OLYMPIA RESOURCES HART'S RANGE GARNET PROJECT: METALLURGICAL TEST WORK 2

JOB NO. 9296

CLIENT: Olympia Resources

DATE: 1st September 2003

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Table Of Contents

APPENDICES

EXECUTIVE SUMMARY

As a follow on from test work conducted earlier this year on Hart's Range garnet feed material, a 50/50 blend of material from two sets of bulk samples (weighing approximately 17 tonnes) was prepared for subsequent wet and dry processing to produce marketing samples and also to facilitate process development.

The flow sheet used was similar to that used in previous work and included scrubbing, oversize rejection and slimes removal, followed by hydrosizer classification and three stage spiral concentration to produce a heavy mineral concentrate (HMC) of garnet and amphibole. The main difference between this and the previous processing was that the amphibole (AMH), which had previously been regarded as a contaminant, was now considered to be a co-product at least as far as blended products were concerned.

Owing to operational problems the hydrosizer was not used in the bulk processing, and as a consequence of this the spiral plant feed was un-classified thus decreasing the separation efficiency realised on the basis of specific gravity (SG). The resultant HMC was low grade (80% HM) and contained 53% of the total garnet distribution.

The four +710 µm to +180 µm size fractions of the spiral concentrate and middling were individually processed through low intensity magnetic separation (LIMS), followed by rare earth drum (RED) high intensity magnetic separation, with final cleaning using high tension roll separation (HTR). Garnet product (plus 80% garnet, less than 2% free quartz) was obtained from the +710 µm , +425 µm and +260 µm spiral concentrate fractions, but was not achievable from the spiral middling fractions due to the low garnet grade and high quartz content. Garnet blend product (minimum 20% garnet, maximum 80% AMH) was achievable from both the spiral concentrate and middling fractions. It was not possible to produce a garnet blend product from the +180 µm fraction of the spiral concentrate due to its high quartz content.

Wet table tests on all the size fractions (including the +180 µm) of the spiral concentrate produced blend grade although at a reduced recovery, especially at +180 µm. Wet tabling of the +180 µm spiral middling did not produce blend grade.

Closed circuit hydrosizer tests were subsequently carried out and clearly demonstrated that the hydrosizer was capable of producing a controlled, good separation based primarily on grain size, which would have been of benefit to the subsequent spiral separation operation. This should be further investigated as per the recommendations in this report and the proposal dated 22/8/03.

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1. INTRODUCTION

Lakefield Oretest Pty Ltd (Oretest) performed metallurgical test work on Hart's Range feed material for Olympia Resources (Olympia) in the first quarter of 2003 (Oretest 2003). A scope for additional test work was subsequently received from Mr Damian Connelly of METS for pilot plant test work on a larger bulk sample of run of mine (ROM) feed material from Hart's Range.

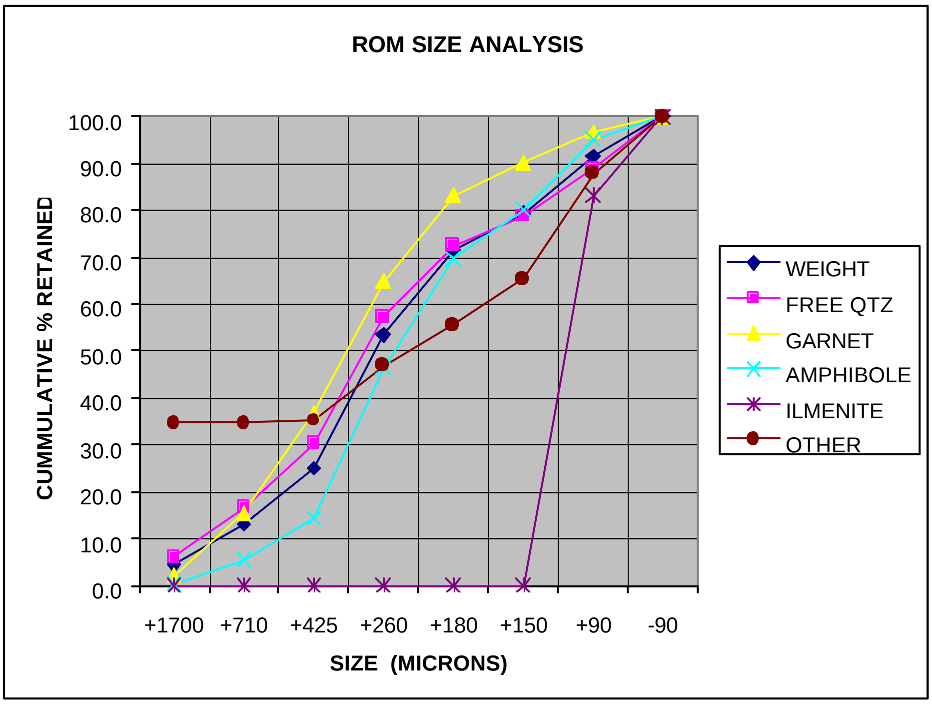
The principal aim of the test program as stipulated at a meeting between Olympia, METS and Oretest on 25th June 2003 was for the production of sufficient quantities of garnet, mixed garnet and amphibole products for marketing purposes. The process employed was similar to that used in previous test work and consisted of wet scrubbing, screening, desliming, hydrosizing and gravity separation using spirals, followed by dry screening, low intensity magnetic separation(LIMS), rare earth drum magnetic separation (RED), and high tension separation (HTR) on the +710 µm, +425 µm and +260 µm size fractions.

2. SAMPLE PREPARATION

A total of 14 bulker bags containing ROM feed from Hart's Range was received at Malaga on 26th June 2003. In accordance with the client's instructions, 12 of the bulker bags, labelled Samples 1 and 2, were opened and blended in a 50/50 ratio (six bags of each) using a bobcat and the coning and quartering technique, prior to being placed into 200 L drums which were then weighed. The blended ROM feed material was also sub-sampled to allow free moisture content to be determined.

The total dry weight of the ROM feed material was estimated to be 19.2 tonnes. The size distribution of the ROM feed components are given in Appendix A and illustrated in the Figure 1 below:

Figure 1 : ROM SIZE ANALYSIS



The indicated a D50 of the garnet is about 340 µm, while the D50 of the AMH is about 260 µm. Approximately 15% of the garnet is +710 µm, with 65% +260 µm and 82% +180 µm. All of the

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ilmenite appears to be in the –180 µm size range. The size distribution of the free quartz is similar to garnet at the coarse sizes (15% +700 µm) and to AMH in the fine sizes (80% -150 µm).

A specific gravity (SG) analysis of hand sorted garnet and AMH grains in the ROM feed material returned results of 4.03 and 3.29, respectively.

3. TESTWORK

3.1 Test Procedure

The drums of blended ROM were processed through the wet pilot plant as follows:

3.1.1 Scrubbing, Screening and Desliming

The contents of the 200 L drums were discharged into a feed hopper and fed at a controlled rate by means of an adjustable gate and variable speed conveyor. Some problems were experienced maintaining a steady feed rate due to the sticky nature of the ROM feed material and regular operator attention was required to prevent the feed material from hanging up in the hopper.

The ROM feed material was discharged onto an inclined conveyer and fed into a rotary drum scrubber fitted with a discharge trommel (3 mm apertures). Trommel oversize (+3 mm) was collected, dewatered and weighed. Trommel undersize slurry (-3 mm) was deslimed using a hydrocyclone. Originally it was planned to gravitate the cyclone overflow into a slurry storage tank, however, the flowsheet was modified to discharge the slimes into the spiral tailings cyclone feed hopper and thence to the slimes storage tanks via the spiral tailing cyclone overflow stream. This modification reduced the amount of slimes returned to process water circuit (normally the tailings cyclone overflow reports to process water).

The cyclone underflow was fed to the hydrosizer.

The mass of slimes was calculated by difference on the basis of:

? measuring the volume of slurry in the slimes storage tanks;

? measuring the solids content of the slurry in the storage tanks; and

? by wet screening the ROM at 53 µm to determine its slimes content.

3.1.2 Hydrosizing and Spiralling

Attempts to operate the hydrosizer to produce an underflow concentrate or an overflow tailing, or a sized overflow and underflow for the spirals were unsuccessful. This was attributed to problems associated with establishing a steady supply of hydrosizer injection water.

As a consequence the hydrosizer was bypassed and the desliming cyclone underflow was pumped directly to a triple start MG4 rougher spiral. The concentrate from this spiral gravitated to the cleaner spiral feed and the tails to the scavenger spiral feed, with the middling being recycled to head.

The twin start scavenger Multotec spiral produced a concentrate which gravitated to the cleaner spiral feed; a final tailing which was pumped to a tailing cyclone, the underflow of which was collected in 200 L drums; and a middling was recycled to the head.

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The single start HG8 cleaner spiral produced a final concentrate which gravitated to 200 L drums, a tailing which gravitated to the scavenger spiral feed and a middling that recycled to the head. In practise however, the cleaner middling was also collected in separate drums due to the significant amount of garnet and amphibole contained in it. The reason for the mineral reporting to middling was attributed to the lack of sizing ahead of the spirals (inability of the hydrosizer to achieve requisite cut).

Grab samples of rougher feed, cleaner concentrate and scavenger tailings were collected at regular intervals during the campaign for assay purposes. The samples were assayed for heavy minerals (HM) and grain counted for garnet, amphibole, ilmenite and other minerals.

The tailings drums were dewatered, weighed and spear sampled to determine a dry weight and to provide a check assay sample. The cleaner concentrate and middling drums were sent to Cook Industrial Minerals (CIM) at Jandakot for drying and screening.

A mass and mineral balance for the wet processing based on back calculated concentrate and middling products is given in Appendix A

The mass balance indicates that the HM grades of the concentrate and middling were low at 80% and 67%, respectively. Overall recovery of garnet was high, with only 4.5% reporting to the tailings, 53% to concentrate and the balance to the middling. The mass of middling was high at 4.0 tonnes with a low garnet grade of 8.1% compared to the concentrate mass of 1.6 tonnes with a garnet grade of 24.6%. The AMH grades and distributions of the concentrate and middling were reversed at 47.2% and 57.2% grade and 19.3% and 58.1% distribution, respectively. These results made subsequent dry processing of the middling difficult.

The calculated garnet head grade was 4.7%, with AMH 24.6%, slimes content was estimated at 20.5% and oversize at 3.7%.

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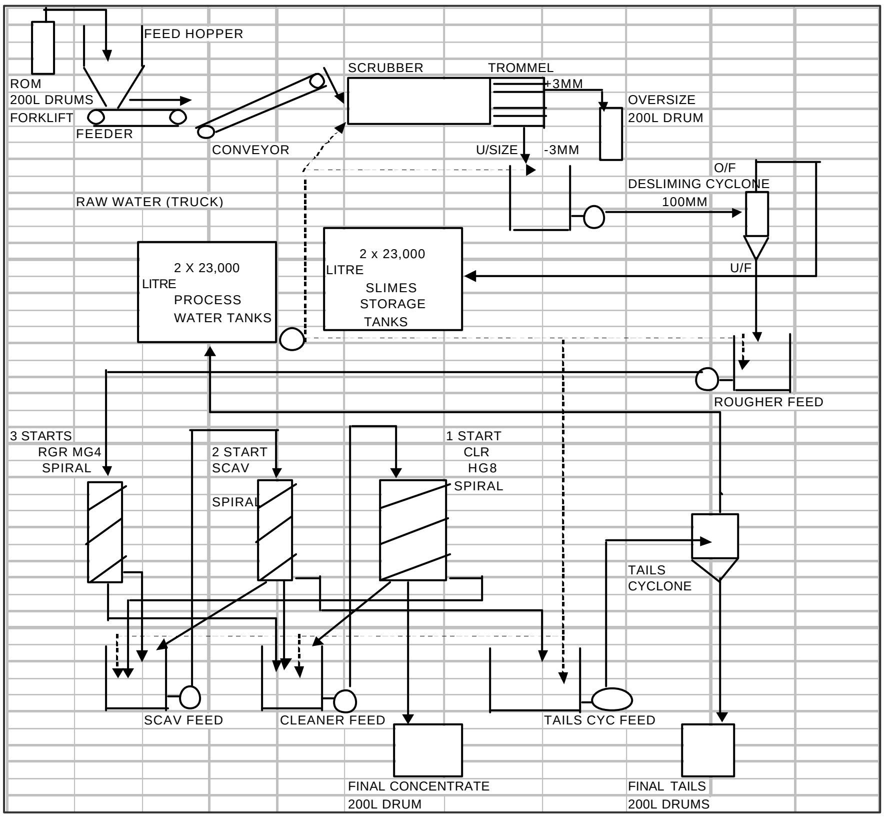
Figure 2 : WET PROCESS FLOWSHEET



3.1.3 Wet Table Separation

Because of the low HM grade of the spiral concentrate and middling, the client requested Oretest to investigate the use of a wet table to upgrade the spiral concentrate and also to generate a product.

Wet tabling was carried out on a sub-sample of each of the four spiral concentrate fractions (+710 µm / +425 µm / +260 µm / +180 µm). A concentrate, middling and tailing were collected from the +710 µm and +425 µm fractions in a single pass, while a concentrate and tailing were collected from the +260 µm and +180 µm fractions, also in a single pass. The concentrate from the +180 µm fraction was then re-passed over the table to produce an ilmenite rich concentrate.

Further wet table tests were subsequently carried out on the +180 µm middling.

The results of this work are given in Appendix D.

The results indicate that the spiral concentrate upgraded in all the tests to a higher grade garnet concentrate, although at the expense of recovery. The +710 µm material upgraded from 50% to 76% at a recovery of 32%, the +425 µm material from 33% to 53% at a recovery of 19%, the +250 µm material worked best with an upgrade from 21% to 65% at a recovery of 60%. The two pass +180 µm material produced an "ilmenite con" grading 27% garnet and 51% ilmenite, and a concentrate grading 53% garnet with overall recovery (both products) of 46%. All of these concentrates achieved blend grade. The +180 µm spiral middling could not be processed to generate a product due to its high quartz content.

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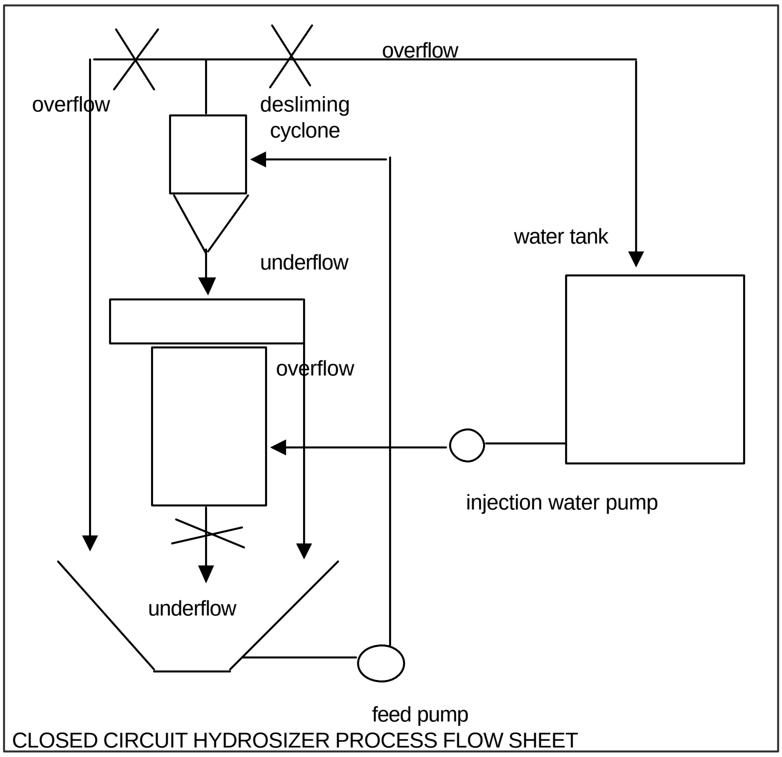
3.1.4 Closed Circuit Hydrosizer Tests

Because the hydrosizer was not operated ahead of the spirals during the bulk wet processing run, it was decided to determine the operating parameters of this separator by carrying out a series of closed circuit tests using a fresh sample of the same feed used in the bulk run. Two sub-samples (200 L each) were taken from two bulker bags containing similar ROM feed material to that used for the bulk run.

The two samples were mixed and passed over a 2.5 mm aperture deck Kason screen to remove oversize, and the resulting slurry was progressively fed to a Linatex hydrosizer running in closed circuit. Stable closed circuit conditions were achieved by fitting valves to the cyclone overflow to return it to the hydrosizer feed, or to a bulker bin used to enable a controlled rate of injection water to be established (see Figure 3).

Three tests were carried out using different settings of injection water flow and slurry density in the hydrosizer, with the aim of producing different mass splits to overflow and underflow. The results of these tests are detailed in Appendix E. The distributions by size fraction to underflow of mass, garnet and AMH are shown in Figure 4.

Figure 3 : CLOSED CIRCUIT HYDROSIZER FLOWSHEET



CLOSED CIRCUIT HYDROSIZER PROCESS FLOW SHEET

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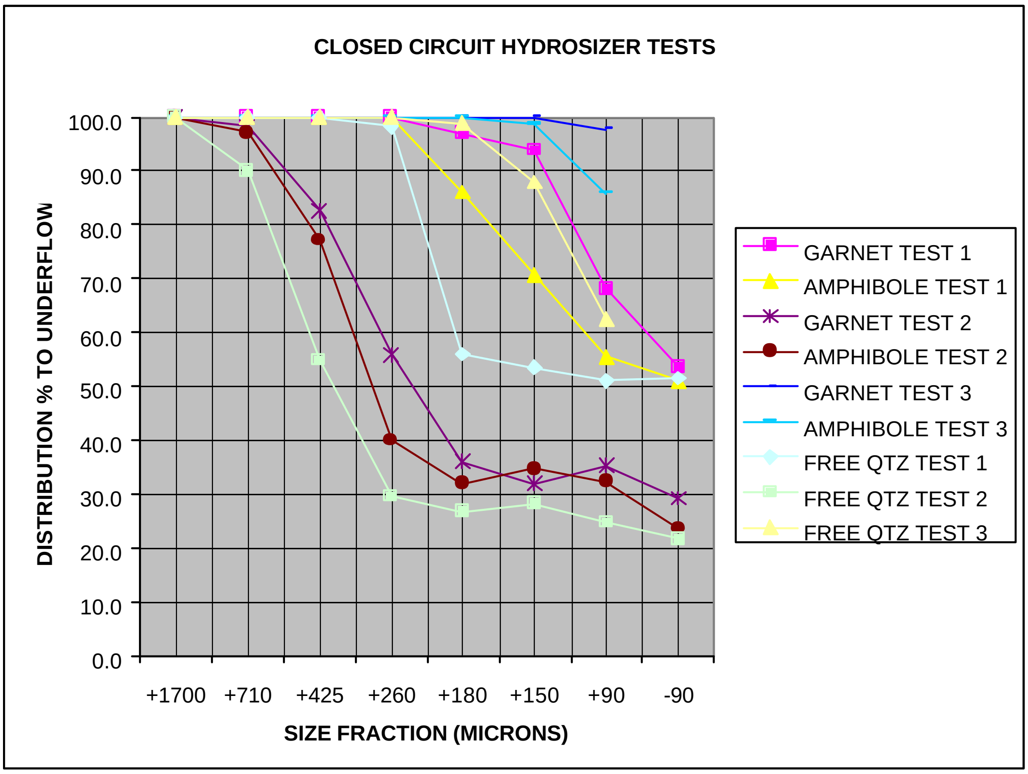
Figure 4 : CLOSED CIRCUIT HYDROSIZER TESTS



The results indicate that the hydrosizer is capable of producing a wide range of mass and size splits to underflow / overflow depending on the operating conditions used. The separation is predominately size based, although the SG of the grains also has an effect.

In Test 1, 85% of the feed weight was recovered to underflow, with almost 100% of the +260 µm free quartz, garnet and AMH, although 44% of the -180 µm free quartz reported to overflow, while 97% of the garnet remained in the underflow.

In Test 2, 61% of the feed weight was recovered to underflow, with 30 % of the +260 µm free quartz, 56% of the +260 µm garnet and 40% of the +260 µm AMH.

In Test 3, 96% of the feed weight was recovered to underflow, with almost 100% of the +180 µm free quartz, garnet and AMH, although 37% of the –90 µm free quartz went to overflow at this size range, most of the garnet was still in the underflow.

3.2 Dry Processing

The bulk spiral concentrate and middling generated from wet processing were then dry processed as described below:

3.2.1 Drying and Screening

The products were transported to Cook Industrial Minerals, where the contents of the 200 L drums were emptied out and a front-end loader (FEL) used to transfer the concentrate and middling separately to a feed hopper, where they were fed via an inclined conveyer into a gas fired rotary dryer.

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The dryer was purged of silica sand by running a small quantity of GMA garnet through it and then hosed out thoroughly. The dryer discharge was transferred using an inclined conveyer to hoppers where the dry concentrate and middling was collected and weighed. Fine mineral carried up in the dryer exhaust system was collected as cyclone underflow and weighed.

An inspection of the system after processing indicated mineral losses of mineral had occurred during processing and the total estimated loss was 25 kg. The two dry products were then screened separately over a series of progressively finer Kason screens, starting at 710 µm, then 425µm, 260 µm and finally 180 µm.

The latter screening was a variation to the original proposal, as was the drying and screening of the middling, as these products were not originally anticipated.

As anticipated, dry screening was inefficient, particularly at the finer sizes, and despite slow feed rates and re-screening the oversize, a significant amount of undersize reported to the oversize fraction. This was subsequently confirmed when the products from the dry processing tests were screened by Oretest (see Appendix F).

3.2.2 LIMS & RED Magnetic Separation

Starting with the spiral concentrate +710 µm fraction, each fraction down to 260 µm of the concentrate and middling were processed through a single stage LIMS and multi stage RED magnetic separation circuit.

A similar circuit was used in each case, although for the +425 µm and +260 µm middling fraction it was found to be unnecessary to scavenge the rougher RED middling.

The LIMS was used to remove a small amount of ilmenite and any foreign rust that was collected during drying and handling (magnetic component). The non-magnetic component then formed the RED feed.

The RED was used as a three stage rougher / scavenger / cleaner circuit with non- magnetic, middling and magnetic products being produced at each stage except as stated above.

The RED circuit was used to produce garnet concentrates (generally cleaner RED magnetic), garnet / amphibole blends (generally cleaner RED non magnetic / scavenger RED middling and scavenger non magnetic), and quartz /amphibole / others tailing (rougher RED non-magnetic).

On the basis of a visual inspection and subsequent assaying of the products, it was apparent that the coarser concentrate fractions generated the cleanest garnet and highest yield, with the finer middling fractions generating the dirtiest garnet and lowest yield. This was in accordance with expectations. An additional factor affecting grade was the presence of undersize material in the various fractions. The majority of this undersize was "close undersize" for example +425 µm in the +710 µm fraction rather than –425 µm grains, however these still had a deleterious affect on product quality.

Following a preliminary assessment of the mass and mineral balance generated by the dry separation test work, the client requested that two further RED magnetic separations on the spiral concentrate +710 µm cleaner non magnetic and scavenger middling and +260 µm cleaner middling be carried out. The results from these tests are given in Appendix G and indicate that in case of the +710 µm material a good upgrading to garnet grade was achieved, while little was achieved with the +260 µm material.

Subsequently it was requested by the client that the +180 µm spiral concentrate and middling fractions be dry processed. The +180 µm concentrate was able to produce a garnet blend that was high

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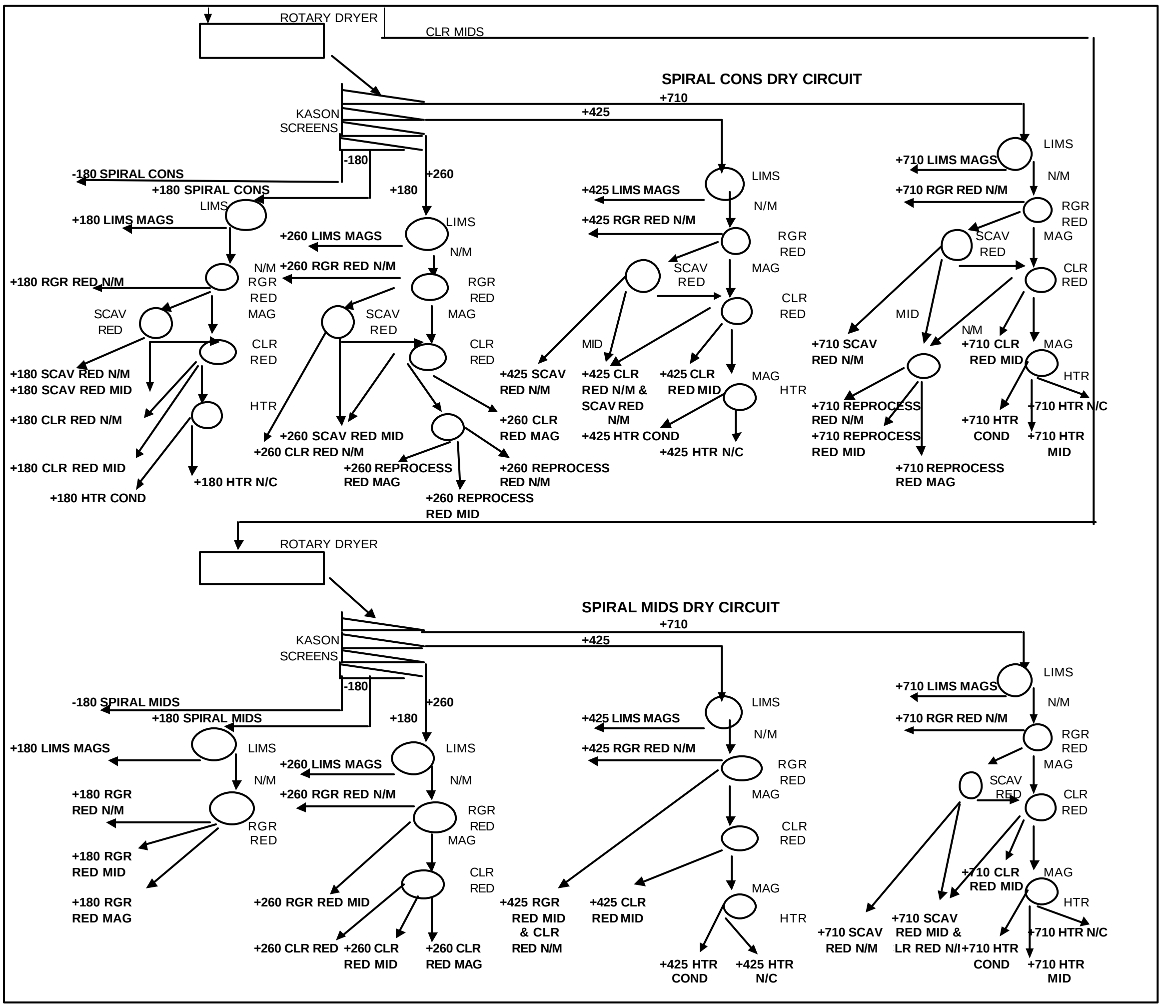
in free quartz, but the +180 µm middling was unable to make any suitable separation. The results of these tests are also given in Appendix G.

Figure 5 : DRY PROCESSING FLOWSHEET



3.2.3 HTR Separation

HTR separation was used to remove black magnetic ilmenite grains from the garnet in the RED cleaner magnetic fractions.

Most of the ilmenite was contained in the +250 µm concentrate fraction, which was the only stream to have a significant effect on final garnet product quality. It was quite noticeable for the +710 µm micron size fractions that the major effect of the HTR was to produce a size separation (coarsest grains to conductor), which in turn produced an upgraded garnet product to non -conductor.

3.2.4 Summary and Detailed Mass and Mineral Balances

A summary of the mass and mineral balance for the wet and dry processing operations is presented below. A detailed process mass and mineral balance based on size fractions is given in Appendix B. An overall mass and mineral balance from the test results is presented in Appendix C.

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Table 1 : SUMMARY MASS BALANCE

SUMMARY TABULATION	WEIGHT KG	GARNET KG	AMPHIBOLE KG	WEIGHT MASS %	GARNET MASS %	AMPHIBOLE MASS %
TO +710 / +425 / +260 GARNET PRODUCTS	195	196	13	1.2	25.5	0.3
TO +710 / +425 / +260 BLEND PRODUCTS	926	196	725	5.7	25.6	18.3
TO +710 / +425 / +260 HIGH QUARTZ PRODUCTS	1061	138	822	6.6	18.0	20.7
TO -260 SPIRAL CONS	863	99	475	5.3	12.9	12.0
TO -260 SPIRAL MIDS	746	57	367	4.6	7.4	9.2
TO SPIRAL TAILS	6572	34	897	40.7	4.5	22.6
TO +710 / +425 / +260 DRY TAILS	1856	42	659	11.5	5.4	16.6
DRY WASTE & OTHER	23	6	11	0.1	0.8	0.3
OVERSIZE	605	0	0	3.7	0.0	0.0
SLIMES	3317	0	0	20.5	0.0	0.0
TOTAL	16164	768	3970	100.0	100.0	100.0

4. CONCLUSIONS

? The spirals produced a concentrate containing 20% of the ROM mass, with a grade of 80% HM and 25% garnet at a recovery of 53% garnet.

? The spirals also produced a middling which contained 25% of the ROM by mass and 25% of the garnet at a grade of 8% garnet, which meant that this became a co-product as a result. The middling had an AMH grade of 57% at a recovery of 58%.

? The overall recovery of garnet in the spiral plant was high, with only 4% lost to tails, although the large middling product contributed towards this.

? The spiral gravity separation stage would have benefited from a classification stage ahead of it, as was originally proposed to enhance the specific gravity differential effect of a closer sized feed to the spirals.

? The calculated feed grade (based on product unit summation and spiral tailings units and assuming no losses to oversize and slimes) indicated a HM content of 31%, a garnet grade of 4.8%, an amphibole grade of 24.7% and an ilmenite grade of 0.2%.

? The +3 mm oversize was 3.8% by mass of the ROM feed material, while the calculated slimes was 20.4% by mass of the ROM feed material.

? Dry screening of the dried spiral concentrate and middling was not efficient, particularly at the finer sizes, and resulted in significant amounts of close undersize in the product fractions. As a result it has been concluded that wet screening should be used in any future test work, and in the proposed production scale processing facility.

? Highly susceptible magnetic grains were removed by the LIMS from all of the product size fractions, although the quantity was small (0.1%) in all cases.

? The RED magnetic circuit produced a clean garnet non magnetic tailing from the rougher stage, while rejecting quartz (between 99% and 88% of the quartz in the feed), for both spiral concentrate and spiral middling feeds. The mass rejection to non magnetic tails was between 60% and 23% of the feed.

? The ability of the RED magnetic circuit to produce a garnet concentrate product from the cleaner RED magnetic fraction only (based on a minimum garnet content of 80%), was dependent on the feed being spiral concentrate and varied with the size fraction. Garnet product was cleanest for the

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+710 µm fraction (97% garnet grade for 58% of garnet in the feed) compared to the +425 µm fraction (85% garnet grade for 64% of the garnet in the feed), and the + 260 µm fraction (80% garnet grade for 35% of the garnet in the feed). The cleaner RED +710 µm middling was also a garnet product at 91% garnet grade and 21% of the garnet in the feed.

? The total mass of garnet concentrate produced weighed 195 kg and represented 23% of the total calculated garnet in the ROM feed material and 1.2% of the ROM feed material by mass.

? Blend product (typically minimum 20% garnet and maximum 80% AMH), was produced from both spiral concentrate and middling feeds in much greater quantity. A total of 926 kg of this product was generated, representing 5.7% of the ROM feed material by mass, containing 25% of the total calculated garnet in the ROM feed material.

? High quartz off-specification product (defined as over 2% free quartz) was only produced from the spiral middling feed, and weighed 1061 kg and represented 18% of the garnet in the ROM feed material.

? The previous bullet point highlights the need to ensure that the maximum amount of garnet is recovered to spiral concentrate, and the cleaner spiral middling is not sent to a product by itself.

? The HTR stage, which was used to clean up the garnet product by removing any black ilmenite grains, was able to do this in the +260 µm size spiral concentrate fraction where the ilmenite mostly occurred. The conductor fraction from this separation assayed 92% ilmenite. The +710 µm fraction, which contained less ilmenite, basically produced a size separation over the HTR.

? The +180 µm fraction of the spiral concentrate was unable to produce a garnet product (due to its low grade) or blend product by dry processing in either case due to high quartz.

? The +180 µm fraction of the spiral middling was not suited to dry processing.

? Wet tabling test work indicated that for all size fractions, the spiral concentrate could be further upgraded to produce a blend product, but at the expense of recovery, particularly at finer sizes.

? Wet tabling of the +180 µm spiral middling was unable to produce a product due to its high quartz content.

? Closed circuit hydrosizer tests showed that an effective size separation could be achieved using screened and deslimed ROM feed.

? It has been concluded that the use of a hydrosizer has the potential to significantly improve spiral separation and hence downstream dry processing.

5. RECOMMENDATIONS

? In order to define an effective process flowsheet for the production of garnet and blend products from Hart's Range feed, it is recommended that a second bulk sample be processed using the spiral pilot plant with pre-classification of feed by a hydrosizer. This should enable the wet gravity separation to be improved, producing a higher HM and garnet grade and recovery to concentrate, thus eliminating the cost and need to process additional quantities of lower grade spiral cleaner middling, from which product grades are difficult to achieve.

? To improve the selectivity of screening ahead of dry separation it is recommended that the spiral concentrate be wet screened at 710 µm using either a DSM or a vibrating screen, followed by Derrick screening at 250 µm, assuming that a single –710 µm / +250 µm product for the sandblast market is required.

? If further screened products are required (such as –250 µm / +180 µm), or if it is necessary to carry out an intermediate screening at 425 µm to enhance RED magnetic separation, then additional Derrick screen stages can be used.

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? Tests are required to confirm spiral selection and capacity as well as RED capacity to facilitate equipment selection for the process design.

Reference

Oretest 2003, *Olympia Resources Hart's Range Garnet Metallurgical Test work,* dated 1st May 2003, Job No 9135.

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Appendix A: ROM Sizing and Wet Processing Mass & Mineral Balance

Appendix B: Process Mass and Mineral balance – by Size Fractions

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Appendix C: Overall Mass and Mineral Balance from Test Results

Appendix D: Wet Table Test Results

Appendix E: Closed Circuit Hydrosizer Test Results

Appendix F: Dry Processing Product Size Analyses

Appendix G: Additional Dry Processing results

This report has been prepared by Lakefield Oretest Pty Ltd (Oretest) at the request of *Alan Lockett* of *Olympia Resources.*

This Report presents the results of the metallurgical testwork conducted by Oretest on the samples (the Samples) provided by the Client. Details of the Samples are presented in sections 3 and 4 of the Report and the Testwork results are presented in Sections 5 to 12 of the Report.

This Report is provided to the Client on the basis that the Client expressly acknowledges that:

(a) no representations have been made to Oretest as to the purpose for which the tests are required to be conducted; and

(b) the Testwork was carried out by Oretest on the Samples provided by the Client.

(c) Oretest was in not involved in:

- the drilling, collection or transportation of the Samples; and
- the handling of the Samples prior to their delivery to Oretest.

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