

TR6-229-239

R. 390

CONCENTRATION TESTS ON DIAMOND DRILL CORE FROM
HOLE D.P. 1, ARDLETHAN, N.S.W.

Introduction

This is the first of a series of investigations to obtain data relative to the recovery of tin by gravity concentration from diamond drill core samples from Ardlethan, N.S.W. In this investigation (R.390) detail is given concerning sample preparation, &c. To save repetition, these data will not be repeated in later investigations.

Sample

Tin determinations on core from diamond drilling operations at Ardlethan, N.S.W., have been carried out in the Department of Mines Laboratory for some time. The whole of the core is received as sample.

The cores are reduced to approximately one eighth inch size and a sample removed for further size reduction as assay sample preparation. The reject sample, i.e., the portions left after removing the assay samples, are used to make up the composite samples used in the investigations.

Usually 25 samples are received from each diamond drill hole. Each sample is taken to represent 10 feet of core, and all composite samples have been made up on an equal weight per sample basis using the reject samples.

Compositions of the composite samples, together with the tin content of the various samples were:

| Reg. No. | Description | % Sn | Sample Number | % Sn Composite Sample |
|----------|-------------|------|---------------|-----------------------|
| 780 | D.P. 1— 1 | 0.39 | | |
| 781 | D.P. 1— 2 | 0.33 | | |
| 782 | D.P. 1— 3 | 0.30 | R.390A | 0.36 |
| 783 | D.P. 1— 4 | 0.30 | | |
| 784 | D.P. 1— 5 | 0.39 | | |
| 785 | D.P. 1— 6 | 0.16 | | |
| 786 | D.P. 1— 7 | 0.39 | | |
| 787 | D.P. 1— 8 | 0.43 | R.390B | 0.43 |
| 788 | D.P. 1— 9 | 0.53 | | |
| 789 | D.P. 1—10 | 0.59 | | |
| 790 | D.P. 1—11 | 0.52 | | |
| 791 | D.P. 1—12 | 0.44 | | |
| 792 | D.P. 1—13 | 0.47 | R.390C | 0.44 |
| 793 | D.P. 1—14 | 0.60 | | |
| 794 | D.P. 1—15 | 0.18 | | |
| 795 | D.P. 1—16 | 0.17 | | |
| 796 | D.P. 1—17 | 0.30 | | |
| 797 | D.P. 1—18 | 0.50 | R.390D | 0.32 |
| 798 | D.P. 1—19 | 0.34 | | |
| 799 | D.P. 1—20 | 0.21 | | |

| | | | | |
|-----|-----------|------|--------|------|
| 800 | D.P. 1—21 | 0.28 | R.390E | 0.38 |
| 801 | D.P. 1—22 | 0.25 | | |
| 802 | D.P. 1—23 | 0.29 | | |
| 803 | D.P. 1—24 | 0.65 | | |
| 804 | D.P. 1—25 | 0.42 | | |

A composite sample from the whole drill hole, R.390F, was made by taking equal weights of the composites R.390A-E.

Investigation

Aberfoyle Tin N.L. (Tin Development Partnership) requested investigations on composite samples of the sample rejects to obtain data relating to recovery of tin by gravity concentration. The concentration method suggested by the company for each composite of 50 feet of core length, was briefly:—

- (1) Stage crush and grind the samples minus 44 mesh.
- (2) Remove sulphides by flotation.
- (3) Size the desulphidized sample into four fractions.
- (4) Table each fraction separately, with possible regrinding of middlings.
- (5) Carry out a vanning assay for tin for each composite.

The company also requested a heavy liquid (S.G.2.92-2.95) separation on the minus five mesh plus 30 mesh fraction of a sample representing the drill core from the whole hole.

Summary

Table concentration tests gave:—

| Sample No. | Composite Head % Sn | Combined Concentrate % Sn | Combined Tailings % Sn | % Recovery Sn in Concentrate |
|----------------------|---------------------|---------------------------|------------------------|------------------------------|
| R.390A | 0.36 | 9.2 | 0.17 | 52.6 |
| R.390B | 0.46 | 10.1 | 0.19 | 59.0 |
| R.390C | 0.44 | 12.3 | 0.23 | 48.9 |
| R.390D | 0.34 | 7.6 | 0.13 | 62.7 |
| R.390E | 0.41 | 9.6 | 0.16 | 62.6 |
| Arithmetical Average | 0.40 | 9.8 | 0.18 | 57.2 |

Middlings were not removed in the above tests. If middlings had been removed and ground as in investigation R.392 and later investigations, overall tin recovery would have been improved, particularly in samples R.390A, R.390B and R.390C, as the plus 60 mesh fractions of the tailings contained 0.24, 0.23 and 0.31% tin respectively. At this stage, with ore grades similar to those above (i.e. 0.34-0.46), a recovery of some 60% of the tin in a concentrate assaying about 10% tin appears practicable.

Heavy liquid separations on the plus 30 mesh material indicate that preconcentration by T.B.E., or other heavy media methods, would not be warranted due to high tailing losses.

Research

Sample Reduction

Each of the composite samples R.390A-E inclusive was stage roll crushed through a five mesh screen. Equal parts (by weight) of samples R.390A-E were then taken and mixed to constitute sample R.390F.

Samples R.390A-E were further stage roll crushed through a 22 mesh screen. A sample for head value determination and for vaning examination was removed from each of the minus 22 mesh samples.

The samples R.390A-E were then stage ball mill ground through a 44 mesh screen, using short grinding intervals to minimize production of slimes.

Flotation of Sulphides

Sulphides were removed from the ground material by flotation. No attempt was made to determine optimum flotation conditions. The following reagents were used in the test and appeared to be effective.

| Reagents | Approximate Usage: Pounds Per Ton of Flotation Feed |
|-----------------------------|---|
| Sulphuric Acid | 1 |
| Copper Sulphate | 1 |
| Sodium ethyl xanthate | 0.2 |
| Sodium amyl xanthate | 0.3 |
| Cresylic Acid | 0.1 |

No sulphides floated from samples R.390A and R.390B.

A very small quantity of sulphides floated from sample R.390C, but the quantity was negligible, and the product was returned to the bulk of the sample.

The quantities of sulphides removed from samples R.390D and R.390E are shown in the tabulations following.

Table Concentration

After flotation the desulphidized minus 44 mesh material was wet screened to give plus 60 mesh, minus 60 plus 100 mesh, minus 100 plus 200 mesh and minus 200 mesh fractions.

The four sized fractions were then tabled separately on the Deister laboratory table. As the tests are aimed at obtaining data relating to possible recovery of the tin, tabling conditions were set to give a clean tailing, with a comparatively low grade concentrate containing about 10% tin. Middling products were removed separately in this investigation, so that the various sized fractions could be assessed independently for recovery, concentration of tin, &c.

The overall test results for the various samples are shown in the tabulations. The results for each of the fractions tabled separately are also shown.

Sample R.390A

| Product | Weight | Percent Sn | Percent Distribution Sn |
|--|---------------|-------------|-------------------------|
| Concentrate: | | | |
| + 60 mesh | 0.41 | 17.4 | 19.8 |
| + 100 mesh | 1.06 | 5.2 | 15.3 |
| + 200 mesh | 0.24 | 12.2 | 8.2 |
| - 200 mesh | 0.34 | 9.8 | 9.3 |
| Total Concentrate | 2.05 | 9.2 | 52.6 |
| Tailings: | | | |
| + 60 mesh | 49.52 | 0.24 | 33.0 |
| + 100 mesh | 17.95 | 0.09 | 4.5 |
| + 200 mesh | 9.69 | 0.11 | 3.0 |
| - 200 mesh | 20.79 | 0.12 | 6.9 |
| Total Tailings | 97.95 | 0.17 | 47.4 |
| Composite Head | 100.00 | 0.36 | 100.0 |
| Head (Assay) | | 0.36 | |
| <i>Concentration Results—Individual Screen Fractions</i> | | | |
| + 60 mesh fraction: | | | |
| Concentrate | 0.83 | 17.4 | 37.8 |
| Tailings | 99.17 | 0.24 | 62.2 |
| Composite | 100.00 | 0.38 | 100.0 |
| + 100 mesh fraction: | | | |
| Concentrate | 5.60 | 5.2 | 77.4 |
| Tailings | 94.40 | 0.09 | 22.6 |
| Composite | 100.00 | 0.38 | 100.0 |
| + 200 mesh fraction: | | | |
| Concentrate | 2.38 | 12.2 | 73.0 |
| Tailings | 97.62 | 0.11 | 27.0 |
| Composite | 100.00 | 0.40 | 100.0 |
| - 200 mesh fraction: | | | |
| Concentrate | 1.61 | 9.8 | 57.2 |
| Tailings | 98.39 | 0.12 | 42.8 |
| Composite | 100.00 | 0.28 | 100.0 |

Sample R.390B

| Product | Weight | Percent Sn | Percent Distribution Sn |
|--|---------------|-------------|-------------------------|
| Concentrate: | | | |
| + 60 mesh | 0.40 | 22.8 | 19.7 |
| + 100 mesh | 1.55 | 5.6 | 18.8 |
| + 200 mesh | 0.25 | 16.2 | 8.8 |
| - 200 mesh | 0.51 | 10.6 | 11.7 |
| Total Concentrate | 2.71 | 10.1 | 59.0 |
| Tailings: | | | |
| + 60 mesh | 50.69 | 0.23 | 25.2 |
| + 100 mesh | 18.68 | 0.12 | 4.8 |
| + 200 mesh | 8.84 | 0.14 | 2.7 |
| - 200 mesh | 19.08 | 0.20 | 8.3 |
| Total Tailings | 97.29 | 0.19 | 41.0 |
| Composite Head | 100.00 | 0.46 | 100.0 |
| Head (Assay) | | 0.43 | |
| <i>Concentration Results—Individual Screen Fractions</i> | | | |
| + 60 mesh fraction: | | | |
| Concentrate | 0.78 | 22.8 | 43.8 |
| Tailings | 99.22 | 0.23 | 56.2 |
| Composite | 100.00 | 0.41 | 100.0 |
| + 100 mesh fraction: | | | |
| Concentrate | 7.67 | 5.6 | 79.5 |
| Tailings | 92.33 | 0.12 | 20.5 |
| Composite | 100.00 | 0.54 | 100.0 |
| + 200 mesh fraction: | | | |
| Concentrate | 2.76 | 16.2 | 76.7 |
| Tailings | 97.24 | 0.14 | 23.3 |
| Composite | 100.00 | 0.58 | 100.0 |
| -200 mesh fraction: | | | |
| Concentrate | 2.59 | 10.6 | 58.5 |
| Tailings | 97.41 | 0.20 | 41.5 |
| Composite | 100.00 | 0.47 | 100.0 |

Sample R.390C

| Product | Weight | Percent Sn | Percent Distribution Sn |
|--|---------------|-------------|-------------------------|
| Concentrate: | | | |
| + 60 mesh | 0.33 | 16.6 | 12.3 |
| + 100 mesh | 0.82 | 8.4 | 15.5 |
| + 200 mesh | 0.29 | 15.7 | 10.2 |
| - 200 mesh | 0.33 | 14.6 | 10.9 |
| Total Concentrate | 1.77 | 12.3 | 48.9 |
| Tailings: | | | |
| + 60 mesh | 47.55 | 0.31 | 33.2 |
| + 100 mesh | 18.60 | 0.12 | 5.0 |
| + 200 mesh | 8.75 | 0.12 | 2.4 |
| - 200 mesh | 23.33 | 0.20 | 10.5 |
| Total Tailings | 98.23 | 0.23 | 51.1 |
| Composite Head | 100.00 | 0.44 | 100.0 |
| Head (Assay) | | 0.44 | |
| <i>Concentration Results—Individual Screen Fractions</i> | | | |
| + 60 mesh fraction: | | | |
| Concentrate | 0.68 | 16.6 | 26.8 |
| Tailings | 99.32 | 0.31 | 73.2 |
| Composite | 100.00 | 0.42 | 100.0 |
| + 100 mesh fraction: | | | |
| Concentrate | 4.23 | 8.4 | 75.6 |
| Tailings | 95.77 | 0.12 | 24.4 |
| Composite | 100.00 | 0.47 | 100.0 |
| + 200 mesh fraction: | | | |
| Concentrate | 3.20 | 15.7 | 81.2 |
| Tailings | 96.80 | 0.12 | 18.8 |
| Composite | 100.00 | 0.62 | 100.0 |
| - 200 mesh fraction: | | | |
| Concentrate | 1.40 | 14.6 | 50.9 |
| Tailings | 98.60 | 0.20 | 49.1 |
| Composite | 100.00 | 0.40 | 100.0 |

Sample R.390D

| Product | Weight | Percent Sn | Percent Distribution Sn |
|--|---------------|-------------|-------------------------|
| Concentrate: | | | |
| + 60 mesh | 0.99 | 6.9 | 20.2 |
| + 100 mesh | 1.08 | 5.0 | 15.9 |
| + 200 mesh | 0.27 | 12.9 | 10.3 |
| - 200 mesh | 0.45 | 12.3 | 16.3 |
| Total Concentrate | 2.79 | 7.6 | 62.7 |
| Tailings: | | | |
| + 60 mesh | 40.51 | 0.13 | 15.6 |
| + 100 mesh | 16.33 | 0.07 | 3.4 |
| + 200 mesh | 8.99 | 0.13 | 3.4 |
| - 200 mesh | 29.70 | 0.16 | 14.0 |
| Sulphides | 1.68 | 0.17 | 0.9 |
| Total Tailings | 97.21 | 0.13 | 37.3 |
| Composite Head | 100.00 | 0.34 | 100.0 |
| Head (Assay) | | 0.32 | |
| <i>Concentration Results—Individual Screen Fractions</i> | | | |
| + 60 mesh fraction: | | | |
| Concentrate | 2.38 | 6.9 | 56.4 |
| Tailings | 97.62 | 0.13 | 43.6 |
| Composite | 100.00 | 0.29 | 100.0 |
| + 100 mesh fraction: | | | |
| Concentrate | 6.23 | 5.0 | 82.6 |
| Tailings | 93.77 | 0.07 | 17.4 |
| Composite | 100.00 | 0.38 | 100.0 |
| + 200 mesh fraction: | | | |
| Concentrate | 2.90 | 12.9 | 74.8 |
| Tailings | 97.10 | 0.13 | 25.2 |
| Composite | 100.00 | 0.50 | 100.0 |
| - 200 mesh fraction: | | | |
| Concentrate | 1.50 | 12.3 | 53.9 |
| Tailings | 98.50 | 0.16 | 46.1 |
| Composite | 100.00 | 0.34 | 100.0 |

Sample R.390E

| Product | Weight | Percent Sn | Percent Distribution Sn |
|--|---------------|-------------|-------------------------|
| Concentrate: | | | |
| + 60 mesh | 1.40 | 8.1 | 27.6 |
| + 100 mesh | 0.73 | 6.6 | 11.7 |
| + 200 mesh | 0.33 | 14.2 | 11.4 |
| - 200 mesh | 0.22 | 22.2 | 11.9 |
| Total Concentrate | 2.68 | 9.6 | 62.6 |
| Tailings: | | | |
| + 60 mesh | 43.04 | 0.13 | 13.6 |
| + 100 mesh | 20.02 | 0.21 | 10.2 |
| + 200 mesh | 10.17 | 0.12 | 3.0 |
| - 200 mesh | 21.22 | 0.19 | 9.8 |
| Sulphides | 2.87 | 0.11 | 0.8 |
| Total Tailings | 97.32 | 0.16 | 37.4 |
| Composite Head | 100.00 | 0.41 | 100.0 |
| Head (Assay) | | 0.38 | |
| <i>Concentration Results—Individual Screen Fractions</i> | | | |
| + 60 mesh fraction: | | | |
| Concentrate | 3.15 | 8.1 | 67.0 |
| Tailings | 96.85 | 0.13 | 33.0 |
| Composite | 100.00 | 0.38 | 100.0 |
| + 100 mesh fraction: | | | |
| Concentrate | 3.54 | 6.6 | 53.6 |
| Tailings | 96.46 | 0.21 | 46.4 |
| Composite | 100.00 | 0.44 | 100.0 |
| + 200 mesh fraction: | | | |
| Concentrate | 3.10 | 14.2 | 79.1 |
| Tailings | 96.90 | 0.12 | 20.9 |
| Composite | 100.00 | 0.56 | 100.0 |
| - 200 mesh fraction: | | | |
| Concentrate | 1.01 | 22.2 | 54.4 |
| Tailings | 98.99 | 0.19 | 45.6 |
| Composite | 100.00 | 0.41 | 100.0 |

Concentration by "Vanning"

The "vanning" assay involves digestion of the sample with nitric and hydrochloric acids, followed by concentration by panning, with intermediate stage grinds. The acid treatment effectively removes sulphides and some heavy minerals such as iron oxides. The subsequent panning is much simplified, as the residue consists essentially of silicates and cassiterite.

Recovery of tin by vanning from the various samples is shown below.

| Sample | Percent Recovery of Tin in Concentrate |
|--------|---|
| R.390A | 40.1 |
| R.390B | 51.7 |
| R.390C | 48.2 |
| R.390D | 47.2 |
| R.390E | 47.4 |

Heavy Liquid Separation

Sample R.390F, representing the whole bore, was screened into three fractions, viz. minus five mesh plus 10 mesh; minus 10 mesh plus 30 mesh, and minus 30 mesh. The two coarse fractions were separated into "sink" and "float" fractions using acetylene tetrabromide at Sp.G. 2.93. The company requested this test to help assess the possibility of using the recently developed T.B.E., or other heavy media process for pre-concentration of the ore.

Results of heavy liquid separations are tabulated below to show recoveries on individual fractions and also overall recovery.

| Product | Weight | Percent Sn | Percent Distribution Sn |
|---------------------------------------|--------|---------------|-------------------------------|
| Minus 5 mesh plus 10 mesh: sink | 1.7 | 2.50 | 11.0 |
| Minus 5 mesh plus 10 mesh: float | 31.5 | 0.25 | 20.3 |
| Minus 5 mesh plus 10 mesh: Composite | 33.2 | 0.37 | 31.3 |
| Minus 10 mesh plus 30 mesh: sink | 5.0 | 2.11 | 27.2 |
| Minus 10 mesh plus 30 mesh float | 38.3 | 0.15 | 14.8 |
| Minus 10 mesh plus 30 mesh: Composite | 43.3 | 0.38 | 42.0 |
| Minus 30 mesh | 23.5 | 0.44 | 26.7 |
| Composite sample | 100.0 | 0.39 | 100.0 |

| Product | Weight | Percent Sn | Percent Distribution Sn |
|-----------------------------------|--------|------------|-------------------------|
| Sink: minus 5 mesh plus 10 mesh | 1.7 | 2.50 | 11.0 |
| Sink: minus 5 mesh plus 30 mesh | 5.0 | 2.11 | 27.2 |
| Composite sink | 6.7 | 2.11 | 38.2 |
| Float: minus 5 mesh plus 10 mesh | 31.5 | 0.25 | 20.3 |
| Float: minus 10 mesh plus 30 mesh | 38.3 | 0.15 | 14.8 |
| Composite float | 69.8 | 0.20 | 35.1 |
| Minus 30 mesh | 23.5 | 0.44 | 26.7 |
| Composite sample | 100.0 | 0.39 | 100.0 |

The high tin content of the float of the plus 10 mesh fraction viz. 0.25% almost certainly excludes the possible use of T.B.E., or any other heavy media process, as a preconcentration step. The tin content of the minus 10 mesh plus 30 mesh float is also high, considering the low grade of the corresponding sink product, and indicates that appreciable tin is still composited at this size range.

The sink product from the minus 5 mesh plus 10 mesh fraction consists essentially of silicates, often with small inclusions of iron sulphides. An odd piece of cassiterite up to about match-head size was noted, but the majority of cassiterite grains noted was much smaller, only a few pieces being larger than pin-head size.

The iron sulphide particles were up to match-head size, but mostly occurred as small grains on the siliceous minerals.

The sink products from the minus 10 mesh plus 30 mesh fraction is similar to the coarser fraction, except that free cassiterite crystals are a little more obvious.

Discussion

The five tabling tests can be summarized as:—

| Sample No. | Composite Head % Sn | Combined Concentrates % Sn | Combined Tailings % Sn | % Recovery of Tin in Concentrates |
|-----------------------|---------------------|----------------------------|------------------------|-----------------------------------|
| R.390A | 0.36 | 9.2 | 0.17 | 52.6 |
| R.390B | 0.46 | 10.1 | 0.19 | 59.0 |
| R.390C | 0.44 | 12.3 | 0.23 | 48.9 |
| R.390D | 0.34 | 7.6 | 0.13 | 62.7 |
| R.390E | 0.41 | 9.6 | 0.16 | 62.6 |
| Arithemetical Average | 0.40 | 9.8 | 0.18 | 57.2 |

It will be noted that the overall concentrate grade is comparatively low, and it must be assumed that there will be a further drop in the recovery of the tin in dressing this concentrate to normal sale-grade concentrates.

In the concentration test R.390A, the tailings can be roughly divided into the plus 60 mesh fraction containing 0.24% tin, and the minus 60 mesh fractions averaging approximately 0.11% tin. Finer grinding, or production and regrinding, of a middling fraction could be expected to reduce the 0.24% tin from the coarsest fraction to perhaps 0.10-0.16% tin as in similar sized fractions from Investigation R.392. This assumes that the tin lost is composited with siliceous minerals. As this appears to be the case, then regrinding would be expected to increase the overall recovery of the tin in the low grade concentrate to a little over 60%.

The minus 200 mesh fraction of the tailings, at 0.12% tin, is considerably lower than equivalent fractions from the four other tests.

In concentration test R.390B, the tin content of the plus 60 mesh fraction is 0.23%, and remarks similar to those above referring to R.390A apply.

In concentration test R.390C, the tin content of the plus 60 mesh fraction is 0.31%. Remarks similar to those above referring to R.390A apply.

In concentration test A.390D, the tin content of all tailings fractions can be considered satisfactory, giving an overall tailing containing 0.13% tin.

In concentration test R.390E, the tin content of the minus 60 mesh plus 100 mesh fraction at 0.21% is a little high for no apparent reason. Corresponding values from the other similar fractions vary between 0.07 and 0.12% tin.

There does not appear to be major association between cassiterite and the sulphides. Tin contents of the floated sulphides from samples R.390D and R.390E were 0.17 and 0.11% respectively.

Test work is to be carried out on other samples from Ardlethan. In future test work, concentration procedure will be varied to allow a middling to be taken from the three coarsest size fractions of each test. The middlings will be stage ground to the next size fraction. It is felt that the revised procedure will give a lower tailing with similar grade of concentrate to that obtained in the present investigation.