REPORT ON PROPOSED CONCENTRATION OF

ONE EX EXHOME OF BULLION MINE

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FOREWORD

In this very brief report an attempt has been made to survey the probable effect of concentration of the ore obtained from the above mine.

Undoubtedly concentration by flotation is economic especially under the conditions outlined.

No attempt is made to consider the capital outlay involved since at this stage equipment may be made available at relatively low cost.

The manpower demands for operation of the mill would be small and should be covered by seven men.

There would appear to be very good reason to proceed with a scheme similar to that outlined herein and should a further and more detailed investigation be required, this could be undertaken almost at once.
HISTORICAL

For some time past the Home of Bullion mine, situated some 17 miles from Barrow Creek in the Northern Territory, has been under development and investigation.

This deposit was originally worked some years ago to produce oxidised ores and at that time it was understood that hand picking of the ore at the mine was in practice. This resulted in the despatch to the Electrolytic Refining and Smelting Co. of Australia Pty. Ltd. at Port Kembla, N.S.W., of a product varying between 30% and 40% copper.

Mining and treatment of ore in this manner was carried on for some time, and although the tonnage despatched was not very large there is little doubt that the operations were financially successful even at the relatively lower copper price which obtained during the war.

In 1948 further mining work was done and almost the entire amount of material produced from the sinking and driving which was carried out has been forwarded to Port Kembla and the average copper content has been in the vicinity of 25%. Almost entirely, however, this material has been of a secondary sulphide nature and has been derived from working between the 120' and 200' levels. Development has been in the ore body, which is now known to extend over a length of at least 400' whilst the width although variable is always sufficient to permit of ready working.
In order to test the nature of the ore body at depth, diamond drilling has been used to show that at the point of intersection at (350') depth the ore body persists and still shows the presence of secondary sulphides with 11% of copper present.

A further intersection at a greater depth has now revealed that at 680' the ore body still persists and that here primary sulphides carrying some 7% copper are present.

Whilst production can be maintained from the levels at present developed it seems probable that operations could be continued on a readily profitable basis, by simple continuation of the present methods. The ore extracted in the current developmental work is actually loaded into old 44 gallon oil drums underground and these drums, after being hauled to the surface, are loaded direct onto motor lorries for transport to Alice Springs whence they are shipped by the Commonwealth Railways to Broken Hill (3'6" gauge) and there transferred to the New South Wales Railways for haulage to Port Kembla.

The costs incurred in these operations are approximately:

- Mining Cost ... 12.6 per ton
- Road Haulage ... £5. 0. 0 " "
- Rail Haulage ... £7. 0. 0 " "

The charge for treatment at Port Kembla will vary according to the richness of the material received but would average approximately £8.10. 0 per ton, including metal deductions (valued at current prices).

The total of these amounts — £21. 2. 6 — is almost equivalent to the gross value of a 13% grade of ore.

Now, of these various factors which could be decreased? Obviously one must assume that the mining cost is today as low as it can be expected to be in such a geographical position, and no matter what treatment processes the ores should be subsequently subjected to, this will remain unaltered.

The total freight charges of £12. 0. 0 p.t. are paid irrespective of value of the material and if a more concentrated material were handled these would be less per ton of copper carried.

The treatment charges are of a compound nature; the charge for
receiving sampling and smelting is levied per ton of material handled, irrespective of value; the metal deductions are made per ton of material also. On the other hand the refining charge is proportional to the percentage of copper present. The smelting charge plus deductions would represent almost £5. 0. 0 of the £8.10. 0.

Therefore it is apparent that of the charges levied on the original ore and amounting currently to approximately £21. 2. 6 p. t. £17. 0. 0 represents charges levied per ton independent of the richness, 12/6 p. t. is the mining cost and only £3.10. 0 p. t. would vary with the richness.

But if concentration methods could be used and a high recovery obtained virtually the same tonnage of copper would be shipped in a smaller bulk, i.e. the number of tons subjected to the £17. 0. 0 p. t. charges for freight, smelting etc. would be reduced whilst the same quantity of copper would be produced and subjected to a similar charge for refining as would have been incurred had the untreated ore been shipped.

It is therefore clearly apparent that concentration of this ore is highly desirable from the economic aspect even at the grade of material being produced today; when, however, it is necessary to mine the ore at greater depth the decreasing grade experienced will necessitate concentration to ensure economic operation of the mine. If the intersection of the ore body at (350) is typical (11½ copper) this ore could not be extracted profitably without concentration under the current economic conditions.

The case for concentration is therefore clearly apparent and the means by which this end can be achieved should therefore now be examined.

So far, the only attempts at concentration have been the original hand picking of the oxidised ore, and more recently some crude flotation tests carried out at the Drake mill of the Electrolytic Refining and Smelting Co. of Australia Pty. Ltd. In the latter tests it was not possible to carry out any exhaustive work since testing facilities and various reagents were not readily available and the mill itself, being of simple design, cannot readily be controlled in regard to other fundamental factors.
Two independent tests were made in one of which ore carrying some 15.3% copper and drawn from the secondary sulphide zone was concentrated, whilst in the other material containing only 7.9% copper drawn from the zone in which some oxidation of the secondary sulphides had occurred was treated. Chemical tests suggested that the samples contained respectively 1.5% and 2.0% oxidised copper, but the accuracy of these determinations may not be high.

Dealing with the low grade material first -

The parcel contained 7.9% Cu and 2.28 ozs silver per ton and 0.015 ozs gold p.t. From this a flotation concentrate of only 9.0% copper was produced, while the Wilfley table, which treats the flotation tailings, produced a concentrate of 8.8% copper. The final tailings were 7.0% copper and contained 42.8% of the original copper input.

It should be borne in mind that this material contained secondary sulphides which had been subjected to partial oxidation in situ, and consequently one would anticipate some difficulty in treating this material, since the concentration of oxidised copper ores is not readily carried out by either of the methods available (flotation or gravity separation). Unfortunately, with the lack of facilities at the time of this test, it was not possible to determine whether in any way the oxidised surfaces of the copper bearing minerals could have been reduced and thus the desired concentration secured.

Even if concentration is not possible by flotation, other more modern developments may yet prove effective, for it has recently been shown that oxidised copper ores are amenable to successful treatment by heavy - media separation.

In the case of the secondary sulphide material, the head value of which was 15.3% copper, 1.19 ozs silver and 0.02 ozs gold per ton, it was found possible to produce a concentrate assaying 37.3% copper, whilst the table concentrate was only 6% copper, the tails being 8.2% copper. In this case so there was still 34.9% of the copper in the parcel to be found in the tails.

Even though this material was drawn from a deeper area in the mine chemical tests showed the presence of some 1.5% copper in the oxidised form,
but if this were distributed as a film on the surface of the sulphide grains this would readily explain the high tails figure. However, as was pointed out above, it should not be difficult to suitably treat the ore so as to render the copper minerals flotable, thus securing a ready means for concentrating it.
However, if we now examine the economics of the flotation treatment even under these poor conditions, which are undoubtedly capable of considerable improvement, a surprising result is achieved.

Considering firstly the mining and despatch of a 100 ton parcel of ore corresponding to the material tested — i.e. 15.3% copper.

Mining Cost — 100 tons @ 12/6 p.t. 62.10.0
Freight to Alice Springs @ 5.0.0 p.t. 500.0.0
Freight Alice Springs to Pt. Kembla, £7.0.0 p.t. 700.0.0
Treatment costs — (Smelting etc. @ £2.7.6 p.t. 237.10.0
(Refining etc. @ 3/6 unit 245.0.0
£1,745.0.0

Paid for contents (copper only)

15.3% less 1.3% = 14% or 14 tons @ £180 p.t. = £2,500.

N.B. In the above 100 tons has been assumed to be the Nett Dry Weight, but freight is usually paid on the drums in which the material is packed, plus any moisture. This would increase freight charges by a further £100 approximately.

The nett value of the parcel is then £675.

Now assuming that the same material had been concentrated even under the poor recoveries made in the test detailed earlier.

Mining Cost — 100 tons @ 12/6 p.t. 62.10.0
Concentration Cost — 100 tons @ 12/6 p.t. 62.10.0
Freight on cons. 35.9 tons @ £12 p.t. 430.16.0
+ Allowance drums & moisture (10%) 43.1.7
Treatment Costs — Smelting etc. £2.7.6 p.t. 85.5.3
" " — Refining etc. @ 3/6 unit 169.12.7
£853.15.5

Paid for contents, copper only, would be 35.9 tons concentrates assaying 27.27% copper, less 1.3 units per ton = £1,742.8.0.

Or, in other words, the nett value of the parcel has become £853 approximately.
If now we assume that a concentrate of 40% grade can be produced (37.3% grade was obtained in the first test but in the above figures the bulk concentrate which includes the 6% table concentrate has been used as a basis of calculation.), and that a 90% recovery can be achieved then in the treatment of a similar parcel the following results can be achieved.

100 tons ore containing 15.3% copper, 90% recovery allows for the presence of 13.77 tons copper in a concentrate of 40% grade; i.e. there will be 34.425 tons.

Mining cost @ 12/6 p.t. 62.10.0
Concentration cost @ 12/6 p.t. 62.10.0
Freight on Cons. 34.425 tons @ £12.0.0 p.t. 413.2.0
plus 10% allowance drums, etc. 41.6.3
Treatment cost - Smelting etc. @ £2.7.6. p.t. 81.13.2
- Refining etc. @ 3/6 per unit 227.2.9

£888.4.2

The gross value of the contents would be 34.425 tons

@ 40%, less 1.3% or 34.425 x 38.7 x 180 = £2397.19.2

The difference is £1409.15.0.

It should be borne in mind that the same parcel of ore if sent direct would have yielded only £675 or £6.15.0 per ton of ore; whilst if concentrated to the extent assumed in the most recent case (and this should be readily achieved) the value would be £1409.15.0 or £14.1.0 per ton of ore.

Since it is clearly apparent that concentration can be so highly beneficial, the next step logically is to determine how this desirable result can be achieved.

It is understood that the Drake Mill of the Electrolytic Refining and Smelting Co. of Australia Pty. Ltd. is not receiving sufficient ore supplies to warrant continuing operation and that consequently this equipment could be made available for re-erection at the Home of Bullion mine. With certain modifications and additions this mill could readily be capable of
handling sufficient ore to ensure the delivery of 3,000 tons of copper annually to Port Kembla as concentrates of 40% grade. This would require the production of 7,500 tons concentrates and if 15.3% ore were used to produce this, the amount of ore required would be 21,786 tons annually, an amount which is well within the capacity of the mill.

It will be noted that a concentration cost of 12/6 per ton of ore treated has been assumed; this figure is taken from estimates of cost with the mill operating at approximately the daily rate required to treat the desired quantity (70 - 75 tons per day). Included in this cost is rental for the mill - in lieu of an amortization cost - but this is at a comparatively low rate since the mill has been constructed from secondhand materials. However, the allowance of 12/6 per ton ore treated is ample, especially if, as seems quite possible, the present mill equipment be made available without charge on the basis of producing 3,000 tons copper annually.

To briefly describe the present mill it is composed of primary and secondary jaw crushers followed by a small hardinge mill, the discharge from which passes to a drag classifier connected in closed circuit with the grinding mill. The overflow from the classifier after the addition of the flotation reagents passes direct to a Forrester type flotation cell, the concentrate from which passes to another cell of the same type to produce the final concentrate and a tailings product recirculated through the earlier cell, which in turn yields a final flotation tailing product. This tailing product is passed over a Wilfley table to produce a table concentrate and the final tailing which passes to the tailings dam.

For application at the Home of Bullion mine it would be advisable to modify the mill somewhat by including rolls and a screen in closed circuit between the secondary crushing and grinding stages. The two Forrester flotation cells should be in series and provision should be made for filtration of the concentrate; this may well be quite important since the payment of freight on the moisture contained in the concentrate is a direct loss.

Provision should be made for simultaneous operation of the crushing and milling units by the installation of a larger diesel engine, and the provision of efficient means for sampling the incoming ore and the
products should be made, since the installation of automatic sampling would considerably reduce the manpower requirements for operating.

It should be borne in mind that as the grade of ore decreases so does the incentive to concentrate the ore before shipment become greater.

It has been assumed that a 40% grade of concentrate may be produced but this may also be capable of more improvement, since specimens of ore in the mine have been shown to contain 53% copper. However, a limit to the grade of concentrate is quite certainly not above this figure and so it may well pay subsequently to consider the only additional means of concentration which is currently used - smelting to matte.

It is quite probable that if smelting were resorted to that a still higher grade of matte could be produced and adoption of this system would also allow of the treatment of materials drawn from the upper (oxidised) levels of the mine. It is not proposed to attempt a survey of the economics of this possibility at this stage since more information is required as regards fuel costs and various other items. Also, of course, this is a step which would follow concentration and can be considered quite independently of it. Since the case for concentration is so strong from the economic aspect the design, erection and operation of this equipment can be carried out at once and without in any way being detrimental to the ultimate inclusion of smelting if such a step is warranted.
CONCLUSION

Preliminary tests of concentration of ore ex the Home of Bullion mine have shown that flotation is effective in the concentration of material from the secondary sulphide zone; there is no doubt that primary sulphides will be capable of even more ready concentration.

Further work should be carried out to improve the recovery and grade of concentrate (samples are already in the hands of the G.S. & I.R.O. ore dressing laboratory at Melbourne University).

A milling plant should be erected at the mine and if the E. R. & S. Co's Drake mill is available this with some modifications should provide a cheap and most useful basis for the equipment.

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