FLOTATION OF MAGNESITE ORE EX

ARTHUR RIVER / LYONS RIVER:

PHASE 1; PRELIMINARY TESTS

CLIENT:	Tasmania Magnesite
JOB No.:	7362
DATE:	6 August 1997

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SUMMARY

A sample of magnesite ore from Tasmania has been subjected to a preliminary programme of batch flotation to produce an upgraded magnesite product.

The feed sample was assayed as follows:

HEAD ASSAYS

MgO %	SiO_2 %	Fe_2O_3 %	CaO %	LOI %	TOTAL
41.90	9.21	0.61	2.39	45.10	99.21

Mineralogical examination showed the material consisted of 2 distinct forms of magnesite with coarse (to 0.8mm) grains of quartz and talc as the major mineralogical impurities.

The flotation procedure used stage milling to p100 = 125μm followed by a prefloat (reverse float) to remove silicate minerals and then a float on the prefloat tail to produce a magnesite product.

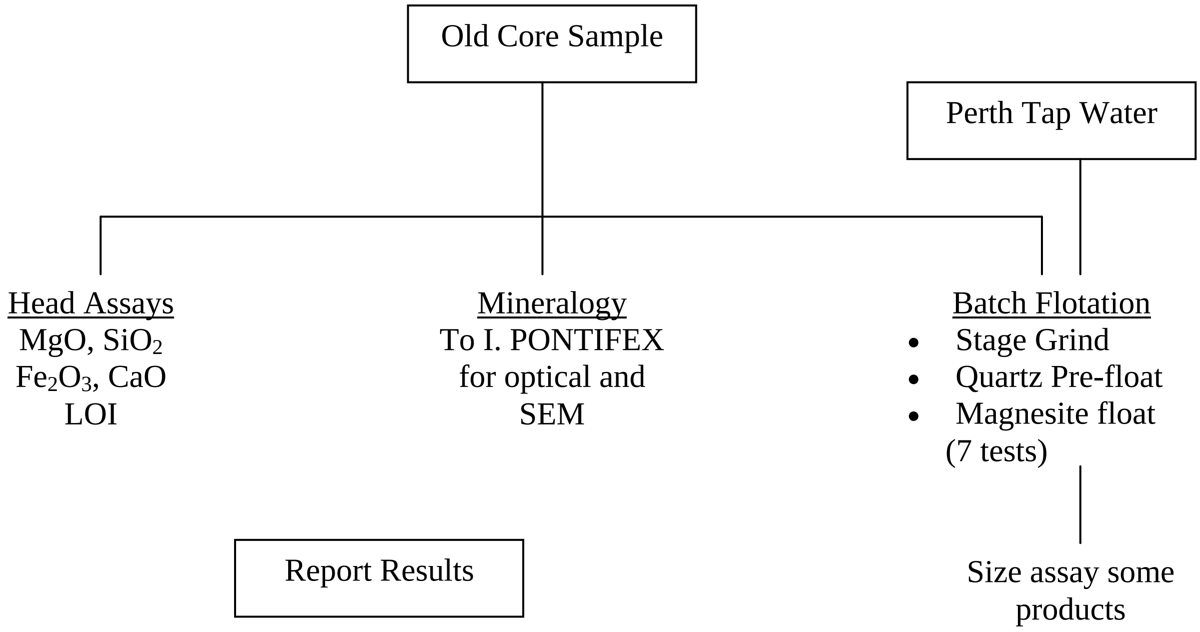
The removal of silica by the prefloat was very efficient (98% rejection of silica) and the ‘tail’ was of an acceptable quality (44-45% MgO, 0.2% SiO_2) without the requirement of a second flotation stage.

1 INTRODUCTION

Dr John Canterford of Minproc Technology (acting on behalf of Tasmania Magnesite) requested Oretest to conduct a programme of batch flotation testwork on samples of "old " drill core from the Arthur River / Lyons River region of north-west Tasmania. The programme carried out is shown below in Figure 1:

FIGURE 1: FLOTATION OF MAGNESITE ORE

(Phase 1 – Preliminary Programme)



The main objectives of the programme were:

- to characterise the ore in terms of the elements of major interest and in terms of the mineralogical composition.
- to obtain a "feel" for the flotation characteristics of the ore using a flotation procedure based on testwork carried out in Germany in 1985.
- to produce magnesite product with specified grades suitable for downstream hydrometallurgical processing.

- To prepare for the next phase of testwork which would be conducted using freshly drilled core.

Assays were carried out both by Amdel Analytical Laboratories (Perth) and by Oretest’s analytical facility using the following methods:

Amdel
MgO, SiO2, CaO etc. + LOI in solids - Fusion / ICP – OES

Oretest
MgO (check) - Multi-acid digest / AAS

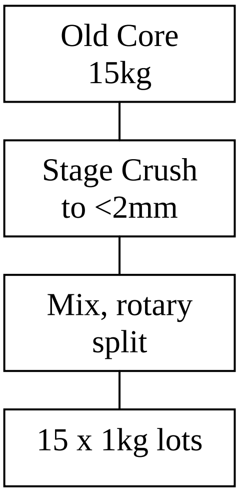
All tests were conducted in Perth tap water.

2 SAMPLES / SAMPLE PREPARATION

Approximately 15kg of “old” ore was dispatched ex storage in Hobart and received in good condition at Oretest in mid June 1997. This core had been drilled several years ago but was considered suitable for flotation testwork as, unlike sulphide ore, oxidation of quartz / magnesite ore would not be a problem.

The core samples were prepared as shown in figure 2 below:

FIGURE 2: SAMPLE PREPARATION



Details of the core samples supplied are given in Appendix 1.

Head Assays

The following head assays were obtained on the material:

MgO %	SiO_2 %	Fe_2O_3 %	CaO %	LOI %	TOTAL
41.90	9.21	0.61	2.39	45.10	99.21

Mineralogy of Feed Material

Mineralogical examination of the feed material was carried out by Ian Pontifex of Adelaide. Initially an optical examination of a polished thin section was done, followed by SEM analysis. The reports describing the findings of these examinations are given in Appendix 2. The following comments summarise the results:

- The magnesite occurs in two morphological forms, massive cryptocrystalline and coarse crystalline.
- Quartz in granular form up to 0.8mm occurs as composites with the magnesite.
- No calcite or dolomite was detected; the calcium probably occurs as replacement atoms within the magnesite.
- Talc and quartz are the only significant mineralogical impurities.
- The detection limit of the SEM for boron is 100ppm; boron was less than this and a more accurate measurement for boron is therefore required. (see section 3.2)

The implications of the mineralogical examination are:

- quartz and talc should be readily liberated from magnesite.

- calcium may be difficult to reduce by flotation.

As will be seen in Section 3.2, these mineralogical observations were supported by the flotation results.

Water Quality

The flotation characteristics of silicate and carbonate minerals are affected by water quality, particularly the presence of heavy metal cations. The water quality at the site in Tasmania is believed to be good, therefore the use of Perth tap water in the current tests was considered to be acceptable. (Perth tap water contained 110 ppm TDS).

3 TESTWORK PROCEDURES AND RESULTS

3.1 PROCEDURES

The following standard procedures were used in the programme.

- Batch Flotation

This procedure is given in Appendix 3.

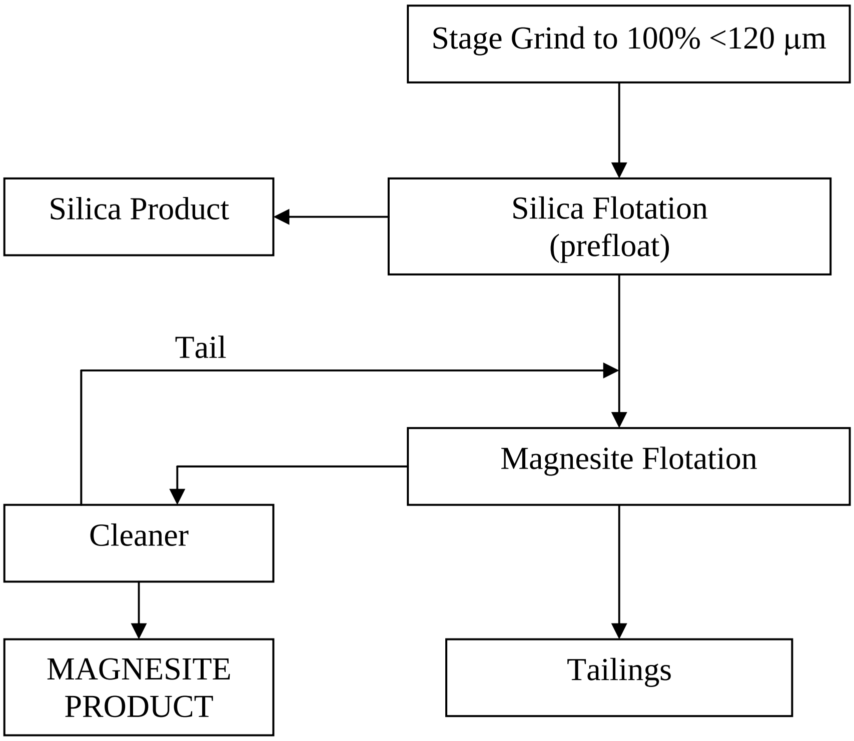
3.2 RESULTS AND DISCUSSION

3.2.1 Preliminary Discussion

Previous Flotation Testwork

Dr. Canterford supplied a copy of a report on flotation testwork carried out in 1985 by KHD Humboldt Wedag in Germany, on similar feed material.

The procedure developed by KHD is shown below:



The feed composition of the KHD sample was:

MgO %	SiO_2 %	Fe_2O_3 %	CaO %	Al_2O_3	LOI %
43.81	5.60	0.51	1.14	0.05	45.54

These feed analyses are fairly close to those obtained for the current feed sample; MgO is about 2% higher while SiO_2 is about 4% lower. The current feed is therefore probably more difficult to upgrade than the sample tested by KHD.

The objectives were to produce an MgO product of MgO >97%, SiO_2 <1% and Fe_2O_3 <1% (on a "burnt" or LOI-free basis). These grades were achieved at an MgO recovery of 61% or better. Very little details of reagents are provided; these were referred to by their "trade" names and neither the suppliers nor the chemical compositions were given.

Procedure for Current Tests

For the current tests it was decided to use a similar procedure to that previously used by KHD; i.e. a silica (quartz) prefloat on a feed stage-milled to about 120µm, followed by a carbonate float on the prefloat tail. (Note, stage grinding was used to minimise slimes formation; sliming of the relatively soft magnesite would result in loss of product and also possibly have an adverse effect on flotation due to slimes coating of coarser particles.)

The choice of reagents was based on standard practice for both the flotation of silicates (the prefloat) and the flotation of carbonate (the magnesite product). A range of fresh reagents was available from the German manufacturer, Hoechst, so these were chosen for the testwork, where applicable.

Details of the reagents are shown in the table below:

Reagent Name	Supplier	Type	Chemical type	Comments
K2C	Hoechst	Cationic Collector	Quaternary alkyl ammonium chloride	Used for reverse silicate flotation
FS-2	Hoechst	Anionic Collector	Mix of saturated & un-saturated carboxylic acids	General use for oxide & carbonate minerals
Starch	various	Depressant	na	Maize starch used & prepared in causticised form
Flotol	Hoechst	Frother	Natural pine oil (turpene alcohol)	Widely used for "oxide" & sulphide flotation; has some collecting properties

Product Specifications

Discussions with Dr. Canterford indicated that the following magnesite product specifications were desirable:

MgO:	>45% or >97% (burnt basis)
SiO_2:	<2% (unburnt basis)
CaO:	<1.5% (unburnt basis)
Fe_2O_3:	<0.5% (unburnt basis)

It was indicated that SiO_2 was the impurity which caused the greatest problems with regards to downstream hydrometallurgical processing and that the lower the SiO_2, the better.

3.2.2 Results

Stage Milling

Stage milling (grinding) was carried out using 6 minute stages in a standard laboratory rod mill. Screening at the desired feed size was carried out prior to the start and after each stage of milling, with oversize returned to the mill. A total of 17-18 minutes of milling was required to achieve a p100 of 125µm. This time is indicative of an ore of medium hardness.

Batch Flotation

A total of 7 floats were carried out; the summarised conditions for these floats is given in the table below:

No.	Test No. IC	Conditions
1	1505	Initial scouting test @ p100 = 125µm. Magnesite float conditioned @ 50% solids. Magnesite slow floating; still floating at 10 minutes.
2	1506	Increased collector dosages (both collectors). Added starch to prefloat. Frother required; magnesite floated faster.
3	1514	Repeat of IC 1506 to optimise recoveries. Appeared to need more starch.
-	1514a	Same as IC 1514 but MgO assays done by Oretest.
4	1515	Finer grind size (p100 = 106µm) to try and improve MgO grade. Increased starch. Froth unstable during prefloat.
-	1515a	Same as IC 1515 but MgO assays done by Oretest.
5	1517	Repeat of IC 1515 but increased temperature to ~32°C during MgO float.
6	1518	Repeat of IC 1515; deslimed float feed at ~7µm. Float was overeagentised and abandoned; deslimed feed needs lower collector addition.
7	1519	Repeat of IC 1518 with reduced reagent additions. Good froth stability obtained.

The detailed results for the batch floats are given in Tables 1-7 in Section 4. These tables show mass balances for MgO and SiO_2 together with reagent and procedure details.

The mass balance results are summarised in the table below:

TEST NO		Quartz Concentrate						Magnesite Concentrate						Tail						Cyclone O/Flow				
	Mass	SiO2		MgO		CaO	Mass	SiO2		MgO		CaO	Mass	SiO2		MgO		CaO	Mass	SiO2		MgO		CaO
	%	Grde %	Rec'y %	Grde %	Rec'y %	%	%	Grde %	Rec'y %	Grde %	Rec'y %	%	%	Grde %	Rec'y %	Grde %	Rec'y %	%	%	Grde %	Rec'y %	Grde %	Rec'y %	%
IC 1505	13.6	54.2	80.2	26.3	8.5		72.3	2.0	12.8	44.9	65.6		27.7	2.3	7.0	44.2	29.0							
IC 1506	20.2	43.8	91.1	28.1	14.3		73.2	1.1	8.5	42.4	78.4		6.6	0.6	0.4	43.8	7.3							
IC 1514	24.3	37.5	98.3	31.6	18.8		73.8	0.2	1.6	43.8	79.2		1.8	0.5	0.1	44.9	2.0							
IC 1514a*	24.3	37.5	98.3	31.9	18.9	1.43	73.8	0.2	1.6	44.0	79.1	2.97	1.8	0.5	0.1	45.9	2.0	1.18						
IC 1515	20.3	44.0	98.1	29.6	14.8		69.2	0.2	1.6	43.3	73.9		10.5	0.2	0.3	43.7	11.3							
IC 1515a*	20.3	44.0	98.1	29.8	14.4	0.82	69.2	0.2	1.6	44.8	74.0	2.95	10.5	0.2	0.3	46.0	11.5	2.2						
IC 1517	26.8	34.2	95.6	32.9	21.7	1.13	65.3	0.6	4.3	43.4	69.7	3.14	7.8	0.2	0.2	44.5	8.6	1.85						
IC 1519	40.8	20.8	88.7	37.5	37.3	2.57	25.0	1.8	4.6	44.0	26.8	1.22	18.3	0.9	1.6	42.4	18.9	5.29	15.8	3.0	5.0	43.9	16.9	1.2

Size Assays

The products (quartz and magnesite) from test IC 1506 were screened at 53µm and the two size fractions assayed for MgO and SiO_2. These results are shown in the table below:

Product	Mass		MgO		SiO2		Head MgO	Head SiO2
	+53 mm g	-53 mm g	+53 mm %	-53 mm %	+53 mm %	-53 mm %	%	%
Qtz con 1	47.5	92.4	18.6	26.6	66.9	49.2	23.9	50.7
Qtz con 2	20.2	38.9	34.5	40.5	30.2	12.2	38.4	27.0
MgO con 1	71.0	281.6	40.1	42.6	2.0	0.5	42.1	1.6
MgO con 2	92.7	149.1	41.5	43.9	1.0	0.4	43.0	0.7
MgO con 3	49.6	73.0	42.4	42.3	0.8	0.6	42.3	0.6
Tailing	38.2	25.5	44.1	43.3	0.6	0.5	43.8	0.6
Totals	319.2	660.5					39.6	9.7

3.2.3 General Comments and Conclusions

The following comments and conclusions can be made:

- The quartz prefloat works very well; the SiO_2 content can be reduced to <0.3% in the "tail", even at the coarser grind size (i.e. at p100 = 125μm).
- The MgO loss to the quartz prefloat is about 19% at p100 = 125μm and 15% at p100 = 106μm.
- The MgO content of the prefloat "tail" is about 43-44%.
- The MgO float therefore may not be needed; the mass recovery to this float was over 90% and the float essentially did not achieve any upgrading with regards to MgO.
- The main impurity in the MgO product was CaO at about 3%. It appears that this cannot be readily reduced because of the mineralogical composition. (See Section 2).
- Temperature increase during the MgO float (based on 1 test) had no obvious beneficial effect on MgO grade.
- Desliming of the float feed at about 7μm rejected 17% of the MgO into 16% of the mass. The recovery of MgO was reduced to 27% in the magnesite product due to loss of MgO in the "slime" as well as increased MgO loss to the prefloat. The only advantage of desliming was to reduce the CaO content of the magnesite product.
- A relatively simple quartz prefloat produced a product with the following approximate composition (i.e. with no MgO float).

MgO %	SiO_2 %	CaO %	Fe_2O_3 %	LOI %	TOTAL
44 to 45	0.2	2.9 to 3.0	<0.5	51	~99.5

- Size assaying of the products from Test No. IC 1506 showed that the SiO2 upgrades to the coarser sizes while the MgO upgrades to the finer sizes; this is consistent with the relative hardness of the minerals and confirms the need for minimising slime formation during milling.

- It should be noted that Oretest obtained MgO assays of slightly higher values than those obtained by Amdel. (i.e. 1-2% at the 44-45% level). MgO assays are relatively “tricky”, but a high level of confidence exists in Oretest’s results as a lot of development has been put into accurate MgO assaying by Oretest in relation to nickel concentrates. Nevertheless a standard sample of magnesite product should be obtained for the next phase of testwork.

- The objectives of the first phase of flotation testing were achieved.

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4 DETAILED TEST DATA

TABLES 1 - 7 BATCH FLOTATION RESULTS

APPENDIX 1

DETAILS OF CORE SAMPLES

APPENDIX 1

SAMPLE	DEPTH (m)	MASS (kg)
AR2	107 – 117	2.18
	117 – 129	1.35
	129 – 137	1.52
	137 – 146	1.60
		6.65
AR7	80.5 – 82.9	0.88
	121 – 127	1.08
	129 – 130	0.33
	142 – 146	1.59
	146 – 147	0.54
	155 – 160	0.73
	162 – 163	0.46
	164.8 – 169	1.02
	177 – 182	1.40
		8.03
TOTAL		14.68

APPENDIX 2

MINERALOGICAL REPORTS

APPENDIX 3

TEST PROCEDURES

BATCH FLOTATION

PROCEDURE No. 1

The charge weight of ore (usually 1 kg or 2 kg) is milled in a laboratory rod mill for the time required to give the desired size distribution. At the completion of grinding, the slurry is washed directly into the roughing flotation cell. The cell size is chosen to give the desired pulp density in the roughing stage (for a 1 kg charge a 2.5 litre cell is used).

Flotation is carried out using standard Agitair bench machines. Special modifications are available (if required) to control pulp volume and froth removal rate during flotation. Air flowrate is controlled by a rotameter. Agitator speed is set, usually at 700 rpm for conditioning, 700 - 750 rpm for rougher flotation and 750 - 800 rpm for cleaning.

Cleaning is carried out in smaller cells, using lower pulp densities compared to roughing. The smallest cell available is 0.5 litre.

Froth products are collected, filtered, weighed, and prepared for assay, as is the final tailings.