concentrates produced in future testing.

4.1.3. Inferences

It appears that a high degree of liberation can be achieved at a relatively coarse grind and that the tabling of two or three classified products should produce concentrates with good recoveries of the tin, providing that overgrinding is avoided by careful closed-circuit sizing. The elimination of the sulphides in the concentrate should be possible in a simple flotation circuit.

As the ore is of such high grade, it is considered that liberated tin should be recovered as early as possible, perhaps by the use of a "unit" jig in the grinding circuit.

Future test work will follow these lines.

## 4.2. YOU-AND-ME ORE

4.2.1. Physical and Chemical Testing

The results of the standard screen-and-assay analysis are shown in Table 4.

TABLE 4 - SCREEN-AND-ASSAY ANALYSIS - YOU-AND-ME ORE

| Size (mesh) | % wt. | Sn % | Sn Distn. % |
|---|---|---|---|
| + 36 | 40.7 | 1.44 | 31.9 |
| 36/52 | 14.3 | 1.92 | 14.9 |
| 52/72 | 9.6 | 1.49 | 7.8 |
| 72/100 | 7.7 | 2.26 | 9.4 |
| 100/150 | 5.8 | 2.26 | 7.2 |
| 150/200 | 4.3 | 2.69 | 6.4 |
| 200/350 | 5.1 | 2.69 | 7.5 |
| -350 | 12.5 | 2.19 | 14.9 |
| | 100.0 | 1.84 (calc.) | 100.0 |

Selected fractions were subjected to sink-float tests, and the products assayed. The results are shown in Table 5.

TABLE 5 - SINK-FLOAT TESTS ON SIZE FRACTIONS - YOU-AND-ME ORE

| Size Fraction | Product | FRACTION % wt. | FRACTION Sn % | FRACTION Sn Distn. % | OVERALL Sn Distn. % |
|---|---|---|---|---|---|
| + 36 mesh | Sink | 17.5 | 5.68 | 69.0 | 22.1 |
| | Float | 82.5 | 0.54 | 31.0 | 9.9 |
| 52/72 | Sink | 18.0 | 7.42 | 89.6 | 7.0 |
| | Float | 82.0 | 0.19 | 10.4 | 0.8 |
| 100/150 | Sink | 21.0 | 10.25 | 95.1 | 6.8 |
| | Float | 79.0 | 0.14 | 4.9 | 0.35 |
| 200/350 | Sink | 27.8 | 9.33 | 96.2 | 7.2 |
| | Float | 72.2 | 0.14 | 3.8 | 0.28 |

#### 4.2.2. Mineragraphy

The major heavy minerals present are cassiterite, titanhaematite, ilmenite, pyrite, pyrrhotite, with minor sphalerite, arsenopyrite and chalcopyrite. The cassiterite occurs mainly associated with light gangue minerals, and the titanhaematite and ilmenite are usually closely associated and/or intergrown. Liberation of the cassiterite is not good until a size of about 150 to 200 mesh is reached.

#### 4.2.3. Inferences

Careful and fairly fine grinding will be necessary in order to achieve good liberation without the production of excessive amounts of fine tin, the recovery of which would be difficult. Gravity concentrates will contain fairly high proportions of iron and iron-titanium minerals, which will be difficult to separate.

### 4.3. LAMB ORE

#### 4.3.1. Physical and Chemical Tests

The results of the standard screen-and-assay analysis are Table 6.

TABLE 6 - SCREEN-AND-ASSAY ANALYSIS - LAMB ORE

| Size (mesh) | % Wt. | Sn % | Sn Distn. % |
|---|---|---|---|
| + 36 | 29.5 | 2.31 | 31.6 |
| 36/52 | 15.1 | 2.05 | 14.4 |
| 52/72 | 10.6 | 1.84 | 9.1 |
| 72/100 | 8.4 | 2.08 | 8.2 |
| 100/150 | 7.0 | 2.36 | 7.7 |
| 150/200 | 5.1 | 2.29 | 5.4 |
| 200/350 | 6.4 | 2.51 | 7.5 |
| -350 | 17.9 | 1.94 | 16.1 |
| | 100.0 | 2.05 (calc.) | 100.0 |

Selected fractions were subjected to sink-float tests, and the products assayed. The results are shown in Table 7.

TABLE 7 - SINK-FLOAT TESTS ON SIZE FRACTIONS - LAMB ORE

| | | | FRACTION | | OVERALL |
|---|---|---|---|---|---|
| Size Fraction | Product | % Wt. | Sn % | Sn Distn. % | Sn Distn. % |
| + 36 mesh | Sink | 13.3 | 16.26 | 93.6 | 29.6 |
| | Float | 86.7 | 0.17 | 6.4 | 2.0 |
| 52/72 | Sink | 12.5 | 15.5 | 93.7 | 8.5 |
| | Float | 87.5 | 0.15 | 6.3 | 0.6 |
| 100/150 | Sink | 20.9 | 10.61 | 94.3 | 7.3 |
| | Float | 79.1 | 0.18 | 5.7 | 0.4 |
| 200/350 | Sink | 26.7 | 9.33 | 99.1 | 7.4 |
| | Float | 73.3 | 0.03 | 0.9 | 0.1 |

### 4.3.2. Mineragraphy

Mineragraphic examination of the products in Table 7 has not yet been completed.

### 4.3.3. Inferences

Without complete mineragraphic information, prediction of the nature and results of future tests is difficult. However, the results of Table 7 indicate that good liberation might be expected at a relatively coarse size, but that dilution of the concentrate by other heavy minerals may be a difficult problem.

## 5. FUTURE WORK:

Investigations similar to those reported in Section 4 are being carried out on the remainder of the ore samples. More sophisticated methods of treatment will be chosen and carried out after examination of these results. Part of the Quarter under review was spent in awaiting the arrival of ore samples and in their initial preparation and storage. It is anticipated that future work will yield many more, and a much wider range of, results.

12/11/64

APPENDIX

## PLANT RECOVERIES

From tonnages of ore treated, weights and grades of concentrates produced, and assuming that the head assays of the ores treated were identical with those reported in Table 1, (Section 4), the plant recoveries may be calculated. The results, calculated from information received, are as follows:-

| Ore | Tons Treated | Head Assay Sn % | Tons Conc. | Conc. Assay Sn % | Calc. Recovery % |
|---|---|---|---|---|---|
| Lamb | 65 | 1.99 | 1.593 | 67.7 | 84.2 |
| Great Southern | 93.85 | 0.80 | 0.818 | 61.3 | 66.7 |

The accuracy of these figures is not vouched for, and the assumption that the head assays used did, in fact, apply to the parcels in question, may not be fully warranted. The recovery values calculated are, therefore, presented only as indications of the performance of the treatment batteries.

12/11/64

2.2 <u>You-and-Me Ore</u> -

2.2.1 The consolidated results of all small-scale concentration tests are shown in Table 2.

<u>Table 2</u>

<u>You-and-Me Ore</u>

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn% | Sink Float Product | Wt.% | Sn.% | distrib. Sn% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 40.7 | 1.44 | Sink | 17.5 | 5.68 | 69.0 | 22.1 | 31.9 |
| | | | Float | 82.5 | 0.54 | 31.0 | 9.8 | |
| -36 +52 | 14.3 | 1.92 | | | | | | 14.9 |
| -52 +72 | 9.6 | 1.49 | Sink | 18.0 | 7.42 | 89.6 | 7.0 | 7.8 |
| | | | Float | 82.0 | 0.19 | 10.4 | 0.8 | |
| -72+100 | 7.7 | 2.26 | | | | | | 9.4 |
| -100+150 | 5.8 | 2.26 | Sink | 21.0 | 10.25 | 95.1 | 6.8 | 7.2 |
| | | | Float | 79.0 | 0.14 | 4.9 | 0.4 | |
| -150+200 | 4.3 | 2.69 | | | | | | 6.4 |
| -200+350 | 5.1 | 2.69 | Sink | 27.8 | 9.33 | 96.2 | 7.2 | 7.5 |
| | | | Float | 72.2 | 0.14 | 3.8 | 0.3 | |
| | | | Superpanner analysis | | | | | |
| -350 | 12.5 | 2.19 | cons | 8.1 | 25.2 | 79.2 | 11.8 | 14.9 |
| | | | Tails | 91.9 | 0.59 | 20.8 | 3.1 | |
| | | | | | 2.6 calc. | | | 100.0 |
| | | 1.84 calc. | | | | | | |
| | | 1.94 assay | | | | | | |

2.3 <u>Lamb Ore</u> -

2.3.1 The consolidated results of small-scale concentration tests are shown in Table 3.

<u>Table 3</u>

<u>Lamb Ore</u>

Screen, Assay, Sink Float, Superpanner Analyses

| Mesh | Wt.% | Sn% | Sink Float Product | Wt.% | Sn.% | distrib. Sn% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 29.5 | 2.31 | Sink | 13.3 | 16.26 | 93.6 | 29.6 | 31.6 |
| | | | Float | 86.7 | 0.17 | 6.4 | 2.0 | |
| -36 +52 | 15.1 | 2.05 | | | | | | 14.4 |
| -52 +72 | 10.6 | 1.84 | Sink | 12.5 | 15.5 | 93.7 | 8.5 | 9.1 |
| | | | Float | 87.5 | 0.15 | 6.3 | 0.6 | |
| -72+100 | 8.4 | 2.08 | | | | | | 8.2 |
| -100+150 | 7.0 | 2.36 | Sink | 20.9 | 10.61 | 94.3 | 7.3 | 7.7 |
| | | | Float | 79.1 | 0.18 | 5.7 | 0.4 | |
| -150+200 | 5.1 | 2.29 | | | | | | 5.4 |
| -200+350 | 6.4 | 2.51 | Sink | 26.7 | 9.33 | 99.1 | 7.4 | 7.5 |
| | | | Float | 73.3 | 0.03 | 0.9 | 0.1 | |
| | | | Superpanner analysis | | | | | |
| -350 | 17.9 | 1.94 | cons. | 3.6 | 33.3 | 71.4 | 11.5 | 16.1 |
| | | | Tails | 96.4 | 0.5 | 28.6 | 4.6 | |
| | | | | | 1.69 | | | 100.0 |
| | | 2.05 calc. | | | | | | |
| | | 1.99 assay | | | | | | |

UNIVERSITY OF QUEENSLAND

DEPARTMENT OF MINING AND METALLURGICAL ENGINEERING

MINERAL INDUSTRIES RESEARCH AND TESTING SERVICE

# METALLURGICAL RESEARCH INTO TIN ORE TREATMENT, NORTH QUEENSLAND

CONTRACT C.506697: FILE NO. V.F. 295/5/11

SECOND QUARTERLY REPORT (PERIOD ENDING JANUARY, 1965)

## 1. INTRODUCTION:

The first quarterly report under the terms of the above contract described the work leading to the selection of ore samples to be treated, their preparation for test work, a discussion of the types of tests it was considered to be justified, and presented the results of small scale sizing, assaying, gravity concentration and mineragraphic tests upon the Bloodwood, You-and-Me and Lamb ores. Since the submission of this report, the finest size fraction (minus 350 mesh) of each of these ores has been subjected to gravity concentration tests. The present report therefore presents the results both of these tests and of the tests carried out on the coarser fractions, the whole being "consolidated" into tables, from which metallurgical balances have been drawn up.

Similar complete tests have now been carried out on the following ores:

Great Southern
Lizzie
Rainbow
Gilmore No.1 sample (two sections)
Gilmore No.2 sample

The products of the tests on these ores have also been subjected to mineragraphic examination.

All results from the abovementioned tests are reported below.

## 2. RESULTS OF TEST WORK:

### 2.1 Bloodwood Ore -

The consolidated results of all small-scale concentration tests are shown in Table 1.

Table 1

Bloodwood Ore

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn% | Sink Float: Product | Sink Float: Wt.% | Sink Float: Sn% | Sink Float: distrib. Sn% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 24.7 | 9.40 | Sink | 60 | 15.46 | 98.7 | 25.4 | 25.8 |
| | | | Float | 40 | 0.31 | 1.3 | 0.4 | |
| -36+52 | 11.3 | 10.18 | | | | | | 12.6 |
| -52+72 | 8.9 | 12.80 | Sink | 58 | 21.92 | 99.5 | 12.5 | 12.6 |
| | | | Float | 42 | 0.21 | .5 | .1 | |
| -72+100 | 7.8 | 12.67 | | | | | | 11.0 |
| -100+150 | 8.3 | 12.51 | Sink | 56 | 22.32 | 99.5 | 11.4 | 11.5 |
| | | | Float | 44 | 0.15 | .5 | .1 | |
| -150+200 | 6.7 | 11.09 | | | | | | 8.2 |
| -200+350 | 7.7 | 9.95 | Sink | 54 | 18.42 | 99.5 | 8.4 | 8.5 |
| | | | Float | 46 | 0.1 | .5 | .1 | |
| | | | Superpanner analysis | | | | | |
| -350 | 25.6 | 3.44 | Cons | 8.7 | 41.55 | 69.4 | 6.8 | 9.8 |
| | | | Tails | 91.3 | 1.74 | 30.6 | 3.0 | |
| | | | | | 5.2 calc. | | | 100.0 |
| | | 9.02 | Calc. | | | | | |
| | | 8.54 | Assay | | | | | |

## 2.2 You-and-Me Ore -

2.2.1 The consolidated results of all small-scale concentration tests are shown in Table 2.

Table 2

You-and-Me Ore

Screen, Assay, Sink-Float, Suporpanner Analyses

| Mesh | Wt.% | Sn% | Sink Float Product | Wt.% | Sn.% | distrib. Sn% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 40.7 | 1.44 | Sink | 17.5 | 5.68 | 69.0 | 22.1 | 31.9 |
| | | | Float | 82.5 | 0.54 | 31.0 | 9.8 | |
| -36 +52 | 14.3 | 1.92 | | | | | | 14.9 |
| -52 +72 | 9.6 | 1.49 | Sink | 18.0 | 7.42 | 89.6 | 7.0 | 7.8 |
| | | | Float | 82.0 | 0.19 | 10.4 | 0.8 | |
| -72+100 | 7.7 | 2.26 | | | | | | 9.4 |
| -100+150 | 5.8 | 2.26 | Sink | 21.0 | 10.25 | 95.1 | 6.8 | 7.2 |
| | | | Float | 79.0 | 0.14 | 4.9 | 0.4 | |
| -150+200 | 4.3 | 2.69 | | | | | | 6.4 |
| -200+350 | 5.1 | 2.69 | Sink | 27.8 | 9.33 | 96.2 | 7.2 | 7.5 |
| | | | Float | 72.2 | 0.14 | 3.8 | 0.3 | |
| | | | Superpanner analysis | | | | | |
| -350 | 12.5 | 2.19 | cons | 8.1 | 25.2 | 79.2 | 11.8 | 14.9 |
| | | | Tails | 91.9 | 0.59 | 20.8 | 3.1 | |
| | | | | | 2.6 calc. | | | 100.0 |
| | | 1.84 calc.<br>1.94 assay | | | | | | |

## 2.3 Lamb Ore -

2.3.1 The consolidated results of small-scale concentration tests are shown in Table 3.

Table 3

Lamb Ore

Screen, Assay, Sink Float, Superpanner Analyses

| Mesh | Wt.% | Sn% | Sink Float Product | Wt.% | Sn.% | distrib. Sn% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 29.5 | 2.31 | Sink | 13.3 | 16.26 | 93.6 | 29.6 | 31.6 |
| | | | Float | 86.7 | 0.17 | 6.4 | 2.0 | |
| -36 +52 | 15.1 | 2.05 | | | | | | 14.4 |
| -52 +72 | 10.6 | 1.84 | Sink | 12.5 | 15.5 | 93.7 | 8.5 | 9.1 |
| | | | Float | 87.5 | 0.15 | 6.3 | 0.6 | |
| -72+100 | 8.4 | 2.08 | | | | | | 8.2 |
| -100+150 | 7.0 | 2.36 | Sink | 20.9 | 10.61 | 94.3 | 7.3 | 7.7 |
| | | | Float | 79.1 | 0.18 | 5.7 | 0.4 | |
| -150+200 | 5.1 | 2.29 | | | | | | 5.4 |
| -200+350 | 6.4 | 2.51 | Sink | 26.7 | 9.33 | 99.1 | 7.4 | 7.5 |
| | | | Float | 73.3 | 0.03 | 0.9 | 0.1 | |
| | | | Superpanner analysis | | | | | |
| -350 | 17.9 | 1.94 | cons. | 3.6 | 33.3 | 71.4 | 11.5 | 16.1 |
| | | | Tails | 96.4 | 0.5 | 28.6 | 4.6 | |
| | | | | | 1.69 | | | 100.0 |
| | | 2.05 calc.<br>1.99 assay | | | | | | |

2.3.2 Mineragraphy -

The main heavy minerals present are haematite and cassitorite, with small amounts of sulphides, mainly pyrrhotite and chalcopryite. Some free cassiterite is present at +72 mesh, but it is mainly in the form of simple binary particles associated with siliceous gangue, liberation of which would require little extra size reduction. At +150 mesh, the liberation of the haematite appears to be improved rather more than that of the cassiterite, but, in the -200 +350 mesh fraction, all heavy minerals are predominantly free. However, the presence of large quantities of haematite presents difficult problems in the production of a high grade tin concentrate.

2.4 Great Southern Ore -

2.4.1 The consolidated results of small-scale concentration tests are shown in Table 4.

Table 4

Great Southern Ore

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn% | Sink Float Product | Wt.% | Sn.% | distrib. Sn% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 23.9 | 0.80 | Sink | 21.6 | 3.01 | 81.5 | 20.3 | 24.9 |
| | | | Float | 78.4 | 0.19 | 18.5 | 4.6 | |
| -36+52 | 17.6 | 0.70 | | | | | | 16.1 |
| -52+72 | 14.7 | 0.87 | Sink | 21.8 | 3.22 | 80.4 | 13.4 | 16.7 |
| | | | Float | 78.2 | 0.22 | 19.6 | 3.3 | |
| -72+100 | 10.3 | 0.72 | | | | | | 9.6 |
| -100+150 | 8.9 | 0.81 | Sink | 23.6 | 3.33 | 97.3 | 9.15 | 9.4 |
| | | | Float | 76.4 | 0.03 | 2.7 | 0.25 | |
| -150+200 | 5.2 | 0.87 | | | | | | 5.7 |
| -200+350 | 5.5 | 1.16 | Sink | 25.7 | 4.33 | 96.2 | 8.0 | 8.3 |
| | | | Float | 74.3 | 0.06 | 3.8 | 0.3 | |
| | | | Superpanner analysis | | | | | |
| -350 | 13.9 | 0.52 | cons. | 1.1 | 51.9 | 71.5 | 6.6 | 9.3 |
| | | | Tails | 98.9 | 0.23 | 28.5 | 2.7 | |
| | | | | | | 0.8 calc | | |
| | | 0.77 calc. | | | | | | |
| | | 0.80 assay | | | | | | |

2.4.2 Mineragraphy -

The main minerals present are earthy haematite and goethite, and relatively small amounts of cassiterite; both of these groups are associated (sometimes intimately) with light siliceous gangue minerals, and liberation of the cassiterite is not good until a size of about 150 mesh is reached. However, any gravity concentrate will inevitably be low grade because of the high proportion of heavy gangue minerals. Separation will have to take the form of selective roasting to produce an artificial magnetite for magnetic separation, or a flotation operation, or a chemical process. However, a considerable ratio of concentration can be realised with relatively good recovery, and a pre-treatment of the ore by gravity methods prior to one of those suggested above would probably be justified.

2.5 Lizzie Ore -

2.5.1 The consolidated results of small-scale concentration tests are shown in Table 5.

Table 5

Lizzie Ore

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn% | Sink Float Product | Wt.% | Sn% | distrib. Sn.% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 19.65 | 0.96 | Sink | 54.2 | 1.62 | 91.9 | 16.5 | 17.9 |
| | | | Float | 45.8 | 0.17 | 8.1 | 1.4 | |
| -36+52 | 17.02 | 0.90 | | | | | | 14.5 |
| -52+72 | 15.14 | 1.07 | Sink | 55.4 | 1.82 | 94.5 | 14.6 | 15.4 |
| | | | Float | 44.6 | 0.13 | 5.5 | 0.8 | |
| -72+100 | 10.66 | 0.98 | | | | | | 9.9 |
| -100+150 | 9.39 | 0.95 | Sink | 51.6 | 1.75 | 94.9 | 8.1 | 8.5 |
| | | | Float | 48.4 | 0.10 | 5.1 | 0.4 | |
| -150+200 | 5.45 | 1.28 | | | | | | 6.6 |
| -200+350 | 6.41 | 1.48 | Sink | 48.5 | 2.92 | 95.4 | 8.6 | 9.0 |
| | | | Float | 51.5 | 0.13 | 4.6 | 0.4 | |
| | | | Superpanner | | analysis | | | |
| -350 | 16.28 | 1.18 | cons. | 1.2 | 56.0 | 76.5 | 13.9 | 18.2 |
| | | | Tails | 98.8 | 0.21 | 23.5 | 4.3 | |
| | | | | | 0.88 calc. | | | |
| | | 1.05 calc. | | | | | | |
| | | 0.97 assay | | | | | | |

2.5.2 Mineragraphy -

The main heavy minerals present are haematite and goethite, with some psilomelane, and minor amounts of cassiterite. Liberation of the cassiterite is good at about 72 mesh and virtually complete at 150 mesh, but, except by very careful gravity concentration on the superpanner, only low grade concentrates can be produced. The results of testing should be better than those of sink-float testing, but nevertheless only a low grade concentrate can be anticipated by gravity methods.

2.6 Rainbow Ore -

2.6.1 The sample supplied proved to be of remarkably high grade (18.0% Sn); nevertheless, it was subjected to the standard test programme. The consolidated results of these small-scale concentration tests are shown in Table 6.

Table 6

Rainbow Ore

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn.% | Sink Float Product | Wt.% | Sn.% | distrib. Sn.% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 22.3 | 16.91 | Sink | 44 | 34.84 | 99 | 21.0 | 21.3 |
| | | | Float | 56 | 0.29 | 1 | 0.3 | |
| -36+52 | 17.1 | 18.23 | | | | | | 17.6 |
| -52+72 | 14.9 | 20.43 | Sink | 43.6 | 46.0 | 99 | 17.0 | 17.2 |
| | | | Float | 56.4 | 0.24 | 1 | 0.2 | |
| -72+100 | 10.2 | 19.85 | | | | | | 11.4 |
| -100+150 | 8.8 | 20.7 | Sink | 44.9 | 45.87 | 99 | 10.3 | 10.4 |
| | | | Float | 55.1 | 0.24 | 1 | 0.1 | |
| -150+200 | 5.7 | 15.38 | | | | | | 5.0 |
| -200+350 | 6.7 | 18.2 | Sink | 44.0 | 41.11 | 99 | 6.8 | 6.9 |
| | | | Float | 56.0 | 0.28 | 1 | 0.1 | |
| | | | Superpanner | | analysis | | | |
| -350 | 14.3 | 12.68 | cons. | 21.0 | 60.5 | 85.5 | 8.7 | 10.2 |
| | | | Tails | 79.6 | 2.75 | 14.5 | 1.5 | |
| | | | | | 14.9 | | | |
| | | 17.69 calc. | | | | | | |
| | | 18.0 assay | | | | | | |

2.6.2 Mineragraphy -

The main heavy mineral present is cassiterite, with relatively minor amounts of pyrite, pyrrhotite, sphalerite and galena. Liberation is almost complete at 150 mesh, and fairly high grade concentrates can be produced by simple sink-float methods. It is expected that higher grade concentrates will be produced by a standard commercial gravity process (such as tabling), but that recovery may be slightly lower. Little difficulty is anticipated in removing the small amounts of sulphides by flotation, if this is found to be necessary.

2.7 Gilmore Ore -

Two samples of Gilmore Ore were delivered to the Department, the latter arriving after the writing of the first quarterly report. This sample was labelled Gilmore No.2 and assayed 6.1% Sn.

The first sample of Gilmore Ore (No.1) was found to contain a large amount of fine material, which appeared macroscopically different from the coarse. The sample was screened in a ¼" screen and the over- and undersize were treated as separate samples.

2.7.1 Gilmore No.1, +¼" -

2.7.1.1 The consolidated results of the small-scale concentration tests are shown in Table 7.

Table 7

Gilmore A Ore + ¼" fraction of ore

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn.% | Product | Sink Float Wt.% | Sn.% | distrib. Sn.% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 33.4 | 2.47 | Sink | 11.6 | 17.8 | 77.4 | 18.3 | 24.6 |
| | | | Float | 88.4 | 0.46 | 25.6 | 6.3 | |
| -36+52 | 16.3 | 2.77 | | | | | | 13.6 |
| -52+72 | 12.3 | 2.90 | Sink | 13.6 | 17.9 | 83.7 | 9.0 | 10.8 |
| | | | Float | 86.4 | 0.54 | 16.3 | 1.8 | |
| -72+100 | 8.2 | 3.3 | | | | | | 8.2 |
| -100+150 | 7.5 | 3.71 | Sink | 16.8 | 20.0 | 90.8 | 7.6 | 8.4 |
| | | | Float | 83.2 | 0.41 | 9.2 | 0.8 | |
| -150+200 | 3.9 | 4.61 | | | | | | 5.4 |
| -200+350 | 4.9 | 6.4 | Sink | 18.5 | 29.3 | 85 | 8.1 | 9.5 |
| | | | Float | 81.5 | 1.19 | 15 | 1.4 | |
| | | | Superpanner analysis | | | | | |
| -350 | 13.5 | 4.81 | cons. | 6.9 | 56.6 | 72.8 | 14.2 | 19.5 |
| | | | Tails | 93.1 | 1.56 | 27.2 | 5.3 | |
| | | | | | 5.3 calc. | | | |
| | | 3.31 calc. | | | | | | |
| | | 3.42 assay | | | | | | |

2.7.2 Gilmore No.1, -¼" -

2.7.2.1 The consolidated results of the small-scale concentration tests are shown in Table 8.

Table 8

Gilmore B Ore $-\frac{1}{4}$" fraction of ore

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn.% | Product | Sink Float Wt.% | Sn.% | distrib. Sn.% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 19.0 | 4.29 | Sink | 19.5 | 20.1 | 91.2 | 12.3 | 13.5 |
| | | | Float | 80.5 | 0.47 | 8.8 | 1.2 | |
| -36+52 | 12.28 | 5.15 | | | | | | 10.4 |
| -52+72 | 9.06 | 5.56 | Sink | 24.3 | 21.2 | 92.4 | 7.7 | 8.3 |
| | | | Float | 75.7 | 0.54 | 7.6 | 0.6 | |
| -72+100 | 7.25 | 6.4 | | | | | | 7.7 |
| -100+150 | 6.90 | 7.41 | Sink | 27.6 | 25.7 | 95.8 | 8.1 | 8.5 |
| | | | Float | 72.4 | 0.43 | 4.2 | 0.4 | |
| -150+200 | 4.28 | 10.61 | | | | | | 7.5 |
| -200+350 | 5.97 | 14.96 | Sink | 33.7 | 40.3 | 93.1 | 13.7 | 14.7 |
| | | | Float | 66.3 | 1.54 | 6.9 | 1.0 | |
| | | | Superpanner analysis | | | | | |
| -350 | 35.26 | 5.06 | cons. | 5.9 | 63.3 | 71.5 | 21.0 | 29.4 |
| | | | Tails | 94.1 | 1.58 | 28.5 | 8.4 | |
| | | | | | 5.2 calc. | | | |
| | | 6.04 calc | | | | | | |
| | | 6.22 assay | | | | | | |

2.7.3 Mineragraphy -

The heavy minerals present in both samples were virtually identical, as were the liberation sizes. The minerals present were pyrite, arsenopyrite, cassiterite, pyrrhotite, sphalerite, with occasional stannite. Liberation of the cassiterite from all other minerals is virtually complete at 150 mesh; any gravity concentrate will inevitably contain large proportions of sulphides as diluents.

Obviously, the most promising method of removing these sulphides will be by flotation (a method already used by producers), and such testing will follow larger-scale gravity concentration tests.

2.7.4 Gilmore No.2 -

2.7.4.1 The consolidated results of small-scale gravity concentration tests are shown in Table 9.

Table 9

Gilmore No.2

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn.% | Product | Sink Float Wt.% | Sn.% | distrib. Sn.% | Distribution Sn.% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 11.0 | 5.8 | Sink | 18.6 | 27.2 | 87.0 | 8.9 | 10.2 |
| | | | Float | 81.4 | 0.93 | 13.0 | 1.3 | |
| -36+52 | 21.8 | 5.6 | | | | | | 19.6 |
| -52+72 | 18.9 | 5.6 | Sink | 17.3 | 29.8 | 92.4 | 15.7 | 17.0 |
| | | | Float | 82.7 | 0.51 | 7.6 | 1.3 | |
| -72+100 | 12.6 | 6.0 | | | | | | 12.1 |
| -100+150 | 9.1 | 7.0 | Sink | 17.3 | 38.2 | 94.4 | 9.8 | 10.4 |
| | | | Float | 82.7 | 0.48 | 5.6 | 0.6 | |
| -150+200 | 4.8 | 8.3 | | | | | | 6.4 |
| -200+350 | 5.2 | 9.6 | Sink | 17.4 | 48.3 | 87.5 | 7.0 | 8.0 |
| | | | Float | 82.6 | 1.45 | 12.5 | 1.0 | |
| | | | Superpanner analysis | | | | | |
| -350 | 16.6 | 6.1 | cons. | 6.9 | 58.2 | 69.4 | 11.3 | 16.3 |
| | | | Tails | 93.1 | 1.9 | 30.6 | 5.0 | |
| | | | | | 5.8 calc. | | | 100.0 |
| | | 6.22 calc. | | | | | | |
| | | 6.1 assay | | | | | | |

2.7.4.2 Mineragraphy -

The main heavy mineral present is cassiterite, with associated pyrite, pyrrhotite, arsenopyrite, chalcopyrite and sphalerite. Although there are some free cassiterite grains at +150 mesh, many are intimately mixed with light gangue minerals, and liberation is by no means complete at the finest size (+350 mesh) investigated. Gravity concentrates of +150 mesh material can be expected to be diluted because of lack of liberation and to contain amounts of sulphides, which may be in proportions sufficiently high to demand removal by flotation.

Future Work:

Larger scale gravity and other concentration testing have already commenced on some of the ores received. Each concentrate produced will present its own problems of further treatment, particularly those containing large amounts of heavy gangue minerals, and it is fairly obvious that these will require treatment methods not now common on the North Queensland tinfields, if good recoveries of the tin are to be obtained.

UNIVERSITY OF QUEENSLAND

DEPARTMENT OF MINING AND METALLURGICAL ENGINEERING

MINERAL INDUSTRIES RESEARCH AND TESTING SERVICE

METALLURGICAL RESEARCH INTO TIN ORE TREATMENT, NORTH QUEENSLAND

CONTRACT C.506697: FILE NO. V.F. 295/5/11

THIRD REPORT (PERIOD ENDING 31ST MARCH, 1965)

## 1. INTRODUCTION:

The first and second reports described the small-scale sizing, assaying, gravity concentration and mineragraphic tests carried out on the following ores:

1. Gilmore No.1 sample - two sections
2. Gilmore No.2 sample
3. Bloodwood
4. Great Southern
5. Lizzie
6. Lamb
7. You and Me
8. Rainbow

A sample of Dover Castle Ore has since been received and small-scale testing has been carried out thereon. Another sample (from Iona Mine) is still awaited at the time of writing this report.

## 2. RESULTS OF TEST WORK:

### 2.1 Dover Castle Ore -

2.1.1 The Dover Castle ore assayed 2.75% Sn.

The consolidated results of the small-scale concentration tests are shown in Table I.

Table I

Dover Castle Ore

Screen, Assay, Sink-Float, Superpanner Analyses

| Mesh | Wt.% | Sn% | Product | Sink Float Wt.% | Sink Float Sn% | distrib. Sn% | Distribution Sn% Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 27.11 | 2.75 | Sink | 17.43 | 12.4 | 90.6 | 24.4 | 26.9 |
| | | | Float | 82.57 | 0.27 | 9.4 | 2.5 | |
| -36+52 | 16.67 | 2.52 | | | | | | 15.2 |
| -52+72 | 12.04 | 2.65 | Sink | 20.37 | 12.3 | 94.3 | 10.8 | 11.5 |
| | | | Float | 79.63 | 0.19 | 5.7 | 0.7 | |
| -72+100 | 8.62 | 2.54 | | | | | | 7.9 |
| -100+150 | 6.96 | 2.98 | Sink | 20.04 | 13.3 | 92.2 | 6.9 | 7.5 |
| | | | Float | 79.96 | 0.28 | 7.8 | 0.6 | |
| -150+200 | 4.16 | 3.50 | | | | | | 5.3 |
| -200+350 | 4.56 | 4.31 | Sink | 19.18 | 19.4 | 86.4 | 6.1 | 7.1 |
| | | | Float | 80.82 | 0.73 | 13.6 | 1.0 | |
| | | | Superpanner analysis | | | | | |
| -350 | 19.88 | 2.57 | Cons | 2.1 | 52.4 | 44.0 | 8.2 | 18.6 |
| | | | Tails | 97.9 | 1.43 | 56.0 | 10.4 | |
| | | | | | 2.5 calc. | | | |
| | | 2.76 | calc. | | | | | |
| | | 2.75 | assay. | | | | | |

2.1.2. Mineragraphy -

The major heavy minerals present include cassiterite, pyrrhotite, pyrite, chalcopyrite, minor galena and sphalerite, and an unidentified translucent mineral with green internal reflection.

The bulk of the cassiterite and sulphides are liberated at -100+150 mesh, and liberation is sensibly complete at about 200 mesh.

2.2. Bloodwood Ore -

2.2.1. The Bloodwood Ore is a high-grade ore, assaying 8.54% tin and containing a considerable quantity of sulphide minerals. Larger scale gravity concentration tests were carried out on the ore.

Sizing, assay, sink-float and superpanner analyses of the Bloodwood Ore were reported in a previous report (vide 2nd Quarterly Report, Section 2.1).

The Bloodwood Ore assayed Sn, 8.54%; Mn, 2.2%; $SiO_2$, 19.9%; S, 5.4%; Fe, 14.2%; $WO_3$, 0.48%; Zn, 2.0%.

The sink fractions of the sink-float test assayed, in addition to the assays shown in a previous report, -

| | |
|---|---|
| -52+72 mesh sink | $WO_3$, 2.5% |
| -100+150 mesh sink | Zn, 3.6% |
| -200+350 mesh sink | Zn, 2.3%; $Fe_2O_3$, 31.9%; $SiO_2$, 10.5%. |

The mineragraphic examination of the sink products from the sink-float tests showed that "the major heavy minerals present, roughly in order of their abundance, are - cassiterite, pyrrhotite, scheelite, sphalerite, pyrite, galena and chalcopyrite. There appears to be little predominant association of one mineral with another, but liberation of all species is sensibly complete at sizes finer than 72 mesh".

2.2.2. Concentration Test No. 1 -

It was decided to make a table concentration test in accordance with the following procedure:-

(a) grinding and screening the crushed ore on 52 mesh; and stage-grinding the +52 mesh product to -52 mesh;

(b) dividing the ground ore into three size fractions by screening on 100 and 350 mesh, thereby obtaining a coarse fraction -52+100 mesh, a fine fraction -100+350 mesh and a slime fraction -350 mesh;

(c) tabling the three fractions separately so as to make concentrate, middling and tailings from each fraction;

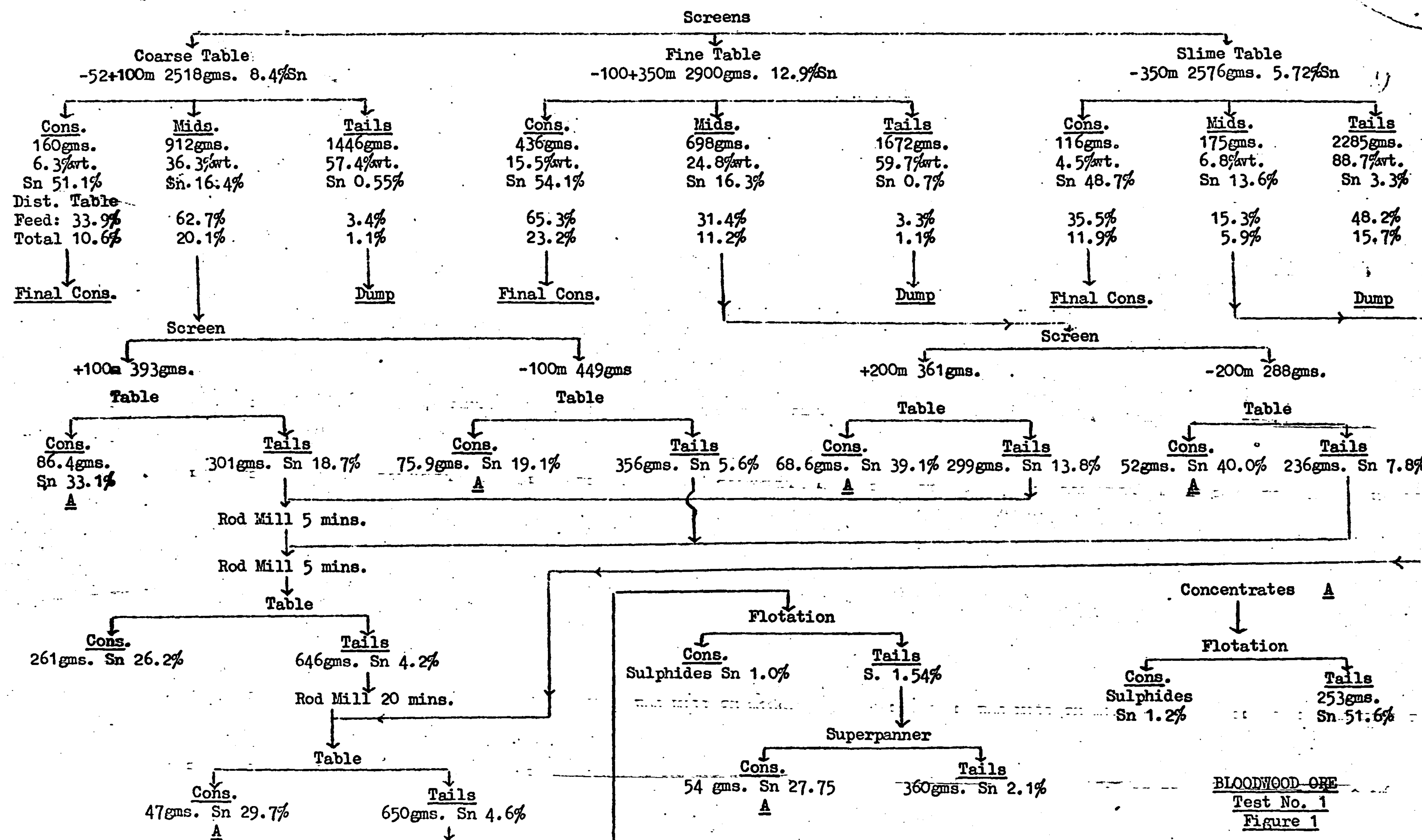
(d) treatment of middling - attempting to upgrade the middling by tabling without re-grinding but, if this should prove unsuccessful, by re-grinding the middling and re-tabling;

(e) cleaning the concentrates by flotation in order to remove sulphides.

A flow-sheet of the test work is shown in Figure 1. The weights, assays and distribution of tin are shown on the flow-sheet.

Comments on Test No. 1 -

The division of the feed between the three rougher tables was:- 8518 gms to the coarse table, 8000 gms to the fine table and 2576 gms to the slime table. The tin contents of the table feeds were 8.4% to coarse table, 12.9% to the fine table and 5.72% to the slime table.




BLOODWOOD ORE
Test No. 1
Figure 1

The table tailings from the coarse table assayed 0.55% Sn and contained 57.4% of the total weight fed to the table. The fine table tailing represented 59.7% of the total weight fed to the table and assayed 0.7% Sn. The slime table tailing represented 88.7% of the total weight fed to the table and assayed 3.3% Sn.

The percentage of the total tin lost on these tables was 1.1% on the coarse table, 1.2% on the fine table and 15.7% on the slime table.

The tabling of the slime fraction was ineffective; 48.2% of the total tin fed to the table was lost in the tailings.

The concentrates produced from the tables were comparatively low-grade (51.1% Sn, 54.1% Sn and 48.7% Sn) and contained 45.7% of the total tin.

The middlings from the coarse table assayed 16.4% Sn and contained 20.1% of the total tin. The middling from the fine table assayed 16.3% Sn and contained 11.2% of the total tin. The slime table middling assayed 13.6% Sn and contained 5.9% of the total tin.

The sulphides present reported in the concentrate and middling.

Attempts to up-grade the middling products by tabling sized feeds were unsuccessful. As will be seen from the flow-sheet, the concentrates obtained were of poor grade (30% to 40% Sn) and the tailings were high (5.6% to 18.7% Sn).

The tailings from these operations were therefore re-ground before re-tabling. The tailing assays were somewhat better after re-grinding.

All of the concentrates, except the Rougher Concentrates, were combined and treated by flotation for the production of a reasonable tin concentrate and a sulphide concentrate assaying 1.0 - 1.2% Sn.

The results of the test are shown in Table II.

Table II

Tin Balance

| | | Gms. | Sn% | Distribution Sn% |
|---|---|---|---|---|
| Input | Ore | 2518 | 8.4 | |
| | | 2900 | 12.9 | |
| | | 2576 | 5.72 | |
| | Total | 7994 | 9.16 | 100.0 |
| Output | Concentrate | 160 | 51.1 | |
| | | 436 | 54.1 | |
| | | 116 | 48.7 | |
| | | 53 | 27.75 | |
| | | 253 | 51.6 | |
| | | 1018 | 51.0 | 70.8 |
| | Tailing | 1446 | 0.55 | 1.1 |
| | | 1672 | 0.7 | 1.6 |
| | | 2285 | 3.3 | 10.3 |
| | | 5403 | 1.76 | 13.0 |
| | Sulphides | 236 | 1.0 | |
| | | 200 | 1.2 | |
| | Other tails | 360 | 2.1 | |
| | | 796 | 1.5 | 1.7 |
| Loss | | 777 | 18.5 | 14.5 |

The loss shown above is represented by the loss in operation and the weights of samples removed from the products for assay and testing. The total weight of the samples was not taken, but the number of samples assayed and tested give the impression that the loss was mainly here.

An examination of these results shows that a poor grade and a low recovery were obtained from the high-grade ore.

It was evident that the sulphides must be discarded at the earliest opportunity in order to enable the tables to produce a good grade of concentrate. It was also evident that the production of -350 mesh slime must be avoided so as to prevent loss in this fraction to the tailing.

It was therefore decided to make another concentration test.

2.2.3. Concentration Test No. 2 -

In this test, the ore was stage-ground through 25 mesh and split into three fractions, namely - -25+100 mesh, -100+350mesh and -350 mesh.

The fractions were tabled separately and the tailing from the coarse table was re-ground and tabled so as to produce a final concentrate. The -350 mesh fraction was cycloned, using a 2" cyclone, and the underflow was tabled. The overflow from the cyclone was later cycloned three times and the tin content of the slime fraction was reduced by 0.52% to 1.78% Sn.

The concentrate from the coarse and fine tables was re-ground in a rod mill and subjected to flotation for the removal of sulphides. The sulphides were cleaned by re-flotation.

The concentrate and middling from the slime table were similarly cleaned by flotation and the tails from flotation added to the tailing from flotation of the coarse and fine tables and the total tabled twice for the production of a tin concentrate and a tailing. The tailing from this section was super-panned to produce a concentrate and tailing.

The middling from the coarse and fine tables were re-ground in a rod mill for 30 minutes, subjected to flotation and cleaned, producing a sulphide concentrate assaying 1.2% Sn. The tailing from flotation was tabled, producing a tin concentrate and tailing which were super-panned.

The tailing from the slime table and the underflow from re-cycloning of the cyclone overflow were super-panned.

The flow-sheet of the test, together with assays and weights, are shown in Figure 2. There were a number of products of low weight which were combined for assay. These are denoted by (1) and (3) close to the products involved.

The assays and weights of these products are:-

(1) Concentrates, the sum of 52 + 3.1 + 49.3 + 30.0 + 20.0
= 154.4 gms. assaying 45.4% Sn

(3) Tailings, the sum of 230 + 42.1 + 26.3 + 960 + 50
= 1308.4 gms. assaying 5.29% Sn

The overall results of the test are shown in Table III.

BLOODWOOD ORE
Test No. 2
Figure 2

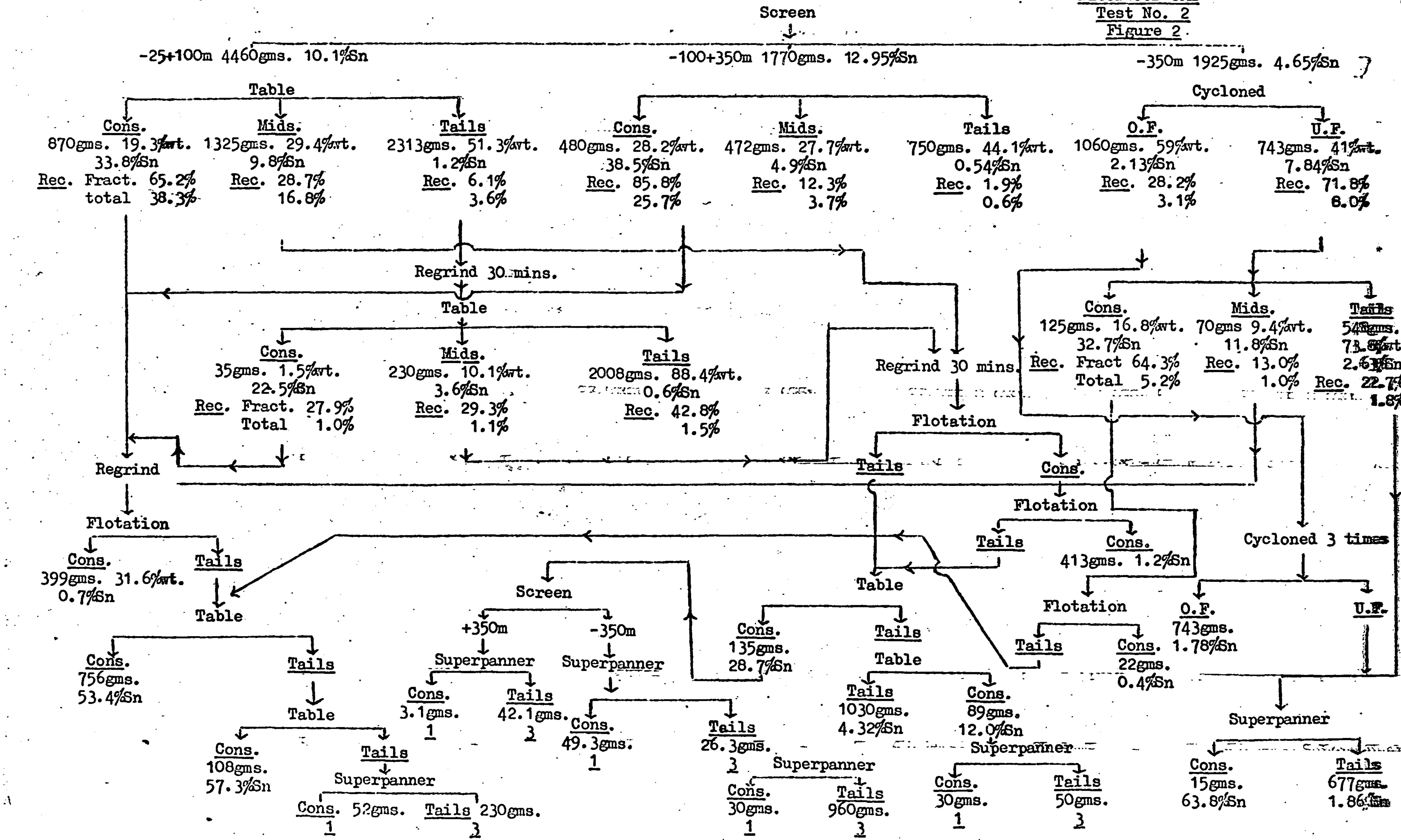


Table III

Tin Balance

| | | Gms. | Sn% | Distribution Sn% |
|---|---|---|---|---|
| Input | Ore | 4460 | 10.1 | |
| | | 1770 | 12.95 | |
| | | 1923 | 4.65 | |
| | | 8153 | 9.4 | 100.0 |
| Output | Concentrates | 756 | 53.4 | |
| | | 108 | 57.3 | |
| | | 15 | 63.8 | |
| | | 154 | 45.4 | |
| | | 1033 | 53.1 | 71.5 |
| | Tailings | 2008 | 0.6 | |
| | | 750 | 0.54 | |
| | | 677 | 1.86 | |
| | | 743 | 1.78 | |
| | | 4178 | 1.0 | 5.4 |
| | Sulphides | 399 | 0.7 | |
| | | 413 | 1.2 | |
| | | 22 | 0.4 | |
| | | 834 | 0.9 | 1.0 |
| | Other Tails | 1308 | 5.29 | 9.0 |
| | Loss | 800 | 12.5 | 13.1 |

The size and assay analyses of two table tailing products are shown in Table IV.

Table IV

Bloodwood Ore

Coarse Table Regrind Tailing
Size and Assay Analyses

| Mesh | Wt.% | Sn% | Distribution Sn% |
|---|---|---|---|
| +150 | 21.86 | 0.31 | 12.0 |
| -150 +200 | 16.82 | 0.31 | 9.3 |
| -200 +350 | 27.43 | 0.35 | 17.0 |
| -350 | 33.89 | 1.02 | 61.7 |
| | 100.00 | 0.56 | 100.0 |

Fine Table Tailing
Size and Assay Analyses

| Mesh | Wt.% | Sn% | Distribution Sn% |
|---|---|---|---|
| +150 | 19.61 | 0.54 | 20.0 |
| +200 | 27.54 | 0.26 | 13.5 |
| +350 | 30.82 | 0.30 | 18.1 |
| -350 | 21.03 | 1.23 | 48.4 |
| | 100.00 | 0.53 | 100.0 |

2.2.4. Comments -

The "loss" reported in the two tests on Bloodwood Ore are very close in weight, percentage of tin, and the percentage of the total tin in the ore. This loss should be allocated to the concentrate and tailing in some as yet unknown proportion.

The overall results of the two tests were similar. The Test No. 2 produced a slightly higher grade of concentrate and a slightly higher recovery.

The tailing loss in both cases was very little different. However, there were some significant differences in the products. The table tailing from the three table operations showed a loss of 13% of the total tin in the first test in contrast to a loss of 5.4% of the total tin in the second test.

This improvement is due to tabling at a coarser size, with a reduction in the weight of the -350 mesh material.

The re-grinding and re-tabling of the coarse table tailing produced a tailing comparable with that produced in the first test. The tailing from the fine table was similar in both cases. The cycloning of the -350 mesh material before tabling the underflow produced a tailing of approximately 1.8% Sn compared to 3.3% Sn in the first test when the whole of the -350 mesh tailing was tabled.

The re-grinding and flotation of the table concentrate and middling produced a sulphide concentrate containing approximately 1% Sn in both cases. The tin loss in the sulphides approximated 1%.

The recovery of tin from the flotation tailing was not satisfactory. In Test No. 2, 9% of the total tailing occurred in the tailings from tabling and super-panning. It is thought that this difficulty was due to over-grinding the concentrate and middling before flotation.

It would appear that the process adopted in the second test would be suitable for the treatment of this ore.

It is necessary to control the grinding at all points so that the tin mineral is not overground.

The use of the cyclone in the treatment of the -350 mesh product is most promising.

2.2.5. Upgrading of Concentrate -

It is seen in Figure 2 that the concentrate produced after re-grinding, flotation, and tabling of primary concentrate assayed 53.4%.

This product assayed:-

| | |
|---|---|
| $WO_3$ | 2.6% |
| Fe | 5.5% |
| $SiO_2$ | 10.0% |

A sample of the concentrate was super-panned in order to determine what higher grade of concentrate could be produced. A concentrate assaying 65.0% Sn and containing 94% of the total tin fed to the panner was obtained. The tailing from this test assayed 9.6% Sn and contained 6% of the total tin fed to the panner.

2.2.6. Conclusion -

It is thought that the process followed in Test No. 2 would be suitable for this ore and that the grade and recovery would be higher than those shown in Table 3. In batch testing, it is not possible to return tailing to the appropriate point in the flow-sheet and 1308 gms. of tailing assaying 5.29% Sn and containing 9% of the total tin remains as a separate product. This is made up of five individual tailings, only one of which has appreciable weight - 960 gms., and assays approx. 3% Sn. The remaining 350 gms. in the four tailings would assay approx. 10% Sn and could be classed as a middling.

This loss would not occur in an operating mill.

2.3. Great Southern Ore -

A batch concentration test on Great Southern Ore is in progress.

UNIVERSITY OF QUEENSLAND

DEPARTMENT OF MINING AND METALLURGICAL ENGINEERING

MINERAL INDUSTRIES RESEARCH AND TESTING SERVICE

METALLURGICAL RESEARCH INTO TIN ORE TREATMENT, NORTH QUEENSLAND

CONTRACT C.506697: FILE NO. V.F. 295/5/11

FOURTH REPORT (PERIOD ENDING 30TH JUNE, 1965)

## 1. INTRODUCTION:

The three previous reports under this contract described the small-scale sizing, assaying, gravity concentration and mineragraphic examination of a set of eight samples of tin ores from North Queensland. [At the time of writing Report No. 3, testing work was in progress on the gravity concentration of the Great Southern Ore, and the report described two gravity concentration tests carried out on the Bloodwood Ore.]

Test work on the gravity concentration of the following ores -

1. Great Southern
2. Dover Castle
3. Rainbow
4. Gilmore
5. Lamb
6. You and Me
7. Lizzie
8. Iona

is covered in this report.

## 2. RESULTS OF TEST WORK:

### 2.1 Great Southern Ore -

Ore from the "Great Southern" is comparatively low grade, assaying 0.9% Sn. The main heavy minerals present are earthy haematite and goethite and relatively small amounts of cassiterite; both of these groups are associated (sometimes intimately) with light siliceous gangue minerals. Liberation of the cassiterite is not good until a size of approximately 150 mesh is reached.

The screen, assay, and sink-float analyses of this ore, are shown in Table 4, paragraph 2.4.1 of the second quarterly report.

#### 2.1.1 Test Work:

Since the ore was low grade and it appeared that concentration would be difficult, 20,456 gm. of the ore were taken for test. The ore was ground in a rod mill and screened into -52 +100 mesh, -100 +350 mesh and -350 mesh fractions for tabling. By this means, it was desired to obtain sufficient concentrate, probably of low grade, for further testing. The -350 mesh product was cycloned to remove the slime and the underflow portion tabled for concentrate and tailing. The washings from the table were collected separately.

The flow sheet of the test, giving the weights and assays of the products, is shown in Figure 1.

#### 2.1.2 Comments on the test:

The results of the test are summarised in Table I.

TABLE I

GREAT SOUTHERN ORE

WEIGHTS, ASSAYS AND DISTRIBUTION OF TIN

| | | | Wt. gm. | | Sn % | Sn Distn. % |
|---|---|---|---|---|---|---|
| Input | Ore | | 8058 | | 0.84 | |
| | | | 7004 | | 1.30 | |
| | | | 5394 | | 0.58 | |
| | | Total | 20456 | | 0.93 | 100.0 |
| | | calc. | 20434 | calc. | 0.88 | |
| Output | Concentrate | | 80.2 | | 44.8 | |
| | | | 80.0 | | 50 | |
| | | | 25.3 | | 20.5 | |
| | | | 5.0 | | 61.0 | |
| | | | 8.9 | | 50 | |
| | | | 199.4 | | 44.3 | 49. 0 |
| | Middling | | 124 | | 4.7 | |
| | | | 987 | | 1.13 | |
| | | | 81 | | 5.4 | |
| | | | 1192 | | 1.8 | 11.7 |
| | Tailings | | 7050 | | 0.28 | |
| | | | 6600 | | 0.43 | |
| | | | 2477 | | 0.3 | |
| | | | 2916 | | 0.5 | |
| | | | 19043 | | 0.37 | 39.3 |

It will be observed that the test produced a low grade concentrate, assaying 44.3% Sn, and containing 49% of the total tin in the feed to the test. If the low concentrate assaying 20.5% had been included in the middling, the concentrate grade would have been 48%, with a drop in recovery. However, this grade is still low.

An examination of Figure 1, reveals that the lowest tailing, assaying 0.28% Sn, was obtained from the coarse table. It is possible that a lower grade tailing could be obtained from this table by re-grinding the whole of the tailing and re-tabling. However, re-tabling was undertaken with a view to obtaining a middling product for re-grinding. On the rougher tables, the middling product was returned to the table feed. The middlings shown are washings and cleanings from the table after the test was finished. The re-tabling of the tailing shows no reduction in the tailing.

A sample of this tailing was tested by sink-float and the sink portion briquetted and examined under the microscope. No pure tin particles were seen and it was not possible to determine the association of the tin due to the large quantity of iron minerals present. In preliminary mineragraphic examination, it was shown that cassiterite was intimately associated with both the iron minerals and the lighter gangue; it is therefore thought that grinding will be the only means of freeing these particles for recovery.

The fine table, treating -100 +350 mesh product, produced a tailing of 0.45% Sn grade. A much lower tailing had been expected from this table, since the feed thereto was higher in tin and the size was such that the tin would be substantially liberated. However, re-tabling reduced the tailing from 0.55% Sn to 0.43% Sn and it is possible that re-grinding may have reduced this further.

The cyclone treating the -350 mesh fraction discarded slightly less than half of the fraction at 0.3% Sn. Tabling the underflow produced a rather low grade concentrate and subsequent super-panning of the tailing produced a tailing of 0.5% Sn. The total tailing from the -350 mesh fraction averaged 0.41% Sn and contained 10.8% of the total tin fed to the test, or approximately 70% of the total tin fed to the section.

GREAT SOUTHERN ORE

20456 g. 0.93% Sn

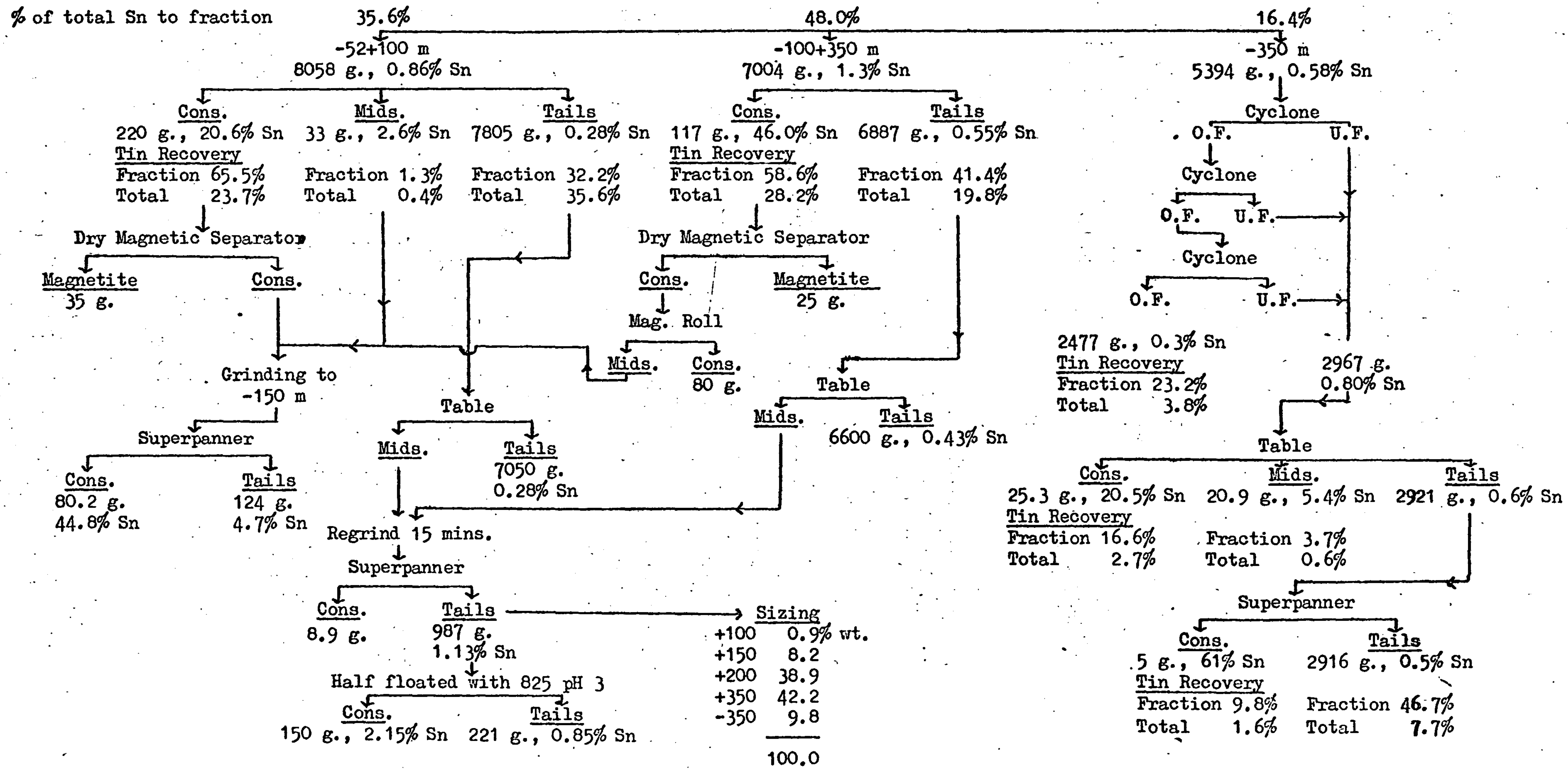



FIGURE 1

The -350 mesh tailing differed very little from the average of the coarse and fine tables.

The concentrates produced were of low grade. A small quantity of magnetite was removed from the concentrate by treatment on a dry magnetic separator. The concentrate was cleaned by grinding and super-panning. Owing to the small quantity of concentrate recovered, no further attempt at cleaning was made.

A portion of tailing which assayed 1.15% Sn was floated with Reagent 825 in an acid solution, using pine oil as a frother.

While the concentrate contained 2.15% Sn and the tailing 0.85% Sn, the concentrate appeared to contain clean iron minerals.

As the float product in the sink-float tests averaged about 75%, it is thought that a flotation operation on new ore may separate the heavy iron minerals into a flotation concentrate and that the tin may be recovered by tabling the lighter flotation tailing.

2.2 Dover Castle Ore -

The Dover Castle is a medium grade ore, assaying 2.75% Sn. It contains some sulphide minerals, including pyrrhotite, pyrite, and chalcopyrite, with minor galena and sphalerite. The cassiterite and sulphide minerals are largely liberated at -100 +150 mesh and liberation is sensibly complete at 200 mesh.

The results of sink-float tests, shown in Table I of the Third Report, demonstrate that the float fraction is reasonably free from tin in the fractions tested and that there is a possibility of discarding clean tailing at a comparatively coarse size.

It is thought that, if a concentrate of cassiterite and sulphides were made, the sulphides may be discarded later by flotation. It is desirable to recover the cassiterite and the sulphides at as coarse a size as possible in order to minimise the losses due to sliming in grinding.

2.2.1 Test Work:

Approximately 10 kg. of ore, previously crushed to -20 mesh, was taken for the test and screened into four fractions, namely, -20 +50 mesh, -50 + 100 mesh, -100 +350 mesh and -350 mesh.

The fractions were tabled. From the coarse table, concentrates, middlings and tailings were taken but, from the other tables, concentrate and tailings only were taken. The tailings from the three tables (+350 mesh) were re-ground and tabled for an acceptable tailing.

The middlings from the coarse table were re-ground and tabled twice.

The concentrates produced on the three tables, together with the concentrate produced for the re-grinding of middlings and tailings from the coarse table, were ground, subjected to flotation in order to remove sulphides, and then tabled to produce a tin concentrate.

The concentrates from re-grinding and super-panning and tabling of the -350 mesh fraction were floated for the removal of sulphides.

The flow sheet, including weights of products, assays, and other results of the test, is shown in Figure 2.

2.2.2 Comments on the test:

The results of the test are summarised in Table II.

TABLE II

DOVER CASTLE ORE

WEIGHTS, ASSAYS AND DISTRIBUTION OF TIN

| | | Wt. gm. | | Sn % | | Sn Distn. % | |
|---|---|---|---|---|---|---|---|
| Input | Ore | 6914 | | 2.9 | | | |
| | | 1843 | | 1.82 | | | |
| | | 1126 | | 3.84 | | | |
| | | 603 | | 3.1 | | | |
| | Total | 10125 | | 2.75 | | | |
| | | 10125 | | 2.9 | calc. | 100 | 100 |
| Output | Concentrate | 407 | | 43.0 | | | |
| | | 68.5 | | 44.2 | | | |
| | | | 475.5 | | | 68.1 | 77.9 |
| | Sulphides | 375 | | 5.23 | | 6.2 | 7.1 |
| | Tailings | 2641 | | 0.24 | | | |
| | | 2620 | | 0.48 | | | |
| | | 1830 | | 0.25 | | | |
| | | 446 | | 0.75 | | | |
| | | 862 | | 1.42 | | | |
| | | | 8399 | 0.47 | | | |
| | | | | | | 13.1 | 15.0 |
| | Samples taken | 507 | | 7.4 | | 12.6 | |
| | Total | 9756 | | 2.9 | | 100.0 | 100.0 |
| | Loss | 369 | | | | | |

A record was kept of the weights of samples taken for assay and other tests. These sample weights, which otherwise would have remained in the circuit, totalled 507 gm. and the average assay was calculated at 7.4% Sn. This represents 12.6% of the total tin. The tin in these samples has been split over the concentrate, sulphides and tailings in the proportion in which tin was present in those fractions. This recovery figure is shown in the final column of Table II.

There was a loss of 369 gm. of ore in the test, due probably to spill and loss of tailings, since greater care was possible in the collection and drying of the smaller quantity of concentrate and sulphides.

The loss has been neglected in the table. The calculated tin content of the original ore is 2.9% Sn, as compared with an assay value of 2.75% Sn. The higher figure is used in the calculation.

The concentrate produced was tabled so as to produce a concentrate and middling product. It is seen that the concentrate assayed 58.4% Sn, and the middling 25.6% Sn. Due to the small quantity of the middling, no further attempt at up-grading was made. The weight and assay of concentrate reported in Table II is that obtained before the final tabling.

Examination of Table 2 shows that 77,9% of the tin was recovered in a concentrate of 43.2% Sn. This concentrate was later separated into a concentrate of 58.4% Sn and a middling of 25.6% Sn. The tailings averaged 0.47% Sn and were made up from the following products, namely -

Sample 1 - re-ground table tailings from -20 +50 m. fraction table tails 0.24% Sn
Sample 2 - re-ground table tailings from -50 +100 m. fraction table tails 0.48% Sn
Sample 3 - re-ground table tailings from -100 +350 m. table tails 0.25% Sn
Sample 4 - re-ground table tailings from -350 m. fraction tails 0.75% Sn
Sample 5 - re-ground table tailings (two tailings combined) 1.42% Sn

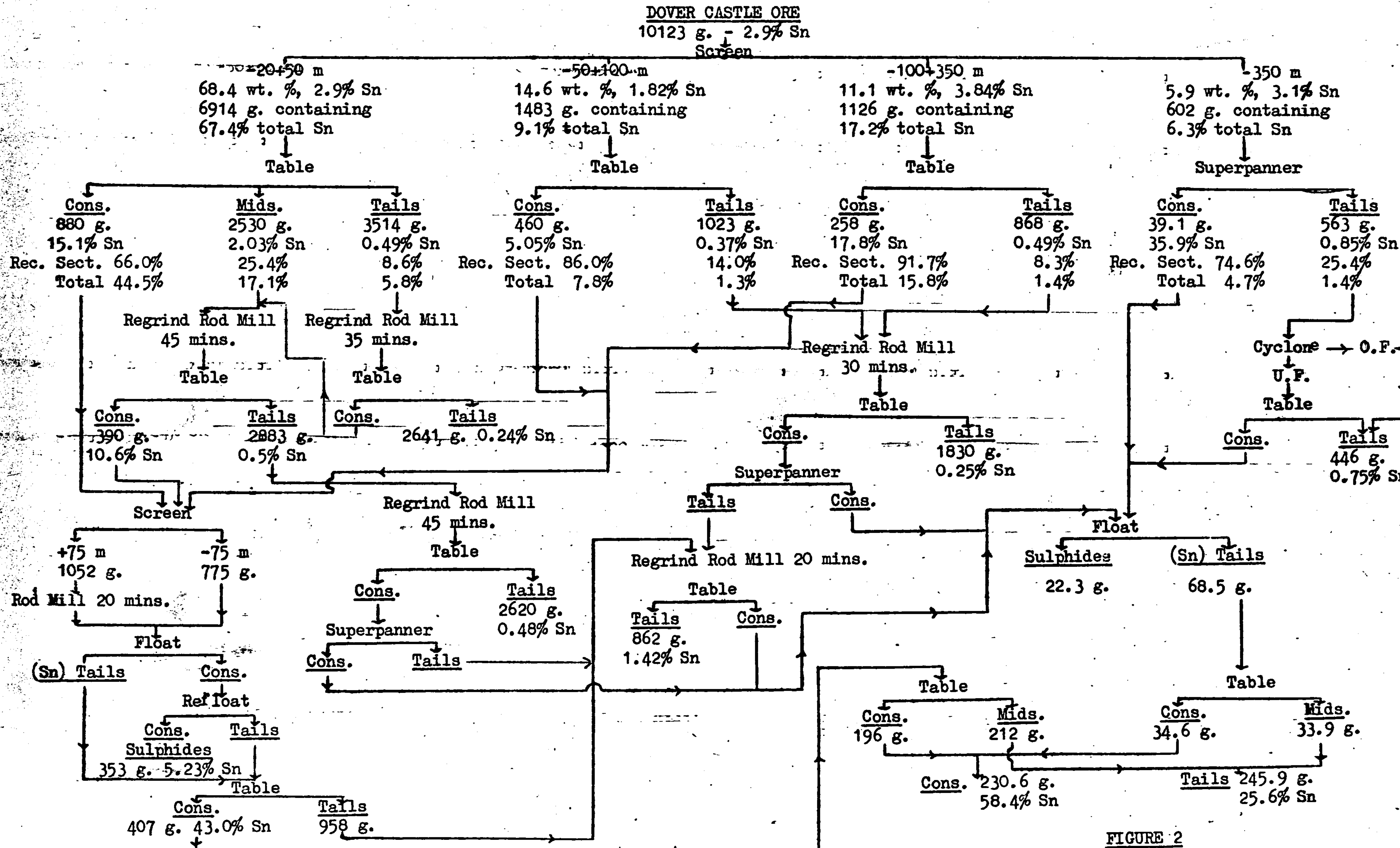

DOVER CASTLE ORE
10123 g. - 2.9% Sn
Screen
-20+50 m
68.4 wt. %, 2.9% Sn
6914 g. containing
67.4% total Sn
-50+100 m
14.6 wt. %, 1.82% Sn
1483 g. containing
9.1% total Sn
-100+350 m
11.1 wt. %, 3.84% Sn
1126 g. containing
17.2% total Sn
-350 m
5.9 wt. %, 3.1% Sn
602 g. containing
6.3% total Sn
Table
Table
Table
Superpanner
Cons.
880 g.
15.1% Sn
Rec. Sect. 66.0%
Total 44.5%
Mids.
2530 g.
2.03% Sn
25.4%
17.1%
Tails
3514 g.
0.49% Sn
8.6%
5.8%
Cons.
460 g.
5.05% Sn
Rec. Sect. 86.0%
Total 7.8%
Tails
1023 g.
0.37% Sn
14.0%
1.3%
Cons.
258 g.
17.8% Sn
Rec. Sect. 91.7%
Total 15.8%
Tails
868 g.
0.49% Sn
8.3%
1.4%
Cons.
39.1 g.
35.9% Sn
Rec. Sect. 74.6%
Total 4.7%
Tails
563 g.
0.85% Sn
25.4%
1.4%
Regrind Rod Mill
45 mins.
Table
Regrind Rod Mill
35 mins.
Table
Regrind Rod Mill
30 mins.
Table
Cyclone → O.F.
U.F.
Table
Cons.
390 g.
10.6% Sn
Tails
2883 g.
0.5% Sn
Cons.
Tails
2641 g. 0.24% Sn
Cons.
Tails
1830 g.
0.25% Sn
Cons.
Tails
446 g.
0.75% Sn
Superpanner
Tails
Cons.
Screen
Regrind Rod Mill
45 mins.
Table
Float
Sulphides
22.3 g.
(Sn) Tails
68.5 g.
+75 m
1052 g.
-75 m
775 g.
Rod Mill 20 mins.
Regrind Rod Mill 20 mins.
Cons.
Tails
2620 g.
0.48% Sn
Table
Tails
862 g.
1.42% Sn
Cons.
Float
(Sn) Tails
Cons.
Superpanner
Cons.
Tails
Refloat
Cons.
Sulphides
353 g. 5.23% Sn
Tails
Table
Table
Table
Cons.
196 g.
Mids.
212 g.
Cons.
34.6 g.
Mids.
33.9 g.
Cons. 230.6 g.
58.4% Sn
Tails 245.9 g.
25.6% Sn
Cons.
407 g. 43.0% Sn
Tails
958 g.

FIGURE 2

Tailings Samples 1, 2 and 3 above were combined and sampled and a screen analysis made. The +72 mesh and -350 mesh products were assayed for tin.

The tailings 4 and 5 above were similarly combined, samples and screen analysis made. The +350 mesh and -350 mesh were assayed for tin.

These results are shown in Table III.

TABLE III

TAILINGS, ASSAYS, SIZE ANALYSIS

| Mesh | Wt. % | Sn % | Sn Distn. % |
|---|---|---|---|
| Composite Sample 1, 2 & 3 | | | |
| +52 | 5.4 | 0.15 | |
| -52+72 | 7.4 | | |
| -72+100 | 7.5 | | 34 |
| -100+150 | 10.1 | 0.4 calc. | |
| -150+200 | 11.6 | | |
| -200+350 | 13.5 | | |
| -350 | 44.5 | 0.48 | 66 |
| | 100.0 | 0.32 assay | 100.0 |
| Composite Sample 4 & 5 | | | |
| +350 | 30.6 | 0.48 | 12.2 |
| -350 | 69.4 | 1.52 | 87.8 |
| | 100.0 | 1.26 assay | 100.0 |

It is clearly seen from these figures that the greater part of the tailings loss is in the -350 mesh fraction.

It is thought that the fine grinding of the ore should be carried out after the removal of the coarse tin. The ineffectiveness of re-grinding after the tin has been slimed is shown in the re-grinding of table tailings from the middlings in the -20 +50 mesh fractions, when the tailings were reduced in grade from 0.5% Sn to 0.48% Sn by re-grinding and tabling.

It is considered that better results would have been obtained by less grinding of the middlings.

The loss in the tailings after super-panning and tabling of the -350 mesh fraction was 0.75% Sn. This is regarded as reasonable, having regard to the percent weight and tin content of the fraction.

The rougher concentrates were generally of poor grade but increased in grade with increased fineness. 44.5% of the total tin was removed as concentrate (15.1% Sn) from the -20 +50 mesh table. It is thought that the feed to this table was too coarse and that a jig may have handled the duty. The coarse tailings would then be ground to pass 50 mesh and fed to the subsequent tables. A jig may remove some of the finer cassiterite and sulphides.

The flotation of sulphides is a comparatively simple matter. The grinding of the tin concentrates prior to flotation would appear to be a matter for enquiry. It is thought that the high tailing loss of 1.52% Sn shown in Table III - composite Samples 3 & 4 - could be caused by sliming of the tin concentrate in re-grinding before flotation.

2.3 Rainbow Ore -

The Rainbow ore is a high grade ore containing 18.0% Sn. Some of the cassiterite is present in large pieces and sink-float tests reported in a previous report (No. 2, Section 2.6) show that good recoveries may be expected in all sizes tested.

"The main heavy mineral present is cassiterite, with relatively minor amounts of pyrite, pyrrhotite, sphalerite and galena." Liberation is almost complete at 150 mesh."

2.3.1 Test Work:

Preliminary concentration tests on a laboratory jig indicated that about one-half of the cas iterite could be recovered as a high grade concentrate in a jig. It was evident that the ore fed to the jig would require crushing to -10 mesh, since this size was the maximum that the jig could handle, although a coarser feed may be desirable.

Ore crushed to -10 mesh of weight 7427 gm. was taken for the test. A bed comprising 68 gm. of shot and a quantity of cassiterite was prepared for the jig and the total ore was fed to it. The bed required "poking" in order to view the passage of cassiterite passing it.

The tails from the jig were wet-screened on 350 mesh, and the +350 mesh were dried and screened on 22 m., 52 m., 100 m., and 350 m.. The +22 mesh was groun ground in a pulverizer to pass 22 mesh and split over the other fractions. The fractions were then tabled in order to produce concentrate and tailings, and all tailings (with the exception of the -350 mesh tailings) were re-ground in a rod mill and re-tabled for concentrate and tailings.

The flow sheet, including weights of products, assays, and other results of the test, is shown in Figure 3.

2.3.2 Comments on the test:

The results of the test are summarised in Table IV.

TABLE IV

RAINBOW ORE

WEIGHTS, ASSAYS AND DISTRIBUTION OF TIN

| | | Wt. gm. | Sn % | Sn Distn. % | |
|---|---|---|---|---|---|
| Input | Ore | 7427 | 18.3<br>18.6 calc. | | |
| Output | Jig Concentrate | 1113 | 72.0 | 57.8 | 58.6 |
| | Table Concentrate | 152<br>160<br>253.5<br>291.8<br>74.3<br>168 | 48.25<br>45.0<br>54.2<br>44.0<br>54.8<br>38.8 | 36.2 | 36.7 |
| | Total | 2212.6 | 58.9 | 93.0 | 95.3 |
| | Middlings | 52.4<br>54.2 | 4.51<br>13.55 | | |
| | | 106.6 | 9.1 | 0.7 | 0.7 |
| | Tailings | 1785<br>1020<br>845<br>687 | 1.32<br>0.43<br>0.45<br>3.20 | | |
| | | 4337 | 1.24 | 3.9 | 4.0 |
| | Samples | 322 | 5.9 | 1.4 | |
| | Loss | 449 | | | |
| | | | | 100.0 | 100.0 |

As with the Dover Castle ore, a record was kept of the weights of samples taken, and the tin in samples has been allocated to concentrates, middlings and tailings in the proportions shown in Table IV.

There was a loss of 449 gm. in the total weight of products recovered and an increase in the total tin. The recovered tin gives a head assay value of 18.6% Sn. This value has been used in calculating the distribution of tin values.

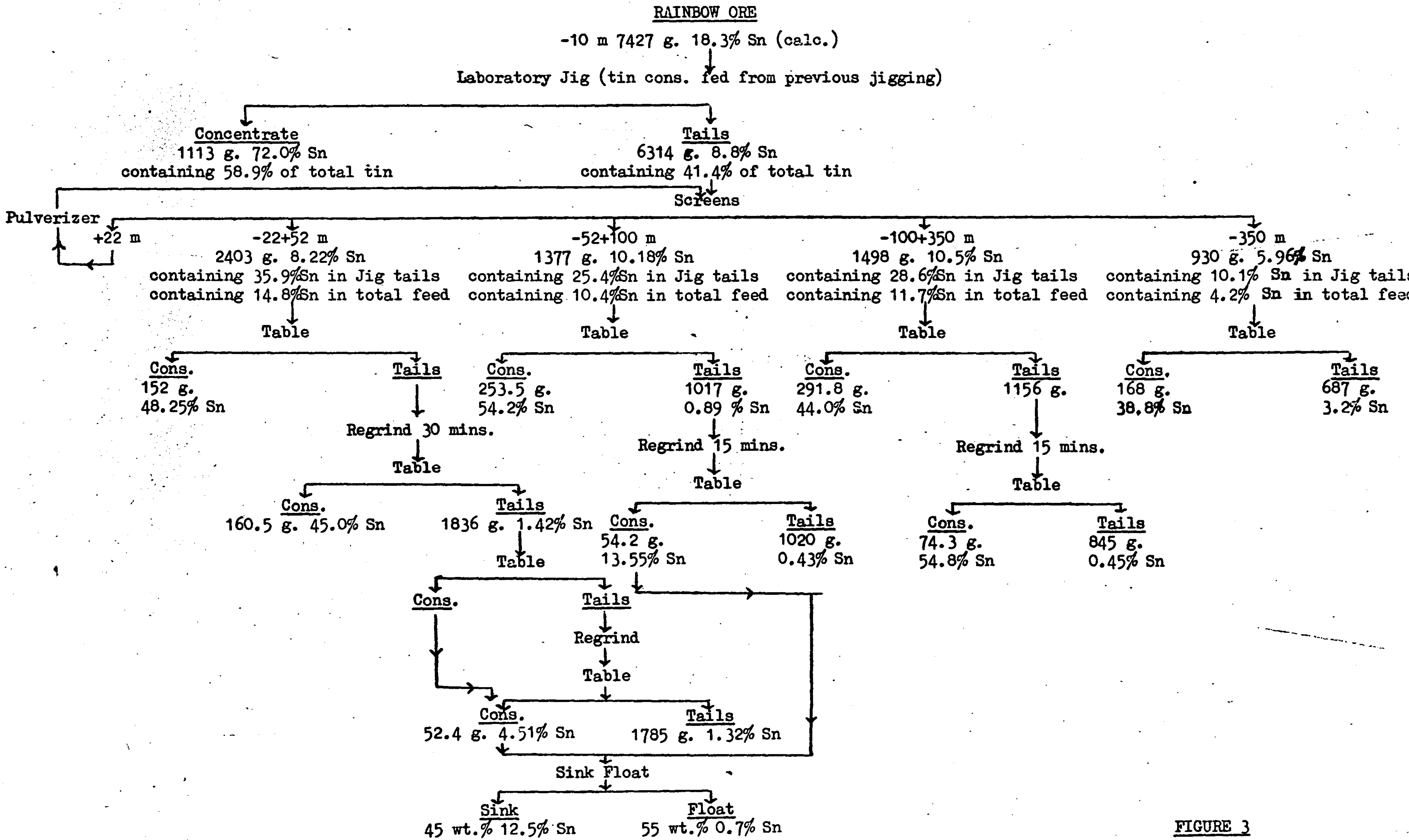

RAINBOW ORE
-10 m 7427 g. 18.3% Sn (calc.)
Laboratory Jig (tin cons. fed from previous jigging)
Concentrate
1113 g. 72.0% Sn
containing 58.9% of total tin
Tails
6314 g. 8.8% Sn
containing 41.4% of total tin
Screens
Pulverizer
+22 m
-22+52 m
2403 g. 8.22% Sn
containing 35.9%Sn in Jig tails
containing 14.8%Sn in total feed
-52+100 m
1377 g. 10.18% Sn
containing 25.4%Sn in Jig tails
containing 10.4%Sn in total feed
-100+350 m
1498 g. 10.5% Sn
containing 28.6%Sn in Jig tails
containing 11.7%Sn in total feed
-350 m
930 g. 5.96% Sn
containing 10.1% Sn in Jig tails
containing 4.2% Sn in total feed
Table
Table
Table
Table
Cons.
152 g.
48.25% Sn
Tails
Regrind 30 mins.
Table
Cons.
160.5 g. 45.0% Sn
Tails
1836 g. 1.42% Sn
Table
Cons.
Tails
Regrind
Table
Cons.
52.4 g. 4.51% Sn
Tails
1785 g. 1.32% Sn
Cons.
253.5 g.
54.2% Sn
Tails
1017 g.
0.89 % Sn
Regrind 15 mins.
Table
Cons.
54.2 g.
13.55% Sn
Tails
1020 g.
0.43% Sn
Cons.
291.8 g.
44.0% Sn
Tails
1156 g.
Regrind 15 mins.
Table
Cons.
74.3 g.
54.8% Sn
Tails
845 g.
0.45% Sn
Cons.
168 g.
38.8% Sn
Tails
687 g.
3.2% Sn
Sink Float
Sink
45 wt.% 12.5% Sn
Float
55 wt.% 0.7% Sn

FIGURE 3

The use of a Denver mineral jig showed a recovery of 58% of the total tin in a concentrate assaying 72% Sn.

It is possible that some of the larger pieces of cassiterite could not pass through the jig screen and that a higher recovery of tin could be made by operating the jig in a continuous grinding circuit. The ore made one pass over the jig and the tin content was reduced from 18.3% Sn to 8.8% Sn. After completion of the test, the jig bed was 68 gm. of shot and 255 gm. of heavy mineral. The volume of the bed was the same as at the beginning of the test, but no assays for tin were made on this material.

The object in jigging the coarse ore was to recover as much cassiterite as possible at coarse size and to minimise the sliming which could take place in later grinding.

The tabling of the screened fractions of the jig tailing produced reasonable grades of concentrates, and no further effort was made to up-grade them.

The tailings, (with the exception of -350 mesh), from the tables were re-ground and re-tabled for concentrate and tailing. The tailing from the two finer tables (-52 + 350 mesh) were reasonable. The re-ground table tailings from the -22 + 52 mesh fraction was high (1.42% Sn) and this was not reduced by re-grinding and re-tabling.

In order to investigate the loss, a screen analysis of a sample of the re-ground table tailings was made and the fractions assayed. The results are shown in Table V.

TABLE V

SCREEN-ASSAY ANALYSIS

RE-GRIND TABLE TAILINGS

| Mesh | Wt. % | Sn % | Sn Distn. % |
|---|---|---|---|
| +350 | 52.8 | 0.18 | 6.9 |
| -350 dry screen | 8.4 | 0.62 | 3.8 |
| -350 wet screen | 38.8 | 3.15 | 89.3 |
| | 100.0 | 1.37 | 100.0 |

It is clear that the loss is mainly in the -350 mesh slime, where the assay was 3.15% Sn, as compared with 0.18% Sn in the +350 mesh. It is also interesting to note that the tailings from tabling -350 mesh fraction was also 3.2% Sn.

It is considered that the first re-grinding of -22 +52 mesh table tailings was carried much too far and that a better recovery on this fraction could have been obtained by halving the re-grinding time. It is clear that very little tin was recovered in the second re-grinding of this tailing and that what tin was recovered might have been obtained by re-tabling only.

The tabling of the -350 mesh fraction recovered 75% of the tin fed to the fraction. It is considered that jigging and tabling of this ore would give satisfactory results. Ore should be passed to the jig as soon as it is crushed to a suitable size and the grinding mill discharge should be jigged so as to recover coarse tin as soon as it is liberated.

The tabling should be carried out at as coarse a mesh as is possible and middlings, if such can be made with an acceptable tailing, should be re-ground and re-tabled. It is necessary to keep the -350 mesh fraction as small as possible, if cassiterite is present in quantity in the ore. After the greater portion of the cassiterite has been removed, fine grinding is necessary in order to liberate the fine particles of cassiterite in the ore.

2.4 Gilmore Ore -

Two samples of Gilmore ore were received. No. 1 sample contained a considerable quantity of fine -¼" material. The sample was screened at ¼" mesh and the +¼" and -¼" fractions were subjected to screen sink-float and superpanner analyses separately. The fractions were examined separately.

No. 2 sample was crushed and tested as usual. The results of the small-scale testing of these ores, together with the mineragraphy, is shown in the Second Quarterly Report, Sections 2.7.1, 2.7.2, 2.7.3, and 2.7.4.

Sample No. 2 was of slightly higher grade than Sample No. 1. The results of the small-scale tests on the two fractions of Sample No. 1 and Sample No. 2 were similar.

The heavy minerals present in the samples examined were almost identical. The liberation of cassiterite was virtually complete at 150 mesh in Sample No. 1 but in Sample No. 2 liberation was by no means complete at 350 mesh. Sample No. 2 was selected for larger scale concentration tests.

The Gilmore ore tested is a high-grade ore assaying 6.1% Sn. The main heavy mineral present is cassiterite, with associated pyrite, pyrrhotite, arsenopyrite, chalcopyrite and sphalerite.

2.4.1 Test Work:

Preliminary concentration tests showed that some of the cassiterite could be recovered in a jig from ore crushed to -10 mesh. Since the grade of ore after jigging would still be high, it was thought advisable to table the ore crushed to -22 mesh for the production of a concentrate and middling before re-grinding the ore for the production of a clean tailing, since it was clear that fine grinding was necessary for the complete liberation of the cassiterite.

The concentrate and middlings so produced could possibly be up-graded by re-grinding and tabling, with less loss than if it were finely ground with the ore before tabling.

A bed for the jig was prepared from shot and crushed magnetite. At the conclusion of jigging, the material remaining in the jig was separated into original bedding and bedding derived from the ore, by a simple magnetic separation; the results would be quantitative.

Approximately 8000 gm. of ore, crushed to -10 mesh, was fed to the jig. A concentrate assaying 54.6% Sn and bedding material assaying 41.7% Sn were reclaimed from the jig. These two products contained 38.9% of the total tin fed to the jig. The jig tailing was crushed to pass through 22 mesh and separated into fractions -22 + 52 m., -52 +100 m., -100 +350 m., and -350 m.. The fractions +350 m. were tabled in order to produce concentrate, middlings and tailings, and the -350 m. was tabled to produce concentrate and tailings on.y.

The tailings from the two tables +52 and +100 mesh, were re-ground and tabled to produce a concentrate and a final tailing. The concentrate and the middling products were re-ground and tabled for a concentrate and tailing.

The -350 mesh product was tabled and it produced a low-grade concentrate and a tailing which was calculated to contain 2.3% Sn. The tailings were cycloned and produced an underflow, assaying 3.9% Sn and containing 53.5% of the tin in 34% of the weight of the tailing. This underflow was tabled, but no concentrate could be obtained.

The flow sheet, including weights of products, assays, and other results of the test, is shown in Figure 4.

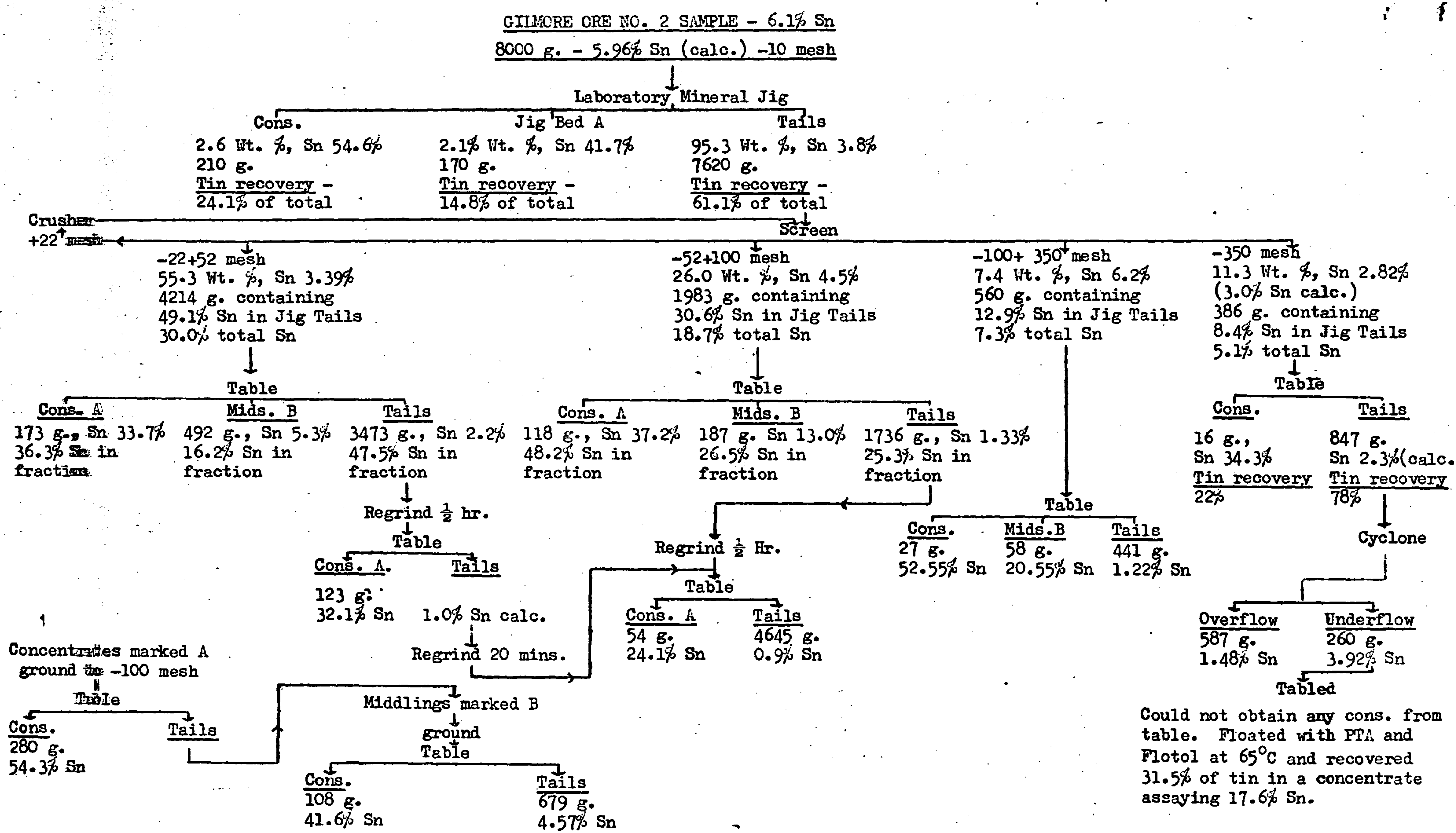

GILMORE ORE NO. 2 SAMPLE - 6.1% Sn
8000 g. - 5.96% Sn (calc.) -10 mesh
Laboratory Mineral Jig
Cons.
2.6 Wt. %, Sn 54.6%
210 g.
Tin recovery -
24.1% of total
Jig Bed A
2.1% Wt. %, Sn 41.7%
170 g.
Tin recovery -
14.8% of total
Tails
95.3 Wt. %, Sn 3.8%
7620 g.
Tin recovery -
61.1% of total
Crusher
+22 mesh
Screen
-22+52 mesh
55.3 Wt. %, Sn 3.39%
4214 g. containing
49.1% Sn in Jig Tails
30.0% total Sn
Table
Cons. A
173 g., Sn 33.7%
36.3% Sn in
fraction
Mids. B
492 g., Sn 5.3%
16.2% Sn in
fraction
Tails
3473 g., Sn 2.2%
47.5% Sn in
fraction
Regrind ½ hr.
Table
Cons. A.
123 g.
32.1% Sn
Tails
1.0% Sn calc.
Regrind 20 mins.
-52+100 mesh
26.0 Wt. %, Sn 4.5%
1983 g. containing
30.6% Sn in Jig Tails
18.7% total Sn
Table
Cons. A
118 g., Sn 37.2%
48.2% Sn in
fraction
Mids. B
187 g. Sn 13.0%
26.5% Sn in
fraction
Tails
1736 g., Sn 1.33%
25.3% Sn in
fraction
Regrind ½ Hr.
Table
Cons. A
54 g.
24.1% Sn
Tails
4645 g.
0.9% Sn
-100+ 350 mesh
7.4 Wt. %, Sn 6.2%
560 g. containing
12.9% Sn in Jig Tails
7.3% total Sn
Table
Cons.
27 g.
52.55% Sn
Mids.B
58 g.
20.55% Sn
Tails
441 g.
1.22% Sn
-350 mesh
11.3 Wt. %, Sn 2.82%
(3.0% Sn calc.)
386 g. containing
8.4% Sn in Jig Tails
5.1% total Sn
Table
Cons.
16 g.,
Sn 34.3%
Tin recovery
22%
Tails
847 g.
Sn 2.3%(calc.
Tin recovery
78%
Cyclone
Overflow
587 g.
1.48% Sn
Underflow
260 g.
3.92% Sn
Tabled
Could not obtain any cons. from
table. Floated with PTA and
Flotol at 65°C and recovered
31.5% of tin in a concentrate
assaying 17.6% Sn.
Concentrates marked A
ground to -100 mesh
Table
Cons.
280 g.
54.3% Sn
Tails
Middlings marked B
ground
Table
Cons.
108 g.
41.6% Sn
Tails
679 g.
4.57% Sn

FIGURE 4.

2.4.2 Comments on test:

The results of the test are summarised in Table VI.

TABLE VI

GILMORE ORE

WEIGHTS, ASSAYS AND DISTRIBUTION OF TIN

| | Wt. gm. | Sn % | | Sn Distn. % | |
|---|---|---|---|---|---|
| Input | 8000 | 5.96 | | 100 | 100 |
| Output Jig Concentrate | 210 | 54.6 | 24.1 | | |
| Table Concentrate | 27 | 52.55 | - | | |
| | 16 | 34.3 | | | |
| | 280 | 54.3 | 45.4 | | |
| | 108 | 41.6 | | | |
| Total | 641 | 51.7 | | 69.5 | 75.6 |
| Middlings | 679 | 4.57 | | | |
| | 260 | 3.92 | | | |
| Total | 936 | 4.4 | | 8.7 | 9.5 |
| Tailings | 4645 | 0.9 | | | |
| | 441 | 1.22 | | | |
| | 587 | 1.48 | | | |
| Total | 5673 | 0.99 | | 11.7 | 12.7 |
| Samples | 498 | 7.7 | | 8.1 | - |
| Loss | 249 | 3.8 | | 2.0 | 2.2 |
| Total | 8000 | | | | |

As before, a record was kept concerning weights of samples taken for test, and the tin in these samples has been allocated to the concentrates, middlings and tailings in proportion to the distribution Sn %.

There was a loss of 249 gm. in weight and a loss of tin. Combining these, the loss was 249 gm. at 3.8% Sn or 2.2% of the total tin.

A Denver mineral jig recovered 24.1% of the total tin in a concentrate, assaying 54.6% Sn. The tables produced a concentrate, averaging 50.0% Sn and containing 45.4% of the total tin. The combined jig and table concentrate averaged 51.7% Sn and contained 75.6% of the total tin.

The material remaining in the jig bed, and derived entirely from the ore, assayed 41.7% Sn and contained 14.8% of the total tin. The jig concentrate and the residual jig bed therefore recovered 38.9% of the total tin. The jig bedding was later ground with other concentrates and up-graded on the table.

The re-grinding of the concentrate and middlings is difficult, and tabling produced a tailing of 4.57% Sn, which is included in the middlings in Table IV. This represented 6.5% of the total tin. The composite tailings assayed 0.99% Sn and contained 12.7% of the total tin.

The tailing from the tabling of the re-ground tailing from the +52 and +100 mesh fractions (weight 4645 gm. and assaying 0.9% Sn) was sized on 350 mesh, and the -350 mesh cyclosized. The size analysis, together with assays and Sn distribution, are shown in Table VII.

## TABLE VII

## GILMORE ORE, TAILINGS 4645 gm., 0.9% Sn

## SIZING, ASSAY AND DISTRIBUTION OF TIN

Screen Analysis

| Mesh | Wt. % | Sn % | Sn Distn. % | |
|---|---|---|---|---|
| +350 | 55.4 | 0.73 | 44.2 | 44.2 |
| -350 | 44.6 | 1.13 | 55.8 | |
| | 100.0 | | 100.0 | |

Cyclosizer Analysis

| Cyclone | Nom. Size | Fraction | Total | Sn % | Sn Distn. % | |
|---|---|---|---|---|---|---|
| 1 & 2 | 34 | 1.0 | | | | |
| 3 | 24 | 10.9 | 12.4 | 1.83 | 45.2 | 25.2 |
| 4 | 16 | 16.0 | | | | |
| 5 | 11 | 12.3 | 32.2 | 0.86 | 54.8 | 30.6 |
| O/F | -11 | 59.8 | | | | |
| | | 100.0 | 44.6 | | 100.0 | 10C.0 |

From Table VII, it will be seen that the loss is greatest in the -350 mesh fraction, which contains 55.8% of the tin in 44.6% of the weight.

The cyclosizer analysis of the -350 mesh fraction is interesting, in that the fractions of tailings reporting in Cones 1 to 4 assay 1.83% Sn and represent 12.4% of the total weight. The material reporting in Cone 5 and the overflow represents 32.2% of the total weight and is calculated to contain 0.86% Sn.

These considerations indicate that more tin might be recovered by finer grinding of the tailing. This was indicated in the mineragraphic examination, when it was observed that "liberation was by no means complete at 350 mesh".

However, it must be remembered that the size of a clean, pure piece of cassiterite of Sp. Gr. 7, which would report in Cone 4, is 8.48 microns as compared with 16 microns for a piece of quartz of Sp. Gr. 2.65.

The tabling of the -350 mesh fraction(2.82% Sn and containing 5.1% of the total tin) was not very satisfactory, since only 22% of the tin fed to the table was recovered in a concentrate assaying 34.3% Sn.

By cycloning the table tailings, an underflow product, assaying 3.92% Sn and an overflow product, assaying 1.48% Sn, was obtained.

No tin concentrate was produced from the table when the underflow produced was fed to it. Some of the underflow product was flotated with P.T.A. and Flotol at 65°C and 31.5% of the tin in a concentrate of 17.6% Sn was recovered.

The feed to the table, -350 mesh, was cyclosized. The results are shown in Table VIII.

TABLE VIII

GILMORE ORE -350 MESH FRACTION

CYCLOSIZER ANALYSIS

| Cyclone | Nom. Size | Wt. % | Sn % | Sn Distn. % |
|---|---|---|---|---|
| 1 | 45 | 1.0 | 41.6 | 14.8 |
| 2 | 34 | 3.14 | 12.5 | 17.1 |
| 3 | 24 | 10.64 | 6.0 | 22.6 |
| 4 | 16 | 14.57 | 3.4 | 17.6 |
| 5 | 11 | 12.7 | 2.1 | 9.4 |
| O/F | -11 | 57.95 | 0.95 | 18.5 |
| | | 100.0 | | 100.0 |

2.5 Lamb Ore -

The sample of Lamb Ore assayed 1.99% Sn. Mineragraphic examination showed that the main heavy mineral present was haematite, with small amounts of sulphides (mainly pyrrhotite and chalcopyrite). The cassiterite is mostly free between 100 and 150 mesh.

The screen assay and sink-float analyses of the ore are shown in Table 3 of the Second Quarterly Report.

2.5.1 Test Work:

Since free cassiterite was present at +72 mesh, the ore was stage-crushed through 22 mesh and separated into fractions +52, -52, +100, -100, +350 and -350 mesh. It was thought that some of the cassiterite could be recovered as concentrate or middling at the coarse size on a table, and the tailing could be re-ground to produce a good table concentrate and clean tailing. It was also thought that the percentage weight and tin content of the -350 mesh fraction would be kept to a minimum by these means.

The fractions were tabled separately. All tailings +350 mesh were re-ground and tabled. The concentrates of lower grade were re-ground and tabled. The tailing from this cleaning were added to the middlings, re-ground and tabled. The -350 mesh fraction on tabling produced very little concentrate. The flow sheet of the test, showing the weights, assays, and other results of the test, is shown in Figure 5.

2.5.2 Comments on test:

The results of the test are shown in Table IX.

TABLE IX

LAMB ORE

WEIGHTS, ASSAYS AND DISTRIBUTION OF TIN

| | | Wt. gm. | Sn % | Sn Distn. % | |
|---|---|---|---|---|---|
| Input | | 7355 | 2.06 | 100 | |
| Output | Concentrate | 91 | 54.15 | | |
| | | 13 | 37.2 | | |
| | | 43.2 | 30.35 | | |
| | | 22 | 25.5 | | |
| | | 221.5 | 48.2 | 68.5 | 74.0 |
| | Middlings | 598 | 2.41 | | |
| | | 15 | 12.85 | | |
| | | 613 | 2.6 | 10.4 | 11.3 |
| | Tailings | 5095 | 0.28 | | |
| | | 857 | 0.85 | | |
| | | 5952 | 0.35 | 13.6 | 14.7 |
| | Samples | 320 | 3.6 | 7.5 | |
| | Loss | 249 | | | |
| | | 7355 | | 100.0 | 100.0 |

There was a loss of 249 gm. in weight in the test.

As before, a record was kept of samples taken for assay and test, and the tin in the samples has been distributed between the concentrate, middling and tailing in the proportion of their tin content.

A recovery of 74% of the tin was made in a concentrate assaying 48.2% Sn. The tailing assayed 0.35% Sn, and a middling product, assaying 2.4% Sn and containing 11.3% of the total tin was made.

The best tabling results were obtained from the -52 +100 mesh fraction. The concentrate assayed 54.15% Sn and contained 77.5% of the tin fed to the table.

The concentrates from both the coarser and finer fractions were of poorer grade. It is thought that the -22 + 52 mesh fraction was too coarse and that a better concentration would have been possible if the coarsest size was -36 instead of -22. The fractions could then be split at 72, 150 and 350 mesh.

The value of re-grinding the table tailing is shown by the fact that tailings of grades 0.72% Sn, 0.4% Sn and 0.6% Sn were reduced to 0.28% Sn by re-grinding.

The re-grinding of the concentrate and middling produced concentrate of grades 64.4% Sn and 30.35% Sn. It was not possible to carry out any up-grading of the lower grade concentrates, due to the small weights involved. Some method other than tabling must be used to up-grade the fine middlings and concentrates. In the -350 mesh fraction, only 20.5% of the tin was recovered in a concentrate assaying 12.85% Sn by tabling.

The re-grinding of concentrate and recovery of tin on the table could doubtless be improved by a study of the operation along the lines of stage-grinding and tabling in order to minimise the production of slime and make possible the recovery of tin at the coarsest size.

The sizing and assay analysis of the tailings from re-treatment of the tails from fractions +350 mesh, and the tailings from re-grinding of middlings is shown in Table X.

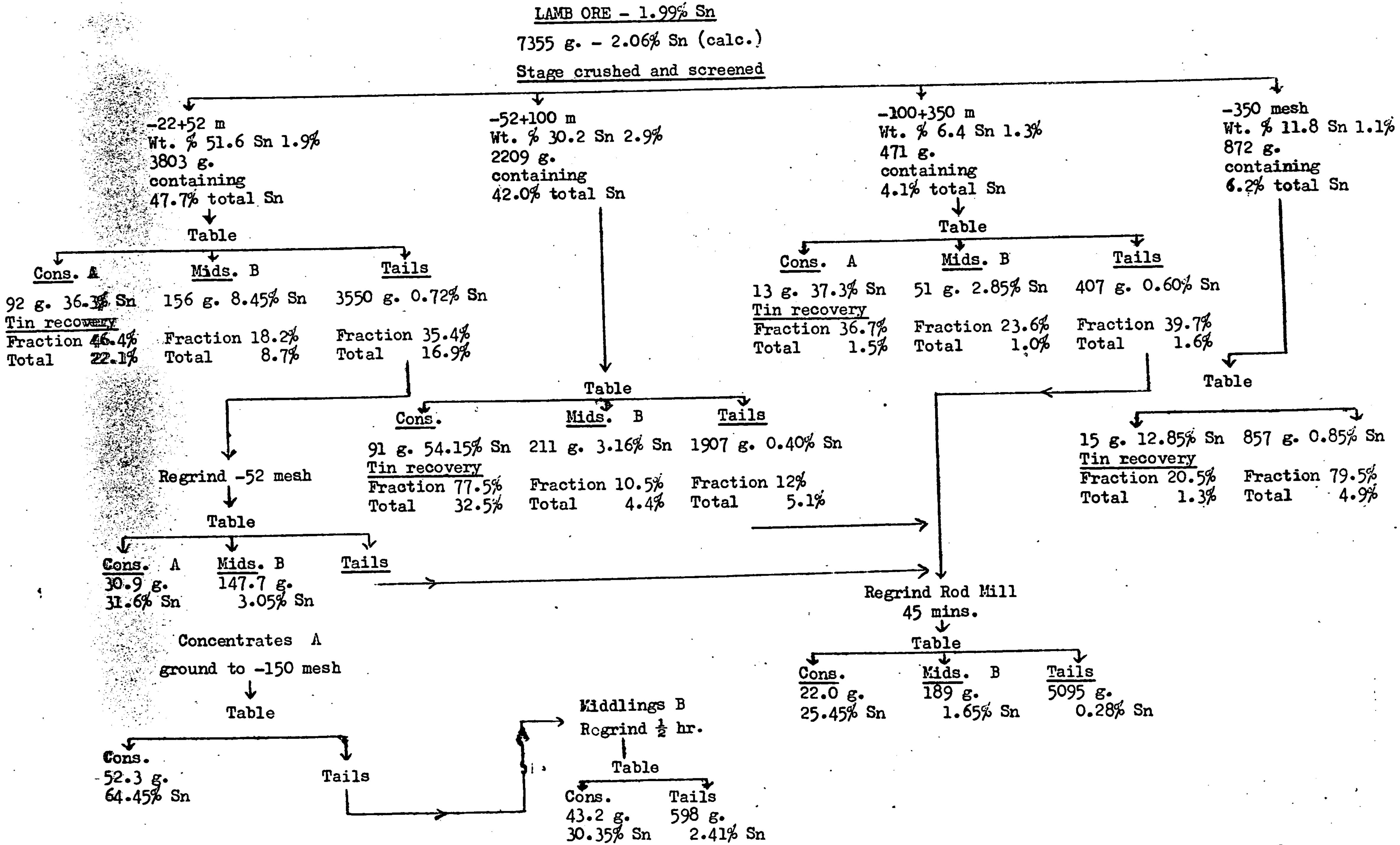

LAMB ORE - 1.99% Sn
7355 g. - 2.06% Sn (calc.)
Stage crushed and screened
-22+52 m
Wt. % 51.6 Sn 1.9%
3803 g.
containing
47.7% total Sn
Table
Cons. A
92 g. 36.3% Sn
Tin recovery
Fraction 46.4%
Total 22.1%
Mids. B
156 g. 8.45% Sn
Fraction 18.2%
Total 8.7%
Tails
3550 g. 0.72% Sn
Fraction 35.4%
Total 16.9%
Regrind -52 mesh
Table
Cons. A
30.9 g.
31.6% Sn
Mids. B
147.7 g.
3.05% Sn
Tails
Concentrates A
ground to -150 mesh
Table
Cons.
52.3 g.
64.45% Sn
Tails
Middlings B
Regrind ½ hr.
Table
Cons.
43.2 g.
30.35% Sn
Tails
598 g.
2.41% Sn
-52+100 m
Wt. % 30.2 Sn 2.9%
2209 g.
containing
42.0% total Sn
Table
Cons.
91 g. 54.15% Sn
Tin recovery
Fraction 77.5%
Total 32.5%
Mids. B
211 g. 3.16% Sn
Fraction 10.5%
Total 4.4%
Tails
1907 g. 0.40% Sn
Fraction 12%
Total 5.1%
-100+350 m
Wt. % 6.4 Sn 1.3%
471 g.
containing
4.1% total Sn
Table
Cons. A
13 g. 37.3% Sn
Tin recovery
Fraction 36.7%
Total 1.5%
Mids. B
51 g. 2.85% Sn
Fraction 23.6%
Total 1.0%
Tails
407 g. 0.60% Sn
Fraction 39.7%
Total 1.6%
-350 mesh
Wt. % 11.8 Sn 1.1%
872 g.
containing
6.2% total Sn
Table
15 g. 12.85% Sn
Tin recovery
Fraction 20.5%
Total 1.3%
857 g. 0.85% Sn
Fraction 79.5%
Total 4.9%
Regrind Rod Mill
45 mins.
Table
Cons.
22.0 g.
25.45% Sn
Mids. B
189 g.
1.65% Sn
Tails
5095 g.
0.28% Sn

FIGURE 5

TABLE X

SIZING AND ASSAY ANALYSIS OF TAILING

LAMB ORE

Sizing of tailings from fractions +350 mesh

Screen Analysis

| Mesh | Wt. % | Sn % | Distn. | Sn % |
|---|---|---|---|---|
| + 350 | 39.1 | 0.10 | 15.9 | 15.9 |
| -350 | 60.9 | 0.34 | 84.1 | |
| | 100.0 | 0.25 | 100.0 | |

Cyclosizer analysis of -350 mesh above

| Cyclone | Nom. Size | Wt. % | Sn % | | |
|---|---|---|---|---|---|
| 1 | 45 | | | | |
| 2 | 34 | 4.0 | 0.50 | 80.4 | 67.6 |
| 3 | 24 | 25.1 | | | |
| 4 | 16 | 25.6 | | | |
| 5 | 11 | 13.9 | 0.15 | 19.6 | 16.5 |
| O/F | -11 | 31.4 | | | |
| | | 100.0 | 0.34 | 100.0 | 100.0 |

Cyclosizing of tailings from middlings re-grind

| Cyclone | Nom. Size | Wt. % | Sn % | Sn Distn. % |
|---|---|---|---|---|
| 1 | 45 | 8.6 | 1.14 | 4.06 |
| 2 | 34 | 28.6 | 1.48 | 17.18 |
| 3 | 24 | 30.5 | 1.96 | 24.81 |
| 4 | 16 | 14.4 | 3.04 | 18.16 |
| 5 | 11 | 4.8 | 3.59 | 7.15 |
| O/F | -11 | 13.7 | 5.00 | 28.64 |
| | | 100.0 | 2.41 | 100.00 |

## 2.6 You-and-Me Ore -

The sample of You-and-Me ore assayed 1.94% Sn. The small-scale tests on this ore are reported in paragraph 2.2.1 of the Second Quarterly Report.

The mineragraphy showed that the major heavy minerals present are cassiterite, titan-haematite, ilmenite, pyrite, and pyrrhotite, with minor sphalerite, arsenopyrite and chalcopyrite. The cassiterite occurs mainly associated with light gangue minerals, and the titan-haematite and ilmenite are usually closely associated and/or intergrown. Liberation of the cassiterite is not good, until a size of about 150 to 200 mesh is reached.

### 2.6.1 Test Work:

It was decided to treat this ore in much the same manner as the Lamb Ore.

Approximately 10½ kg of ore was crushed through 22 mesh and split up as before into fractions -22 +52, -52 +100, -100 +350, and -350 mesh.

The fractions were tabled separately for the production of concentrate, middlings and tailings. The tailings from the +350 mesh fractions was re-ground and tabled for the production of concentrate and tailings. The -350 mesh fraction was tabled for concentrate and tailings only. The concentrate from the coarser table was ground and cleaned on a plaque. The tailings from the plaque and the table middlings were re-ground and tabled for the production of concentrate and middlings.

The flow sheet, showing weights, assays and other results of the test, is shown in Figure 6.

2.6.2 Comments on test:

The results of the test are shown in Table XI.

TABLE XI

YOU-AND-ME ORE

WEIGHTS, ASSAYS AND DISTRIBUTION OF TIN

| | | Wt. gm. | Sn % | | Sn Distn. % | |
|---|---|---|---|---|---|---|
| Input | | 10498 | 1.98 | 20786 | | |
| Output | Concentrate | 85 | 35.2 | 2992 | | |
| | | 117 | 52.4 | 6131 | | |
| | | 89 | 43.7 | 3889 | | |
| | | 30 | 41.9 | 1257 | | |
| | | 321 | 44.4 | 14269 | 69.7 | 73.8 |
| | Middlings | 690 | 2.47 | 1704 | 8.3 | 8.8 |
| | Tailings | 7250 | 0.29 | 2102 | | |
| | | 846 | 1.18 | 998 | | |
| | | 623 | 0.4 | 249 | | |
| | | 8719 | 0.38 | 3349 | 16.4 | 17.4 |
| | | 9775 | | | | |
| | Samples | 368 | 3.1 | 1155 | 5.6 | |
| | Loss | 355 | | 309 | | |
| | | | | | 100.0 | 100.0 |

There was a loss of 355 gm. in weight and a loss of tin in the test. The results, as shown in Table XI, are similar to those obtained from the Lamb Ore shown in Table IX. The recovery figures are almost identical, but the grade of concentrate produced was 4% lower. Since no recovery of tin was made on the table from the -350 mesh fraction, the feed to this table was cyclosized. The results are shown in Table XII.

TABLE XII

YOU-AND-ME ORE

ASSAY SIZING OF THE -350 MESH FRACTION

| Cyclone | Nom. Size | Wt. % | Sn % | Sn Distn. % |
|---|---|---|---|---|
| 1 | 45 | 0.4 | | |
| 2 | 34 | 2.7 | 2.25 | 38.9 |
| 3 | 24 | 17.1 | | |
| 4 | 16 | 23.5 | 1.0 | 31.9 |
| 5 | 11 | 14.0 | | |
| O/F | -11 | 42.3 | 0.82 | 29.2 |
| | | 100.0 | 1.18 | 100.0 |

It is seen that ore of nominal size less than 24 microns contains over 60% of the tin. It would therefore appear that the cassiterite is too fine for recovery on the table. The produce was produced by dry crushing the ore to -22 mesh.

The sizing and assay analysis of the final tailings from the fractions +350 mesh and the tailings (or middlings) from the re-grind of the middling product is shown in Table XIII.

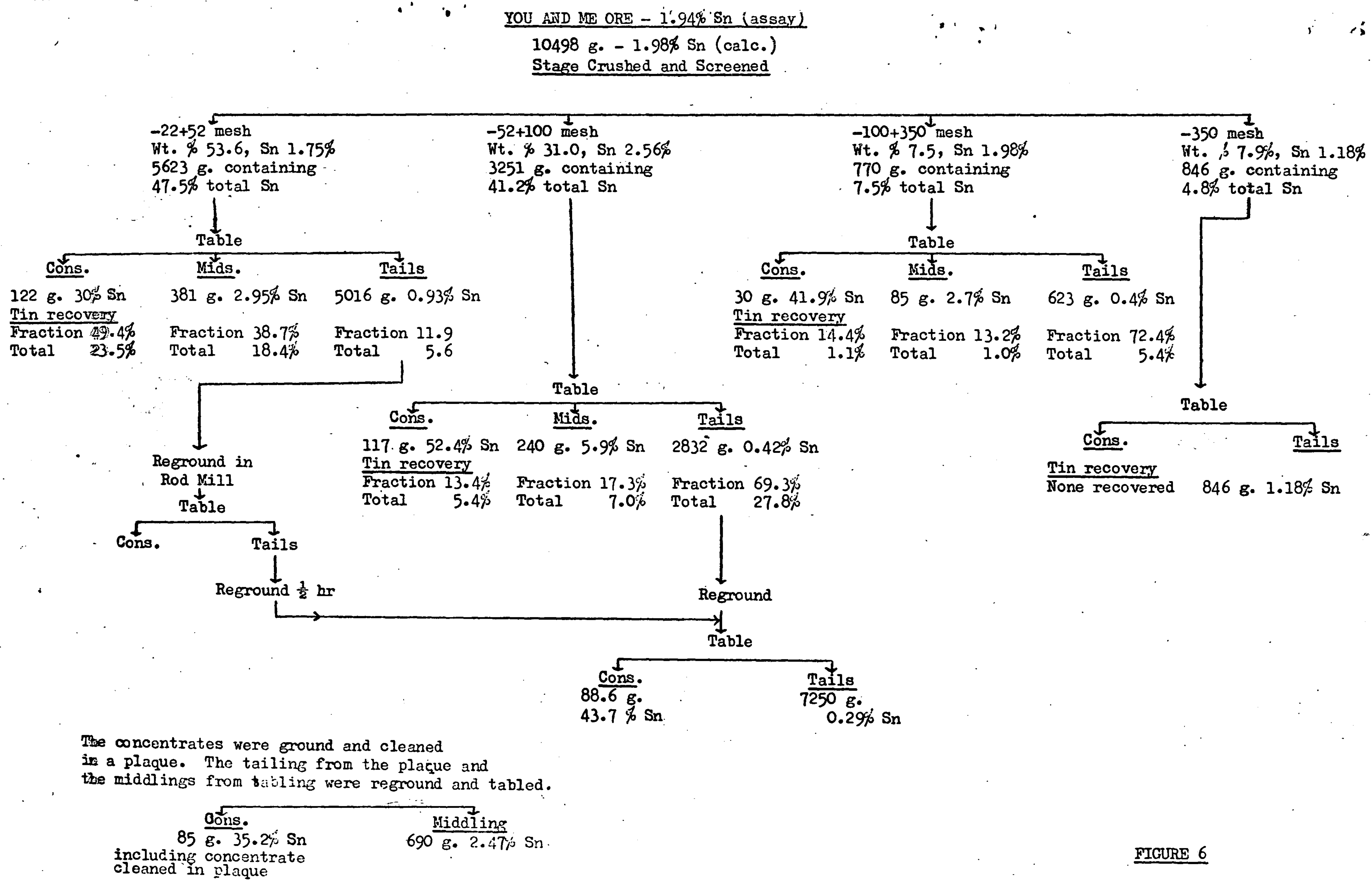

YOU AND ME ORE - 1.94% Sn (assay)
10498 g. - 1.98% Sn (calc.)
Stage Crushed and Screened
-22+52 mesh
Wt. % 53.6, Sn 1.75%
5623 g. containing
47.5% total Sn
Table
Cons.
122 g. 30% Sn
Tin recovery
Fraction 49.4%
Total 23.5%
Mids.
381 g. 2.95% Sn
Fraction 38.7%
Total 18.4%
Tails
5016 g. 0.93% Sn
Fraction 11.9
Total 5.6
Reground in
Rod Mill
Table
Cons.
Tails
Reground ½ hr
-52+100 mesh
Wt. % 31.0, Sn 2.56%
3251 g. containing
41.2% total Sn
Table
Cons.
117 g. 52.4% Sn
Tin recovery
Fraction 13.4%
Total 5.4%
Mids.
240 g. 5.9% Sn
Fraction 17.3%
Total 7.0%
Tails
2832 g. 0.42% Sn
Fraction 69.3%
Total 27.8%
Reground
Table
Cons.
88.6 g.
43.7 % Sn
Tails
7250 g.
0.29% Sn
-100+350 mesh
Wt. % 7.5, Sn 1.98%
770 g. containing
7.5% total Sn
Table
Cons.
30 g. 41.9% Sn
Tin recovery
Fraction 14.4%
Total 1.1%
Mids.
85 g. 2.7% Sn
Fraction 13.2%
Total 1.0%
Tails
623 g. 0.4% Sn
Fraction 72.4%
Total 5.4%
-350 mesh
Wt. % 7.9%, Sn 1.18%
846 g. containing
4.8% total Sn
Table
Cons.
Tin recovery
None recovered
Tails
846 g. 1.18% Sn
The concentrates were ground and cleaned
in a plaque. The tailing from the plaque and
the middlings from tabling were reground and tabled.
Cons.
85 g. 35.2% Sn
including concentrate
cleaned in plaque
Middling
690 g. 2.47% Sn

FIGURE 6

TABLE XIII

YOU-AND-ME ORE

SIZING AND ASSAY ANALYSIS OF TAILING

Sizing of tailings from fractions +350 mesh (0.29% Sn)

Screen Analysis

| Mesh | Wt. % | Sn % | Sn Distn. % | |
|---|---|---|---|---|
| +200 | 19.1 | 0.23 | 16.6 | 16.6 |
| +350 | 34.1 | 0.10 | 12.9 | 12.9 |
| -350 | 46.8 | 0.40 | 70.5 | |
| | 100.0 | 0.27 calc. | 100.0 | |

Cyclosizer analysis of -350 mesh above

| Cyclone | Nom. Size | Wt. % | Sn % | | |
|---|---|---|---|---|---|
| 1 | 45 | | | | |
| 2 | 34 | 11.6 | 0.54 | 67 | 47.2 |
| 3 | 24 | 20.9 | | | |
| 4 | 16 | 17.2 | | | |
| 5 | 11 | 9.4 | 0.26 | 33 | 23.2 |
| 0/F | -11 | 40.9 | | | |
| | | 100.0 | 0.40 | 100 | 100.0 |

Cyclosizing of tailings from middlings re-grind

| Cyclone | Nom. Size | Wt. % | Sn % | Sn Distn. % |
|---|---|---|---|---|
| 1 | 45 | 16.0 | 2.42 | 15.7 |
| 2 | 34 | 29.2 | 1.56 | 18.4 |
| 3 | 24 | 15.4 | 2.67 | 16.6 |
| 4 | 16 | 11.7 | 4.28 | 20.3 |
| 5 | 11 | 6.5 | 3.60 | 9.1 |
| 0/F | -11 | 21.2 | 2.26 | 19.9 |
| | | 100.0 | 2.47 | 100.0 |

2.7 Lizzie Ore -

The Lizzie Ore is comparatively low-grade, assaying 0.97% Sn. Mineragraphic examination shows that the heavy minerals present are haematite and goethite, with some psilomelane. Liberation of cassiterite is satisfactory at about 72 mesh and virtually complete at 150 mesh.

The small-scale sink-float tests show that the sink product is generally greater in eight than the float, and that, while the float would assay 0.14 Sn, the sink product would be less than 2% Sn.

2.7.1 Test Work:

Exploratory work only has been done on this ore. Planning has shown that a reasonable grade of concentrate can be obtained from the ore, but the recovery would be poor.

Portions of the ground fractions have been tabled, with poor results. These were not pursued to completion and were not assayed.

Portion of the ore was tested in a mineral jig, with the object of removing a clean tailing. This was not successful, since the recovery was in the region of 30%.

It may be possible to discard up to 60% of the ore by tabling, after grinding to about 72 mesh. The concentrate from this operation might be treated by flotation in order to remove the haematite and goethite, and the residues upgraded by tabling. There is some possibility of magnetically separating the haematite, but no work has been carried out on this aspect.

## 2.8 Iona Ore -

### 2.8.1 Test Work:

The consolidated results of small-scale concentration tests are shown in Table XIV.

TABLE XIV
IONA ORE - Assay 0.51%

SCREEN ASSAY, SINK-FLOAT, SUPERPANNER ANALYSIS

| Mesh | Wt. % | Sn % | Product | Sink-Float Wt. % | Sn % | Distn. % | Sn Distn. % on Total Ore | |
|---|---|---|---|---|---|---|---|---|
| +36 | 12.6 | 0.39 | | | | | | 9.77 |
| -36+52 | 12.7 | 0.50 | Sink | 9.4 | 3.88 | 72.8 | 9.19) | |
| | | | Float | 90.6 | 0.15 | 27.2 | 3.44) | 12.63 |
| -52+72 | 14.9 | 0.43 | | | | | | 12.74 |
| -72+100 | 12.3 | 0.59 | Sink | 11.2 | 3.84 | 72.8 | 10.50) | |
| | | | Float | 88.8 | 0.18 | 27.2 | 3.93) | 14.43 |
| -100+150 | 10.0 | 0.55 | Sink | 11.1 | 4.56 | 90.2 | 9.87) | |
| | | | Float | 88.9 | 0.05 | 9.8 | 1.07) | 10.94 |
| -150+200 | 6.3 | 0.73 | Sink | 14.7 | 4.71 | 94.2 | 8.61) | |
| | | | Float | 85.3 | 0.05 | 5.8 | 0.53) | 9.14 |
| -200+350 | 8.6 | 0.67 | | | | | | 11.46 |
| | | | Superpanner Analysis | | | | | |
| -350 | 22.6 | 0.42 | Cons. | 0.9 | 15.1 | 33 | 6.3) | |
| | | | Tails | 99.1 | 0.3 | 67 | 12.6) | 18.9 |

Calculated assay 0.50%

Assay 0.51%

### 2.8.2 Mineragraphic Examination of Iona Ore "Sink" Fractions

The assays of the sink and float fractions indicate that good recovery of the tin bearing minerals may be obtained by gravity concentration methods, even at relatively coarse sizes. One mineragraphic examination disclosed that the heavy concentrates contain high proportions of heavy gangue minerals which would always report in a gravity concentrate. Identification of such translucent minerals is difficult by mineragraphic techniques, but the concentrates certainly contained iron oxides, manganese minerals and minor sulphides.

Liberation is good at a relatively coarse size, but the elimination of the diluting gangue minerals will prove extremely difficult.

### 2.8.3 Comments

The shortage of time available, and the low-grade of the ore, together with the discouraging results of the small-scale gravity concentration tests resulted in no further work being carried out on this ore. Even at suitable sizing, superpanning produced a very low-grade concentrate which could almost certainly not be bettered in any larger-scale operation.

A preliminary flotation test upon the ore resulted in a recovery of approximately 67% of the tin in a concentrate assaying 1.64% Sn. This concentrate again contained most of the diluting minerals found in the gravity concentrates.