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EL 43/70 ARTHUR RIVER

METALLURGICAL EVALUATION STUDIES.

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KHD HUMBOLDT WEDAG AG

Cologne, July 25, 1985

IH-YM2 Wi/He -
phone extension 658

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Report

on

process engineering tests
carried out with magnesite
for Conzinc Riotinto Australia Ltd. (CRA),
Melbourne/Australia
P.-No. 9-2121-5-0089
A.-No. 9-8125-9-5011

1. Summary

Following a very heedful reduction of the raw magnesite to a fineness of 100 % less than 0.12 mm, a magnesite concentrate of a MgO-content of 96 - 97 % and a SiO_2-content of approx. 0.5 % (related to burnt magnesite) was produced by way of two-stage flotation at a concentrate recovery of more than 63.5 % .

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2. Material to be tested

On March 15, 1985 the research- and development center of KHD Humboldt Wedag AG received a magnesite sample of 300 kg from Messrs. Conzinc Riotinto Australia Ltd., Melbourne 3000, Australia.

The consignment included lump rock samples of a max. grain size of 400 mm.

3. Test objective

The test objective was to produce a magnesite concentrate of the following contents:

MgO-content	approx. 97 %
SiO_2-content	less than 1 %
Fe_2O_3-content	less than 1 %.

All values are related to burnt magnesite.
The ratio CaO - SiO_2 content was to be ➢ 2.

The values below were reached by the customer during preliminary tests:

MgO-content	97 %
SiO_2-content	0.5%
CaO-content	1.4%
Fe_2O_3-content	0.85 %

According to information by the customer, the MgO-recovery equalled 61 %.

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4. Test procedure and -results

After completion of a particle size analysis the overall sample was subjected to a reduction to a fineness of 100 % less than 31.5 mm. Subsequently, representative samples were extracted for the different tests.

4.1 Raw material testing

4.1.1 Chemical analysis

The wet-chemical analysis of a representative sample of the delivered magnesite yielded the following constituents:

MgO-content	43.81	%
SiO_2-content	5.60	%
CaO-content	1.14	%
Fe_2O_3-content	0.51	%
Al_2O_3-content	0.05	%
loss on ignition	48.54	%

The following semi-quantitive analysis was made by means of X-ray emission analyzing:

element or oxide	contents* portions % by weight (fraction)
Na_2O	not evidenced
MgO	70 - 90
Al_2O_3	0.03 - 0.1
SiO_2	3 - 7
P_2O_5	not evidenced
SO_3	0.03 - 0.07

element or oxide	contents* portions % by weight (fraction)
Cl	traces
K_2O	0.01 - 0.03
CaO	2 - 5
TiO_2	0.005 - 0.02
Cr	0.01 - 0.03
Mn	0.05 - 0.2
Fe	0.8 - 1.5
Cu	0.05 - 0.2
Sr	traces
Ba	0.005 - 0.02
Zn	traces

*contents related to burnt magnesite

4.1.2 Moisture

By drying in a drying oven at 106 °C ± 2 °C, the moisture of the sample was determined at less than 0.1 %.

4.1.3 Bulk density

The bulk density of a representative sample reduced by 100 % to a size less than 5.6 mm, equalled 1.85 t/m^3.

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4.1.4 Grain size distribution

The total delivered sample was subjected to dry sieving with three mesh widths and the coarse pieces were measured. The following grain size distribution resulted:

beyond		125	mm	72	%
125	-	63	mm	23.5	%
63	-	31.5	mm	3.2	%
less than		31.5	mm	1.3	%

The largest pieces had the following dimensions: 400 x 200 x 110 mm, 350 x 300 x 290 mm and 350 x 330 x 160 mm.

4.1.5 Mineralogic testing

4.1.5.1 X-ray powder diffraction method

The X-ray powder diffraction analysis of a representative sample of the raw material yielded the following minerals constituents:

1.	magnesite	main portion
2.	dolomite	secondary component
3.	quartz	low content
4.	talcum	very low content

4.1.5.2 Microscopic investigation of thin- and polished sections of the raw material

The following minerals of the stated fraction ranges were ascertained with the aid of microscopic investigations of thin- and polished sections:

mineral	fraction range total mm	main portion mm
magnesite	approx. 0.005 - approx. 5	0.1 - 0.6
dolomite	0.01 - 0.65	> 0.05
quartz	0.005 - 0.5	< 0.2
goethite	0.01 - 0.3	> 0.1
talcum	< 0.05	finely grained
calcite	0.02 - 0.25	
mica	approx. 0.005 - 0.25	

The delivered raw material is a magnesite, being partly finely- and partly coarsely crystalline (enclosure 1), the main impurities of which are dolomite (enclosure 2) and quartz (enclosure 3). The dolomite occurs partly as veins (enclosure 4) and partly as fine (enclosure 5) and coarse inclusions in the magnesite structure. On the one hand it can be observed along the grain boundaries of the magnesite crystallites and on the other hand as inclusions in the crystallites. The actual dolomite for the predominant portion contains fine magnesite inclusions of a size from 0.005 mm to 0.1 mm.

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PINNAR DEPOSIT

The quartz is present as binder between the magnesite crystallites (enclosure 6), but also as coarse inclusion in the magnesite (enclosure 7). It is partly idiomorphous and frequently includes - as infiltrated - fine and superfine inclusions of magnesite of a fraction range from 0.001 mm to 0.05 mm. To a minor degree, magnesite and quartz form an intimately intergrown, granular structure (enclosure 8), the maximum grain size of both minerals equalling 0.13 mm. This suggests two generations of mineralization, which likewise explains the idiomorphous formations of quartz and magnesite.
Moreover, quartz occurs as inclusions in the dolomite.
Intergrowth, i.e. magnesite existing as binder between the particles in coarse quartz lots (enclosure 9), is observed to a minor degree only.
Goethite as pseudomorphosis of pyrite, is intergrown with magnesite and/or quartz. Talcum, for the major portion, occurs at the grain boundaries of the magnesite crystallites and as inclusions in the magnesite, although rarely only.
Calcite is present in the magnesite as inclusions and is frequently associated with dolomite. Also the coarser calcite inclusions mostly contain fine inclusions of magnesite (enclosure 12) (up to 0.030 mm, max.).
Mica could be observed exclusively as fine inclusions in the quartz.

The microscopic investigations suggest that grinding of 100 % less than approx. 0.12 mm would be suitable for processing the delivered raw magnesite. Due to the partly superfine intergrowth between quartz and magnesite and the fact that dolomite is the main gangue, it has to be presumed that a high magnesite recovery at a high MgO-concentration will hardly be realizable.

NB

Idiomorph-aus -ie - Automorphic

An igneous rock mineral completely bounded by its characteristic crystal faces.

4.1.6 Specific gravity distribution of grain fractions

A representative sample of the raw material reduced to a fineness of 100 % less than 5.6 mm was subjected to wet classification at 0.5 mm. The wet residues retained were admitted to a tank filled with distilled water and transferred to a 0.1 mm sieve after 1 hour. Following a dripping-off period of 15 minutes, the material was immersed into an organic liquid of a tested specific gravity of 2.46 g/cm^3, split into floats and sinks. The sinks were separated by sink-float tests directly afterwards at the next higher specific gravity. The specific gravity distribution of grain fractions obtained with chemical analyses of the specific gravity fractions can be taken from enclosure 13, showing that lowering of the SiO_2-content is not possible for the grain size distribution selected by spec. gravity sizing.

4.2 Flotation

The mineralogic test carried out with the raw magnesite as well as flotation tests revealed that comminution of 100 % less than approx. 0.125 mm is required for processing the magnesite.

4.2.1 Grinding

Applied was a laboratory rod mill of a volumetric capacity of 5 litres. Eight rods made of V2A-steel of a diameter of 20 mm served as grinding media. The solids/water mass ratio equalled 1 : 1.

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One kilogram, each, of the raw ore crushed by 100 % to a size less than 2 mm, was subjected to dry sieving at 0.12 mm and the residues retained on the sieve were ground for five minutes. Subsequently, the material ground was sieved wet at 0.12 mm, the residues retained were ground for five minutes. Following this, they were again subjected to wet classification and the remaining coarse fraction was again ground for three minutes. The grain size distribution of the total quantity of material ground is shown in the RRSB-grading graph in enclosure 14.

4.2.2 Flotation tests

The flotation tests were carried out in a 3 l laboratory flotation cell, type WEDAG.
The solids content equalled 330 g/l, the tap water used had a hardness degree of 10° German hardness and the temperature of the pulp was $15^{\circ}C$.
SiO_2-flotation as well as MgO-flotation were carried out fractionally, i.e. several products were separated by sink-float tests during each stage of flotation.
The advantage of this mode of flotation is that it enables a better evaluation of the different products and adding up of the different MgO-concentrates, depending on the SiO_2- and CaO-content.

4.2.2.1 Reagents

The following reagents were applied for flotation of the SiO_2-impurities:

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EKOFACT DD 95 200 g/t of ore as well as
RESANOL 450 120-150 g/t of ore as
collecting reagent/effervescing reagent combination.

The conditioning time for EKOFACT DD 95 equals 1 - 2 minutes and for RESANOL 450 approx. 5 minutes.

Prior to the subsequent MgO-flotation, 200 g/ton of EKOFACT DD 95 ^{R} and 400 - 500 g/ton of soda water-glass were added for deadening of calcite, dolomite and quartz.

Following a conditioning period of approx. 1 minute for these two reagents, the magnesite was separated in a sink- and float process with RESONAL A ^{R} (as 10 % emulsion).

RESONAL A is a collecting-, effervescing reagent combination, specially developed for flotation of magnesite, which recovers magnesite highly selectively.

Since this reagent is emulsified very rapidly in the flotation pulp, special conditioning periods are not required.

MgO-product 1 and 2 = 300 g/ton of RESONAL A ^{R}
MgO-product 3 = 200 g/ton of RESONAL A ^{R}

and, if required, for MgO-product 4 100 g/ton of RESONAL A ^{R}.

4.2.2.2 Flotation period

As regards flotation of SiO_2, flotation periods between 8 and 10 minutes are required.
MgO-flotation requires approx. 5 minutes.

Including the reacting periods for SiO_2-flotation reagents and a sheer flotation period of approx. 8 minutes, 15 - 16 minutes shall be planned for the total silicic acid flotation.

Including the reacting period required for the reagents for MgO-flotation and a flotation time of 5 minutes, a total of 7 minutes is necessary for MgO-flotation.

4.2.2.3 Results

Apart from a number of flotation tests, which were evaluated only for the mass distributions and the SiO_2-contents, also the contents of MgO, CaO, Fe_2O_3 as well as the losses on ignition of the different products were determined during tests 6139 and 6141.

The results are included in the enclosures, related on the one hand to non-ignited magnesite and on the other hand to burnt magnesite. They show that - at a recovery of 63 - 65 % - a concentrate was produced, being characterized as follows:

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test		6139	6141
concentrate recovery	%	63.83	65.30
contents (non-ignited)			
MgO	%	46.74	46.58
SiO_2	%	0.27	0.23
CaO	%	0.59	0.62
Fe_2O_3	%	0.46	0.47
contents (ignited)			
MgO	%	96.65	95.76
SiO_2	%	0.56	0.47
CaO	%	1.22	1.27
Fe_2O_3	%	0.96	0.97
		99.39	98.47

The MgO-recovery in the concentrate during the tests approx. amounted to 70 % (68.42 % non-ignited during test 6139, 71.30 % related to burnt magnesite). However, this value cannot unrestrictedly serve as a basis for characterizing the success of classifying, since magnesium oxide is not only included in valuable mineral magnesite, but also in the tailings dolomite.

4.3 Sedimentation

4.3.1 SiO_2-product

After a sedimentation period of 15 minutes, thickening of 400 g/l (575 g/l) in the feed to only 500 g/l (600 g/l) could be achieved without addition of flocculants during the sedimentation tests with the froth product from SiO_2-flotation at a slightly turbid excess.
The sedimentation behaviour substantially improved only after addition of 15 g/m^3 of flocculant Praestol 2900/75 (enclosure 19, refer).
At an initial concentration of 400 g of solids in 1 l pulp, a clear water phase of 184 mm was obtained after 15 minutes. After this sedimentation period, the thickening degree equalled 878 g/l.

4.3.2 MgO-concentrate

No auxiliary sedimentation agents are required for thickening the magnesite concentrate, i.e. the froth from MgO-flotation. At an initial concentration of 530 g/l and 740 g/l, respectively, a solids content in the sedimented material of 1100 g/l and 1060 g/l, resp., were reached after a sedimentation period of 15 minutes (see enclosure 20).
At the low specific gravity of the feed pulp, a clear water phase of 180 mm was formed, of which 10 - 20 mm existed as froth, after the period mentioned above.
During all sedimentation tests carried out with the magnesite concentrate, a stable froth layer of a thickness of 10 - 50 mm, in exceptional cases up to 100 mm, was formed at the upper part of the clear water phase.

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4.3.3 Tailings

As regards the residues from MgO-flotation, a small addition of auxiliary sedimentation agents is required, since no phase separation could be determined for the sedimentation tests in the vertical cylinder without addition of flocculants. After addition of 2.5 g/m^3 of Praestol 2900/74, a slightly turbid water phase of 327 mm (see enclosure 21) was formed within five minutes. At a solids content of the feed of 72.5 g/l, the final thickening degree equalled approx. 1100 g/l. A higher addition of flocculants did not improve the results.

4.4 Filtering tests

The magnesite concentrate from the flotation tests was examined for its filtering capacity with the aid of a vertical suction filter. The filtering surface of this suction filter (0.01 m^2) was covered with tissue M/PP 2425. Pulp of a solids content of 550 g/l and 1400 g/l, respectively, served as feed material. The results can be taken from the table included in enclosure 22.
At the low specific gravity of the feed pulp, a residual moisture of 7.3 % was reached at a theoretic throughput of 730 kg/(hm^2). With the thickened slime (1400 g/l), the calculated feed rate could be raised to 2 t/(hm^2) at a residual moisture equalling 10 %.

The tests were carried out by us to the best of our knowledge and ability. A liability, in particular for the process engineering results of machines, plant sections or plants delivered by us can be undertaken by us only, if this has been agreed upon in writing.

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i.V. Dr. Kellerwessel i.V. Dr. Imhof

Encl.

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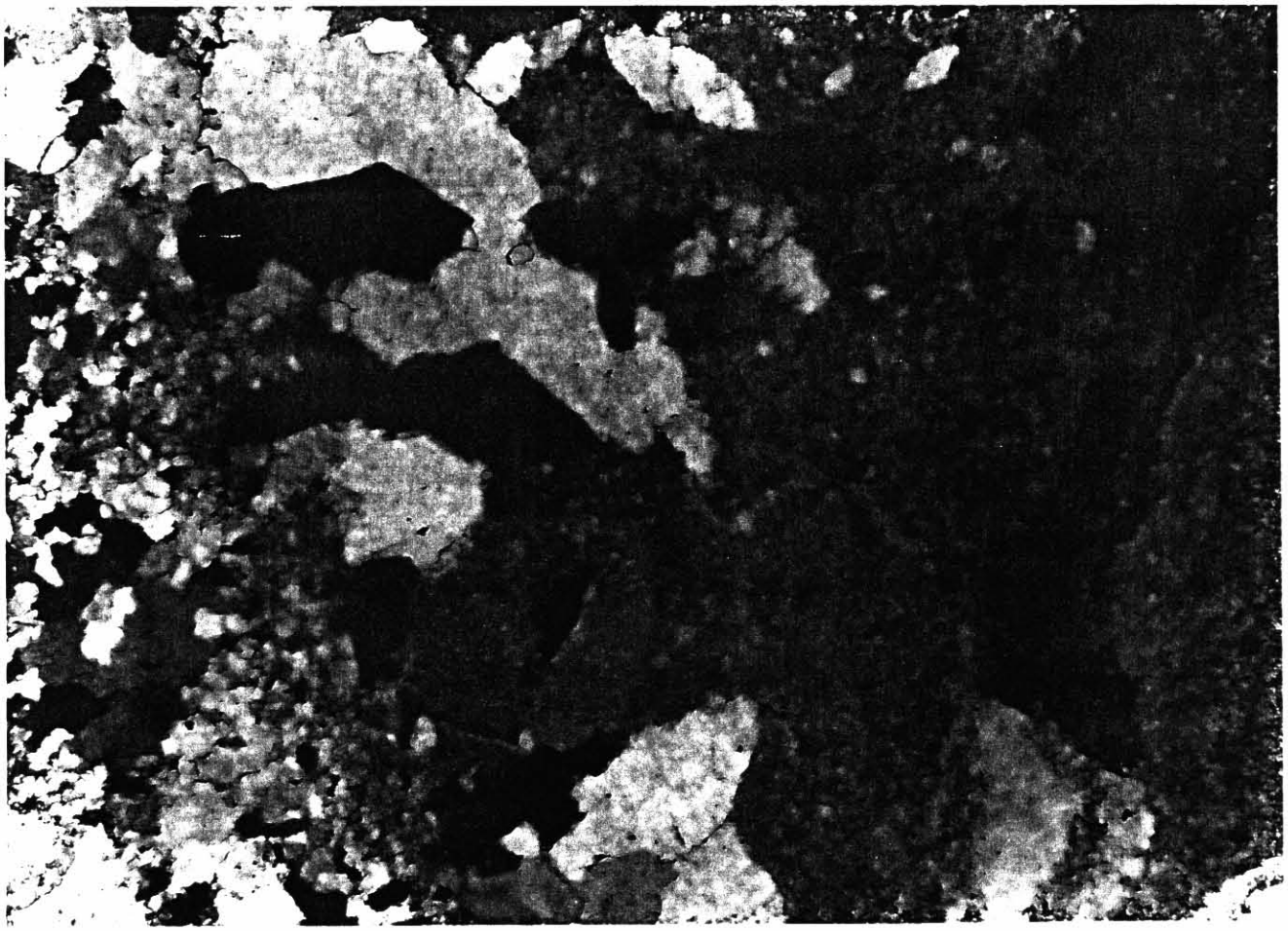
Enclosure

1	Microphotograph no. 1
2	" " 2
3	" " 3
4	" " 4
5	" " 5
6	" " 6
7	" " 7
8	" " 8
9	" " 9
10	" " 10
11	" " 11
12	" " 12
13	Sink-Float-Analysis
14	Grading graph - feed -
15	Balanceflotation test 6139
16	" " " " (dead burned basis)
17	" " " 6141
18	" " " " (dead burned basis)
19	Settling curve SiO_2-product
20	" " MgO-concentrate
21	" " tailings
22	List of filtration tests MgO-concentrate

Enclosure 1



200 µm

Microphotograph no. 1 thin section, N+

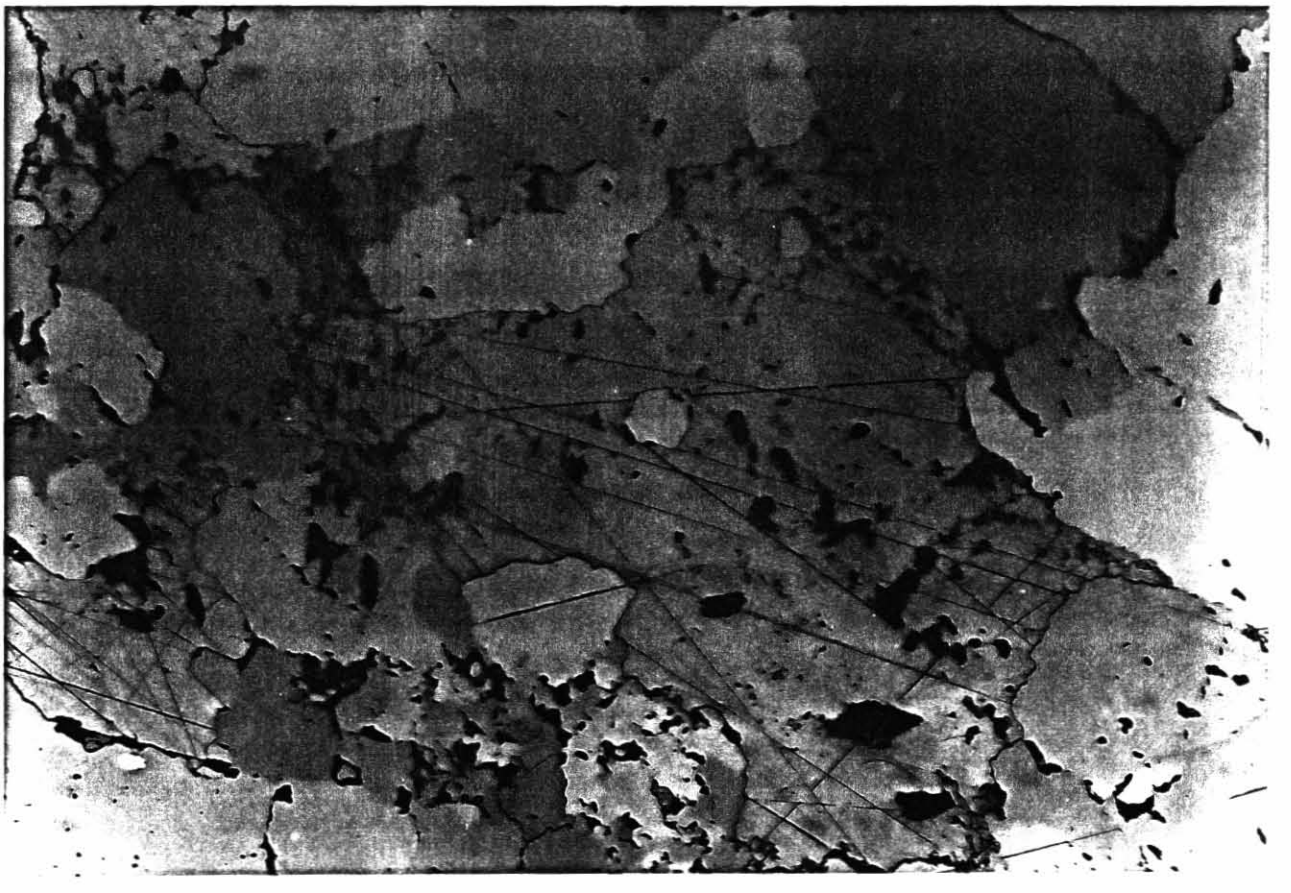
magnification - microscope 67 x)
enlargment - photograph 1.6x) 107 x

Sample: Magnesite from Messrs. C.R.A., Australia

Magnesite (coloured), partly coarse-, partly fine-crystalline exist next to each other. The fine-crystalline magnesite (right-hand side of microphotograph) includes minute quartz veins (light grey, dark grey to black).

5 cm

Enclosure 2



0,1 mm

Microphotograph no. 2

polished section, etched with $Al(NO_3)_3$

magnification - microscope 100 x)
enlargement - photograph 1.6 x) 160 x

Sample: Magnesite from Messrs. C.R.A., Australia

Coarser inclusions of dolomite (grey, etched; grinding scratches visible) in magnesite (grey, smooth).

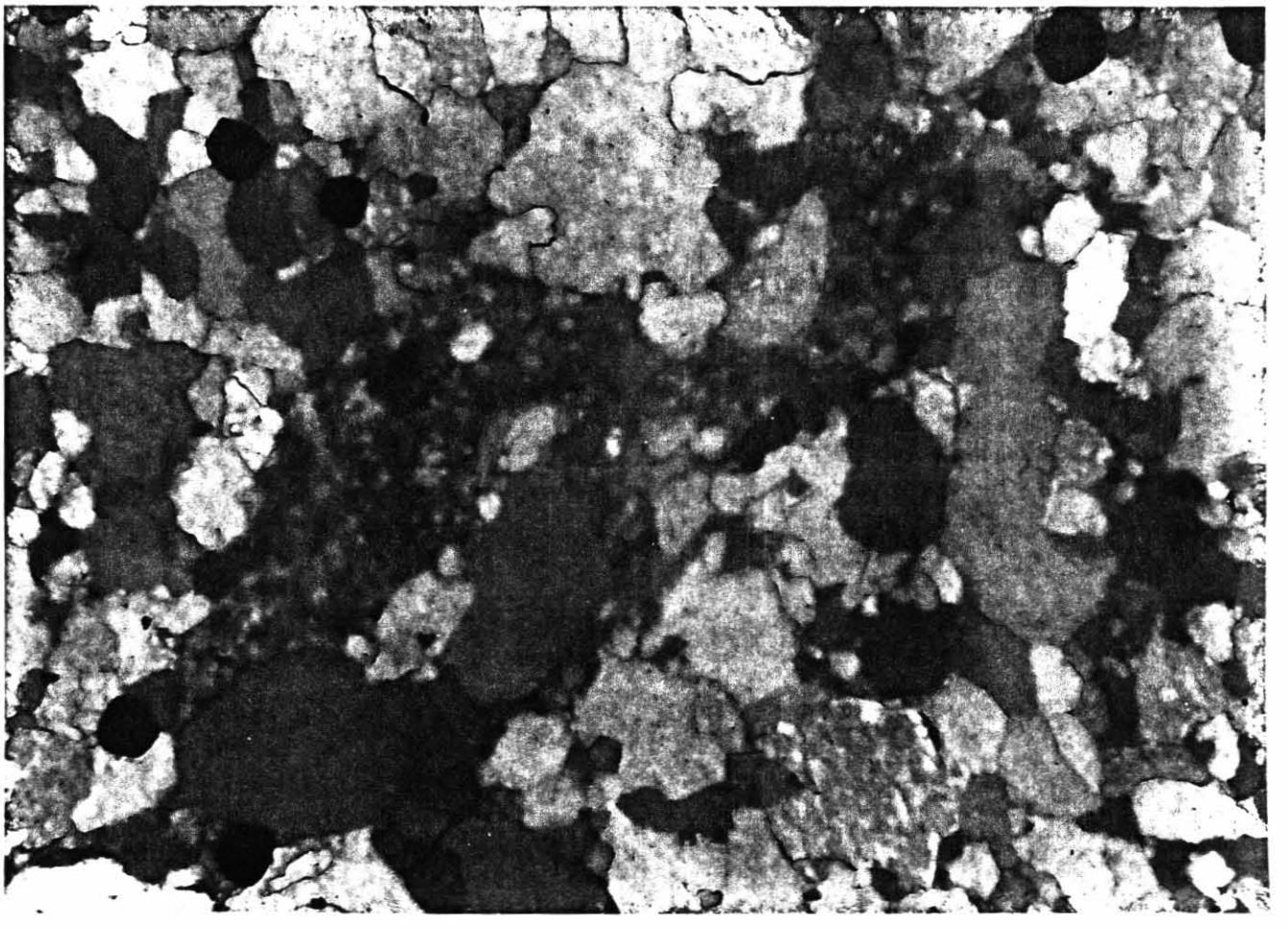
The dolomite shows fine inclusions of magnesite.

Pores and cavities are black.

5 cm

017

Enclosure 3



0,2 mm

Microphotograph no. 3 thin section, N+

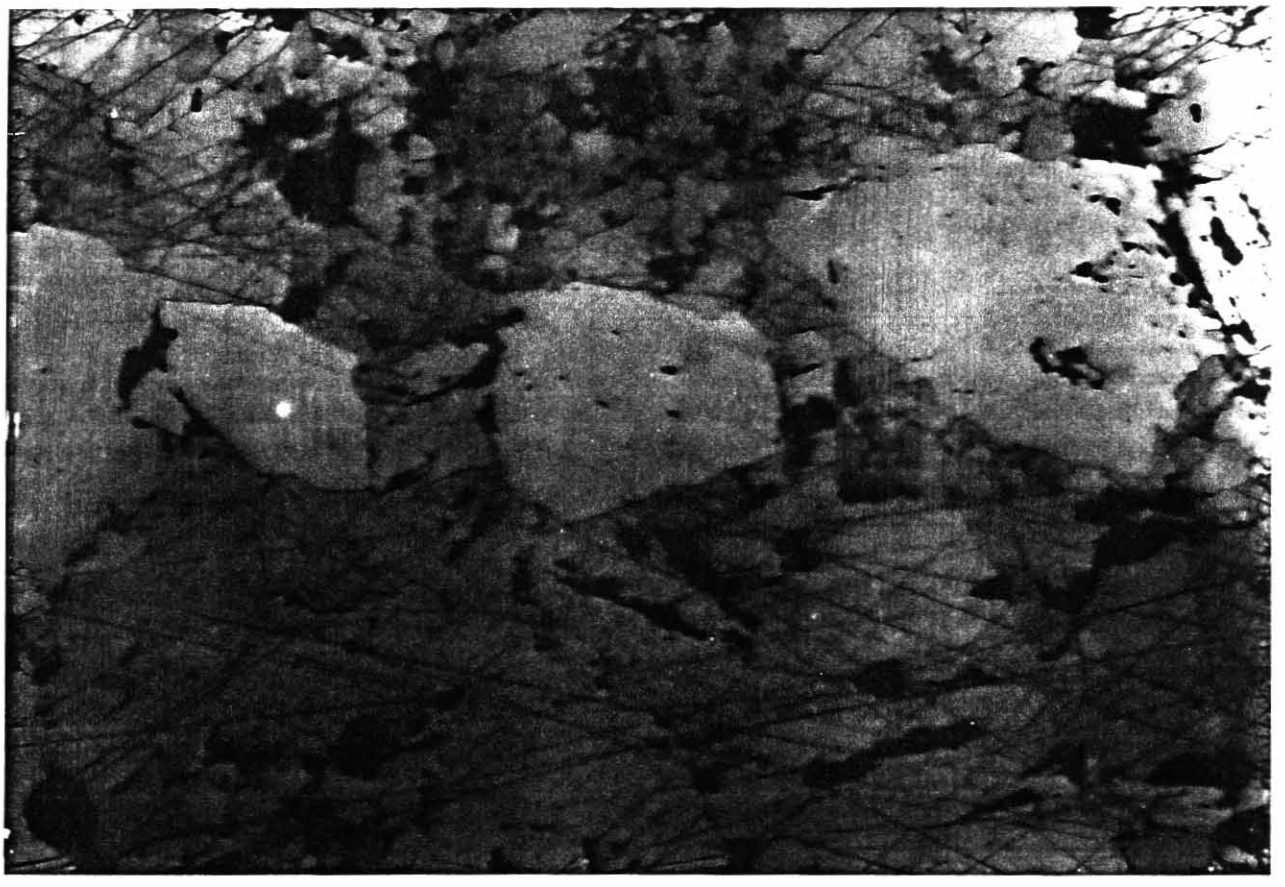
magnification - microscope 67 x)
enlargment - photograph 1.6x) 107 x

Sample: Magnesite from Messrs. C.R.A., Australia

Outline microphotograph, magnesite structure (coloured, coarser crystalline) with inclusions of quartz (blue, red purple, yellow-brown) and goethite (black).

5 cm

Enclosure 4



0,1 mm

Microphotograph no. 4

polished section, etched with Al $(NO_3)_3$

magnification - microscope 100 x) 160 x
enlargement - photograph 1.6 x

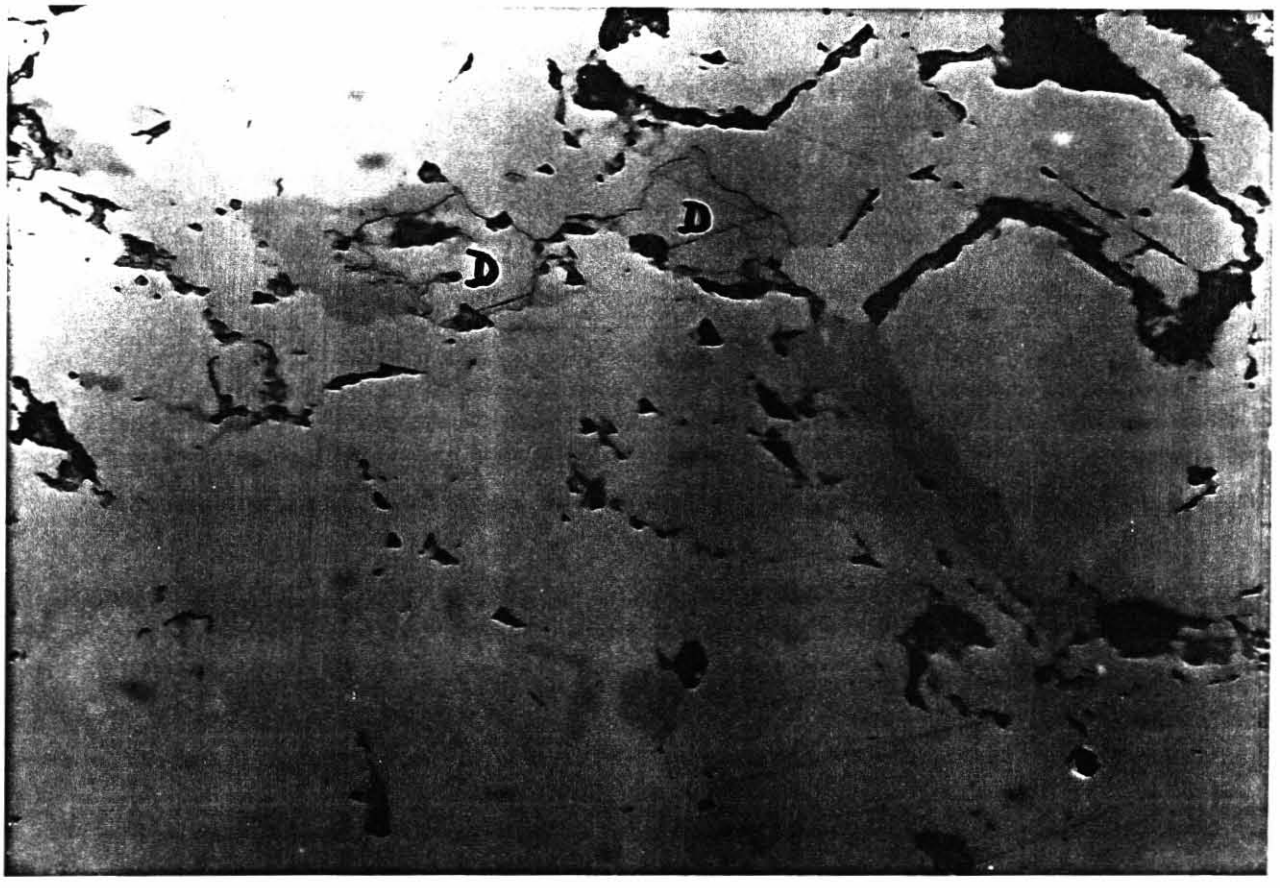
Sample: Magnesite from Messrs. C.R.A., Australia

Dolomite vein (dark grey, etched; grinding scratches visible) with coarser inclusions of magnesite (medium grey, smooth).

Pores and cavities are black.

5 cm

Enclosure 5



0,1 mm

Microphotograph no. 5

polished section, etched with $Al(NO_3)_3$

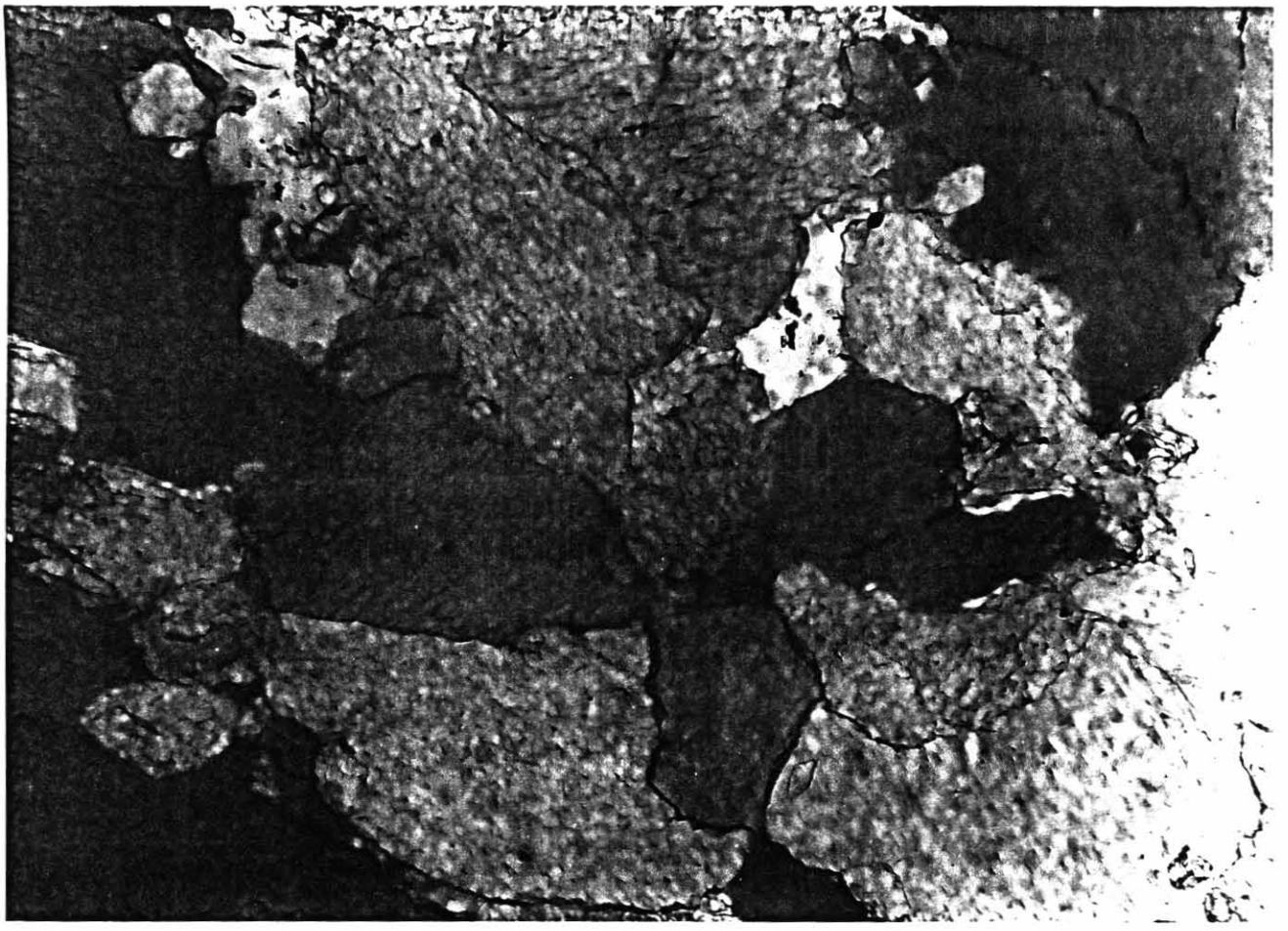
magnification - microscope 200 x)
enlargement - photograph 1.6 x) 320 x

Sample: magnesite from Messrs. C.R.A., Australia

Fine inclusions of dolomite (grey, D) in magnesite (grey, smooth).
Pores and cavities are black.

5 cm

Enclosure 6



0,1 mm

Microphotograph no. 6 thin section, N+

magnification - microscope 160 x)
enlargement - photograph 1.6 x) 256 x

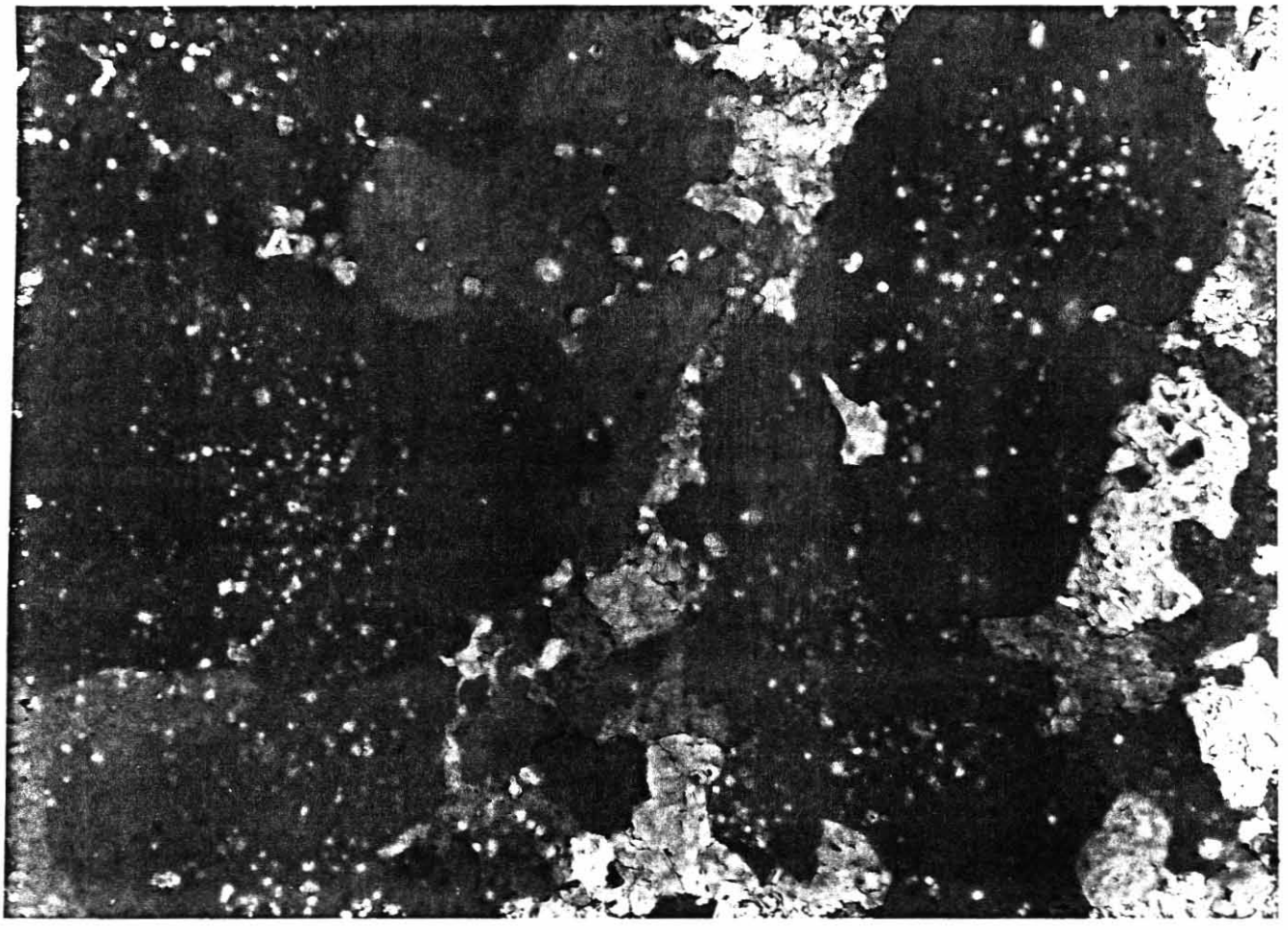
Sample: magnesite from Messrs. C.R.A., Australia

Quartz (blue, light blue, yellow, red purple) partly displaying minute inclusions of magnesite (yellow to yellowish-green) as binder between the various magnesite crystallites (blue-purple, grey-green and grey-pink).

5 cm

021

Enclosure 7



0,1mm

Microphotograph no. 7 thin section, N +

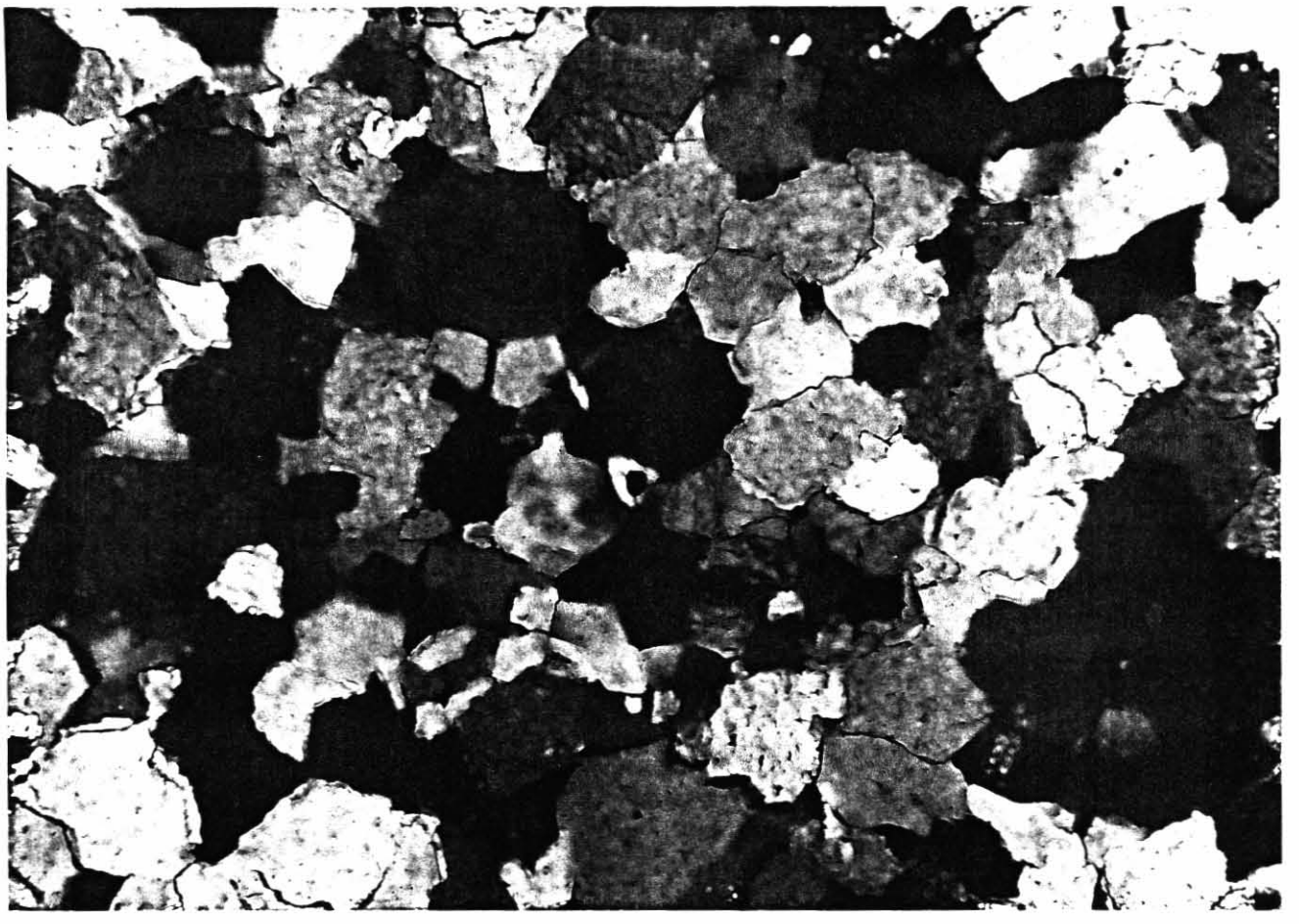
Magnification - microscope 160 x) 256 x
enlargement - photograph 1.6 x)

Sample: magnesite from Messrs. C.R.A., Australia

Quartz (orange-red, blue, red-purple, blue-purple), partly idiomorphic texture with fine and superfine inclusions of magnesite.

5 cm

Enclosure 8



0,1 mm

Microphotograph no. 8 thin section, N+

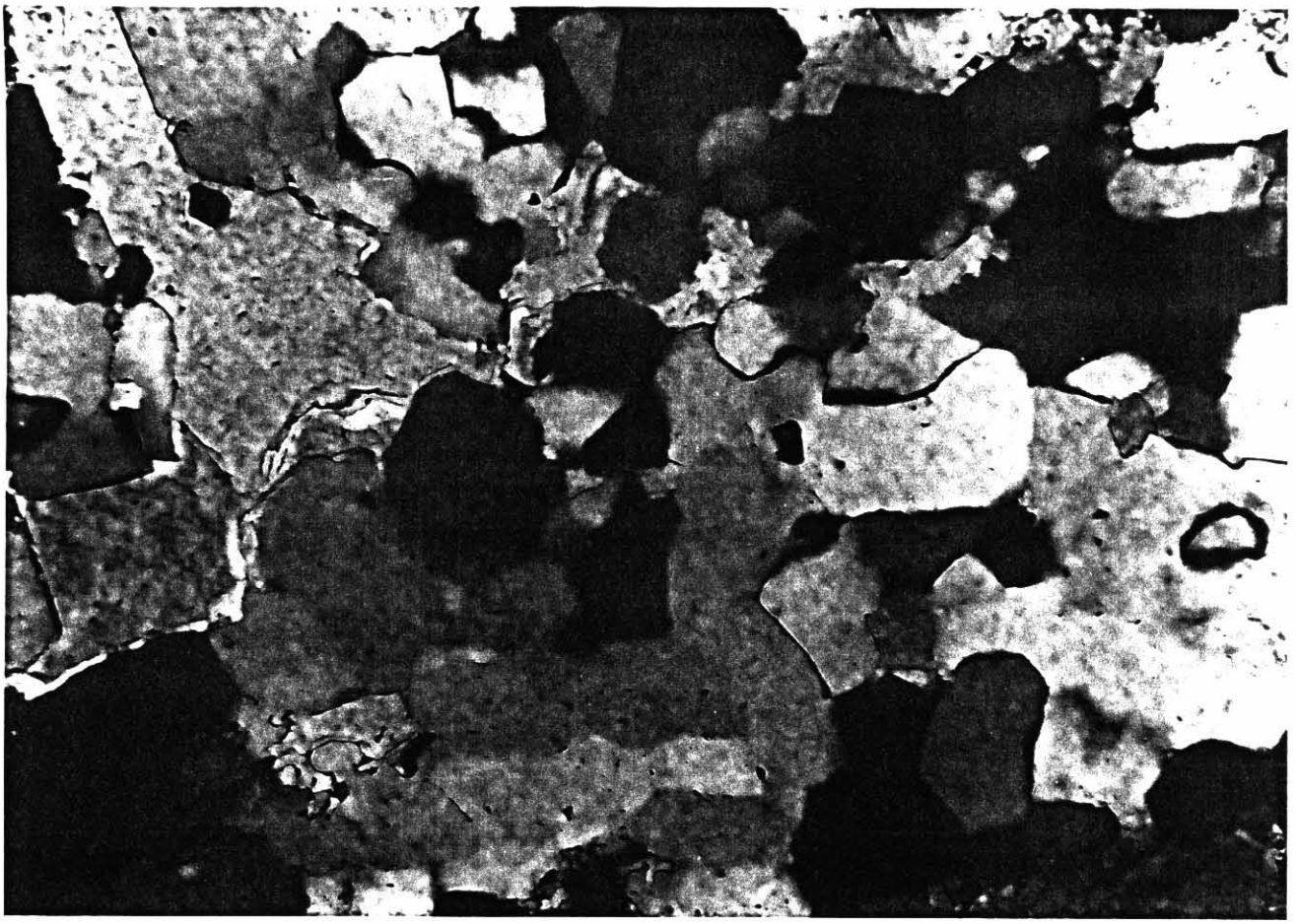
magnification - microscope 160 x)
enlargement - photograph 1.6 x) 256 x

Sample: magnesite from Messrs. C.R.A., Australia

Intimate intergrowth between magnesite (coloured) and quartz (blue grey to black). The grainy structure of this batch is clearly displayed.

5 cm

Enclosure 9



0,1mm

Microphotograph no. 9 thin section, N+

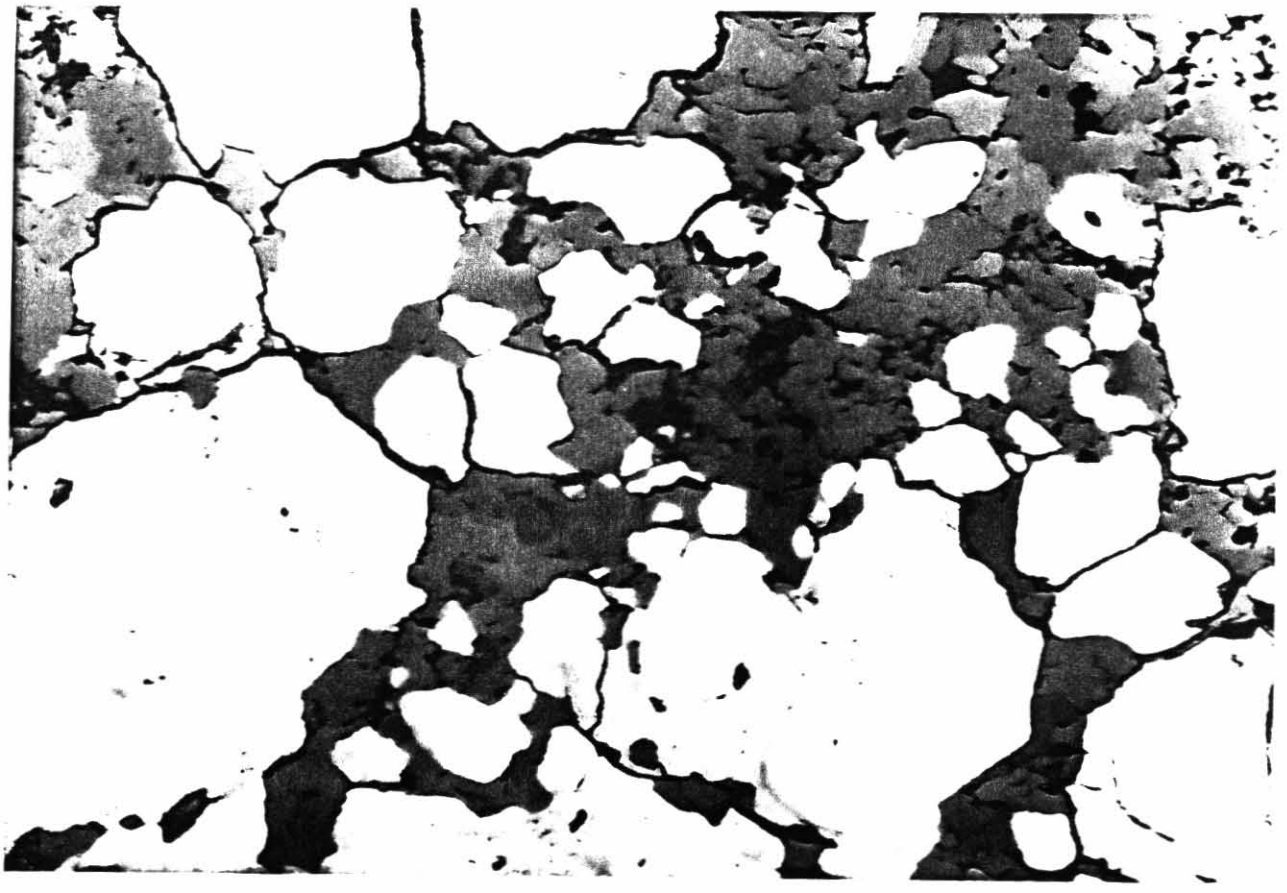
Magnification - microscope 160 x)
enlargement - photograph 1.6 x) 256 x

Sample: magnesite from Messrs. C.R.A., Australia

Magnesite (coloured) occurs as binder in quartz (light to dark grey and black). The sample displays occasional fine inclusions of quartz (black).

5 cm

Enclosure 10



0,1 mm

Microphotograph no. 10

polished section, etched with $Al(NO_3)_3$

Magnification - microscope 100 x)
enlargement - photograph 1.6 x) 160 x

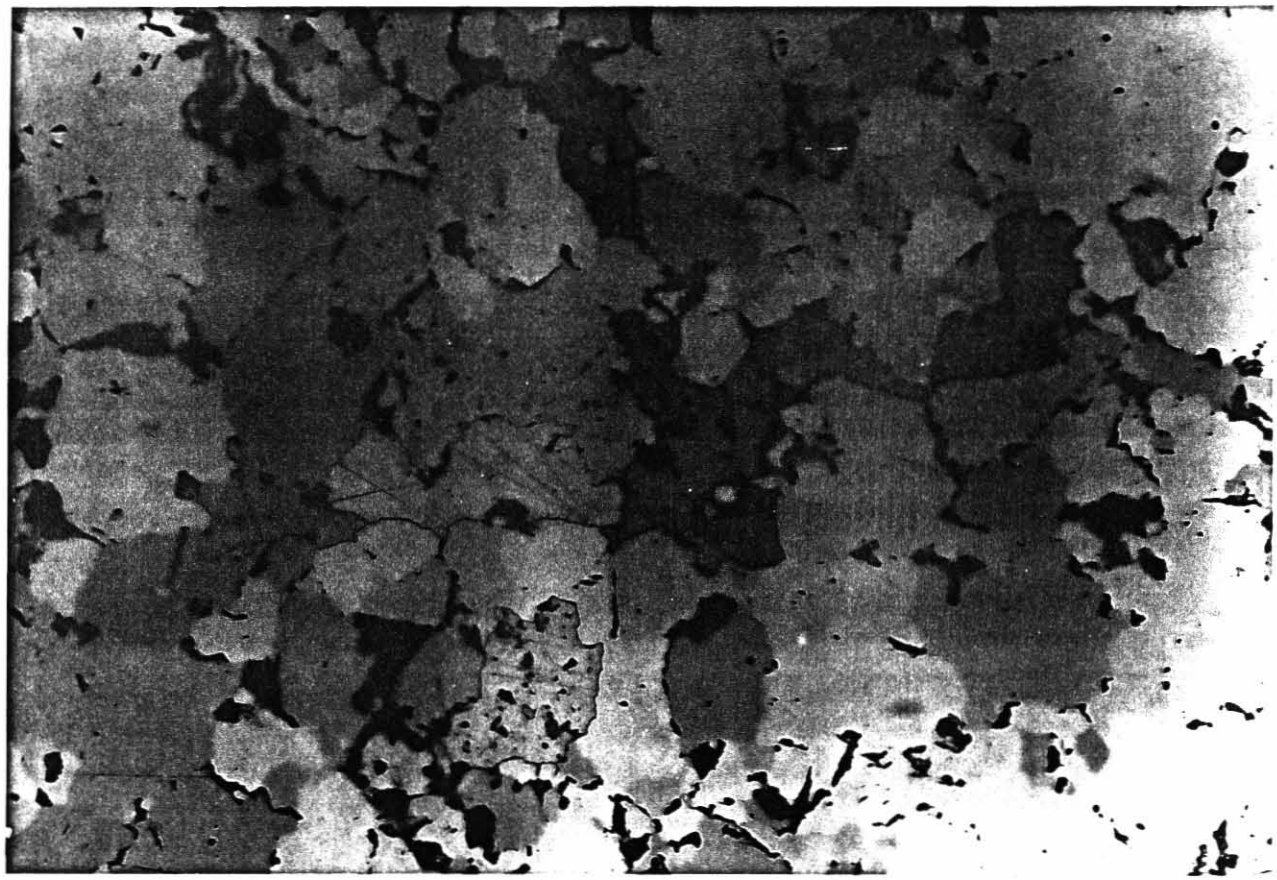
Sample: Magnesite from Messrs. C.R.A., Australia

Clusters of goethite (light grey) in magnesite (grey).

Pores and cavities are black.

5 cm

Enclosure 11



0,1 mm

Microphotograph no. 11

polished section, etched with $Al(NO_3)_3$

Magnification - microscope 100 x)
enlargement - photograph 1.6 x) 160 x

Sample: magnesite from Messrs. C.R.A., Australia

Dolomite (grey, etched, displaying grinding scratches) and calcite (dark grey, etched, rough) occurring as fine inclusions in magnesite (light- to medium grey, smooth).
Pores and cavities are black.

5 cm

Enclosure 12

0,1 mm

Microphotograph no. 12

polished section, etched with $Al(NO_3)_3$

Magnification - microscope 100 x)
enlargement - photograph 1.6 x) 160 x

Sample: magnesite from Messrs. C.R.A., Australia

Fairly coarse calcite (dark grey, rough) occurring in addition to dolomite (grey, showing grinding scratches) as inclusion in the magnesite (light to medium grey, smooth). The calcite contains minute magnesite inclusions.

Pores and cavities are black.

5 cm

S I N K - F L O A T - A N A L Y S I S

enclosure: 13
date: 06.05.1985
A.-Nr.: 9-8125-9-5011

client: CRA Ltd. / Australia
material: Magnesite
grain size: 5.6 - 0.5 mm

density	weight	recovery	MgO				CaO				SiO2			
			grade	recovery		content	grade	recovery		content	grade	recovery		content
Kg/L	%	add.%	%	%	add.%	%	%	%	add.%	%	%	%	add.%	%
-2.46	13.34	13.34	43.32	13.16	13.16	5.7789	1.15	15.06	15.06	.15341	6.87	15.70	15.70	.916458
2.46-2.54	2.88	16.22	43.18	2.83	16.00	1.2436	1.07	3.03	18.09	.030816	7.70	3.80	19.50	.22176
2.54-2.63	2.29	18.51	42.91	2.24	18.24	.9826	1.17	2.63	20.72	.026793	8.11	3.18	22.68	.185719
2.63-2.73	6.46	24.97	42.02	6.18	24.42	2.7145	1.30	8.25	28.97	.08398	9.77	10.81	33.49	.631142
2.73-2.77	10.43	35.40	42.88	10.19	34.61	4.4724	1.46	14.95	43.92	.152278	8.11	14.49	47.98	.845873
2.77-2.83	23.50	58.90	43.69	23.39	58.00	10.2672	.93	21.46	65.38	.21855	5.95	23.95	71.94	1.39825
2.83-2.88	5.67	64.57	44.69	5.77	63.77	2.5339	.79	4.40	69.78	.044793	4.57	4.44	76.38	.259119
+2.88	13.69	78.26	45.80	14.28	78.05	6.2700	.39	5.24	75.02	.053391	3.07	7.20	83.58	.420283
- 0.5 mm	21.74	100.00	44.31	21.95	100.00	9.6330	1.17	24.98	100.00	.254358	4.41	16.42	100.00	.958734
Summe:	100.00	---	43.81	100.00	---	43.8961	1.14	100.00	---	1.01837	5.60	100.00	---	5.83734

+ 0.5 mm

028

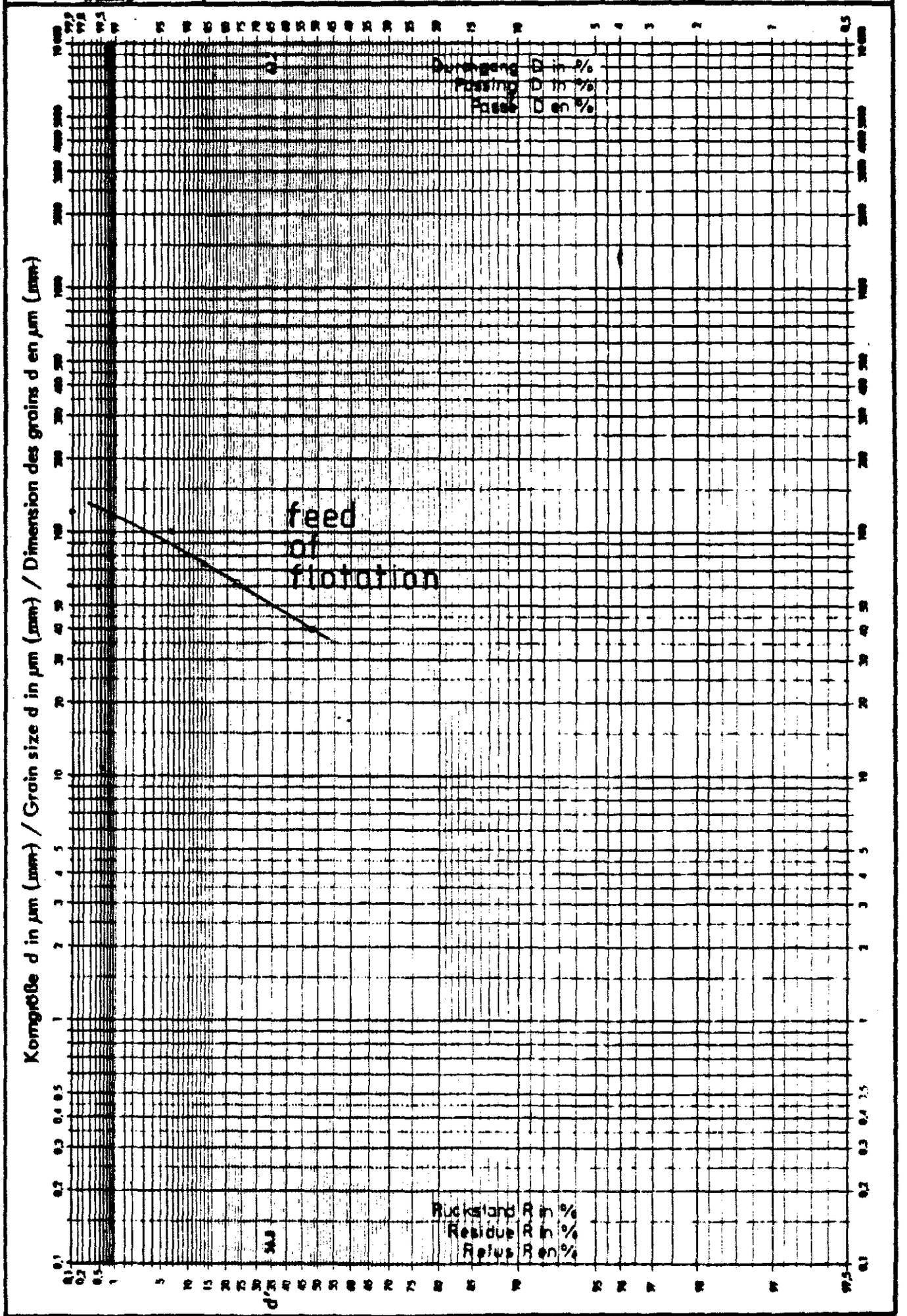
Körnungsnetz / Grading graph
Diagramme granulométrique

Enclosure: 14
Datum:
Date: 25.7.85

Stoff:
Material:
Produit: Magnesite

Firma:
Customer:
Client: CRA

Maschine:
Machine:
Appareil: Rod mill



HB 454/1 (D/E/F)

Test 6139

B A L A N C E

enclosure : 15
date: 25.05.1985
A. - Nr.: 9-8125-9-5011

client: CRA Ltd. / Australia
material: magnesite discharge of the rod mill
84 % - 0.075 mm, 52 % - 0.040 mm
procedure: flotation test 6139
Humboldt Wedag 3 l - flotation cell

product	weight	recovery	MgO				CaO				SiO2			
			grade	recovery		content	grade	recovery		content	grade	recovery		content
	%	add.%	%	%	add.%	%	%	%	add.%	%	%	%	add.%	%
SiO2-product 1	7.95	7.95	28.69	5.23	5.23	2.2809	.61	4.35	4.35	.0485	38.70	53.23	53.23	3.0767
SiO2-product 2	17.13	25.08	39.71	15.60	20.83	6.8023	.71	10.91	15.26	.1216	14.43	42.76	95.99	2.4719
MgO-product 1	9.19	34.27	46.25	9.75	30.58	4.2504	.74	6.10	21.36	.0680	1.06	1.69	97.68	.0974
MgO-product 2	49.64	83.91	47.00	53.50	84.08	23.3308	.39	17.37	38.73	.1936	.13	1.12	98.79	.0645
MgO-product 3	10.73	94.64	45.10	11.10	95.18	4.8392	2.31	22.23	60.96	.2479	.22	.41	99.20	.0236
tailings	5.36	100.00	39.21	4.82	100.00	2.1017	8.12	39.04	100.00	.4352	.86	.80	100.00	.0461
feed	100.00	---	43.81	100.00	---	43.6052	1.14	100.00	---	1.1148	5.60	100.00	---	5.7802

product	weight	recovery	MgO				CaO				SiO2			
			grade	recovery		content	grade	recovery		content	grade	recovery		content
	%	add.%	%	%	add.%	%	%	%	add.%	%	%	%	add.%	%
SiO2 - product	25.08	25.08	36.22	20.83	20.83	9.0840	.68	15.30	15.30	.1705	22.12	96.00	96.00	5.5477
MgO-concentrate	63.83	88.91	46.74	68.42	89.25	29.8341	.59	33.78	49.07	.3766	.27	2.98	98.98	.1723
tailings	11.09	100.00	42.25	10.75	100.00	4.6855	5.12	50.93	100.00	.5678	.53	1.02	100.00	.0588
feed	100.00	---	43.81	100.00	---	43.6036	1.14	100.00	---	1.1149	5.60	100.00	---	5.7788

SiO_2 Reject (25.6% of feed) MgO Product (64.6% of feed) Tail (9.8% of feed)

Assays — both tests

Assays			
MgO	36.2 / 36.8	46.74 / 46.58	42.25 / 41.68
CaO	0.68 / 0.66	0.59 / 0.62	5.12 / 5.47
SiO_2	22.1 / 21.15	0.27 / 0.23	0.53 / 0.45
Fe_2O_3	na	0.46 / 0.47	na

030

B A L A N C E

enclosure : 16
date: 25.05.1985
A. - Nr.: 9-8125-9-5011

client: CRA Ltd. / Australia
material: magnesite discharge of the rod mill
84 % - 0.075 mm, 52 % - 0.040 mm
procedure: flotation test 6139
Humboldt Wedag 3 l - flotation cell

dead burned basis

product	weight %	weight add.%	recovery %	MgO grade %	MgO recovery %	MgO recovery add.%	MgO content %	CaO grade %	CaO recovery %	CaO recovery add.%	CaO content %	SiO2 grade %	SiO2 recovery %	SiO2 recovery add.%	SiO2 content %
SiO2-product 1	7.95	7.95		41.27	3.79	3.79	3.2810	.88	3.20	3.20	.0700	55.67	47.56	47.56	4.4258
SiO2-product 2	17.13	25.08		70.82	14.02	17.81	12.1315	1.27	9.96	13.17	.2176	25.74	47.39	94.95	4.4093
MgO-product 1	9.19	34.27		94.33	10.02	27.83	8.6689	1.51	6.36	19.52	.1388	2.16	2.13	97.08	.1985
MgO-product 2	49.64	83.91		97.53	55.95	83.79	48.4139	.81	18.42	37.94	.4021	.27	1.44	98.52	.1340
MgO-product 3	10.73	94.64		92.21	11.44	95.22	9.8941	4.72	23.20	61.14	.5065	.45	.52	99.04	.0483
tailings	5.36	100.00		77.13	4.78	100.00	4.1342	15.83	38.86	100.00	.8485	1.66	.96	100.00	.0890
feed	100.00	---		85.13	100.00	---	86.5236	2.22	100.00	---	2.1833	10.88	100.00	---	9.3048

product	weight %	weight add.%	recovery %	MgO grade %	MgO recovery %	MgO recovery add.%	MgO content %	CaO grade %	CaO recovery %	CaO recovery add.%	CaO content %	SiO2 grade %	SiO2 recovery %	SiO2 recovery add.%	SiO2 content %
SiO2 - product	25.08	25.08		61.45	17.81	17.81	15.4117	1.15	13.19	13.19	.2884	35.23	94.93	94.93	8.8357
MgO-concentrate	63.83	88.91		96.65	71.30	89.12	61.6917	1.22	35.62	48.81	.7787	.56	3.84	98.77	.3574
tailings	11.09	100.00		84.92	10.88	100.00	9.4176	10.09	51.19	100.00	1.1190	1.03	1.23	100.00	.1142
feed	100.00	---		85.13	100.00	---	86.5210	2.22	100.00	---	2.1861	10.88	100.00	---	9.3074

D. Burned Basis

Assays

	SiO2 Reject	2σ	MgO Product	2σ	Tail	2σ
MgO	61.45 / 64.86	3.9	96.65 / 95.76	97.0	84.92 / 83.10	90.0
CaO	1.15 / 1.15	1.15	1.22 / 1.27	1.44	10.09 / 10.81	4.3
SiO2	35.23 / 31.95	5.3	0.56 / 0.47	<0.5	1.03 / 0.88	<0.5
Fe2O3	na	1.87	0.96 / 0.97	0.85	na.	1.69

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031

B A L A N C E

enclosure : 17
date: 25.05.1985
A. - Nr.: 9-8125-9-5011

client: CRA Ltd. / Australia
material: magnesite discharge of the rod mill
84 % - 0.075 mm, 52 % - 0.040 mm
procedure: flotation test 6141
Humboldt Wedag 3 l - flotation cell

product	weight	recovery	MgO				CaO				SiO2			
			grade	recovery		content	grade	recovery		content	grade	recovery		content
	%	add.%	%	%	add.%	%	%	%	add.%	%	%	%	add.%	%
SiO2-product 1	8.32	8.32	25.80	4.92	4.92	2.1466	.55	4.40	4.40	.0458	45.06	65.25	65.25	3.7490
SiO2-product 2	11.51	19.83	39.51	10.43	15.35	4.5476	.72	7.97	12.37	.0829	14.82	29.69	94.95	1.7058
MgO-product 1	9.45	29.28	46.17	10.01	25.36	4.3631	.71	6.45	18.82	.0671	1.59	2.62	97.56	.1503
MgO-product 2	59.30	88.58	46.71	63.53	88.89	27.6990	.50	28.51	47.33	.2965	.16	1.65	99.21	.0949
MgO-product 3	6.78	95.36	44.47	6.92	95.81	3.0151	2.90	18.90	66.23	.1966	.25	.30	99.51	.0170
tailings	4.64	100.00	39.41	4.19	100.00	1.8286	7.57	33.77	100.00	.3512	.61	.49	100.00	.0283
feed	100.00	---	43.81	100.00	---	43.5999	1.14	100.00	---	1.0401	5.60	100.00	---	5.7452

product	weight	recovery	MgO				CaO				SiO2			
			grade	recovery		content	grade	recovery		content	grade	recovery		content
	%	add.%	%	%	add.%	%	%	%	add.%	%	%	%	add.%	%
SiO2 - product	26.28	26.28	36.80	22.18	22.18	9.6710	.66	16.70	16.70	.1734	21.15	96.73	96.73	5.5582
MgO-concentrate	65.30	91.58	46.58	69.77	91.95	30.4167	.62	38.97	55.67	.4049	.23	2.61	99.34	.1502
tailings	8.42	100.00	41.68	8.05	100.00	3.5095	5.47	44.33	100.00	.4606	.45	.66	100.00	.0379
feed	100.00	---	43.81	100.00	---	43.5972	1.14	100.00	---	1.0389	5.60	100.00	---	5.7463

9880033

B A L A N C E

enclosure : 18
date: 25.05.1985
A. - Nr.: 9-8125-9-5011

client: CRA Ltd. / Australia
material: magnesite discharge of the rod mill
84 % - 0.075 mm, 52 % - 0.040 mm
procedure: flotation test 6141
Humboldt Wedag 3 l - flotation cell

dead burned basis

product	weight	recovery	MgO				CaO				SiO2			
			grade	recovery		content	grade	recovery		content	grade	recovery		content
	%	add.%	%	%	add.%	%	%	%	add.%	%	%	%	add.%	%
SiO2-product 1	8.32	8.32	35.51	3.41	3.41	2.9544	.76	3.09	3.09	.0632	62.02	58.79	58.79	5.1601
SiO2-product 2	11.51	19.83	70.15	9.33	12.74	8.0743	1.28	7.21	10.30	.1473	26.31	34.50	93.29	3.0283
MgO-product 1	9.45	29.28	93.29	10.18	22.92	8.8159	1.43	6.61	16.92	.1351	3.21	3.46	96.75	.3033
MgO-product 2	59.30	88.58	96.15	65.86	88.78	57.0170	1.03	29.89	46.80	.6108	.33	2.23	98.98	.1957
MgO-product 3	6.78	95.36	90.46	7.08	95.87	6.1332	5.90	19.57	66.38	.4000	.51	.39	99.37	.0346
tailings	4.64	100.00	77.11	4.13	100.00	3.5779	14.81	33.62	100.00	.6872	1.19	.63	100.00	.0552
feed	100.00	---	85.13	100.00	---	86.5726	2.22	100.00	---	2.0437	10.88	100.00	---	8.7772

product	weight	recovery	MgO				CaO				SiO2			
			grade	recovery		content	grade	recovery		content	grade	recovery		content
	%	add.%	%	%	add.%	%	%	%	add.%	%	%	%	add.%	%
SiO2 - product	26.28	26.28	64.86	19.69	19.69	17.0452	1.15	14.80	14.80	.3022	31.95	95.66	95.66	8.3965
MgO-concentrate	65.30	91.58	95.76	72.23	91.92	62.5313	1.27	40.62	55.42	.8293	.47	3.50	99.16	.3069
tailings	8.42	100.00	83.10	8.08	100.00	6.9970	10.81	44.58	100.00	.9102	.88	.84	100.00	.0741
feed	100.00	---	85.13	100.00	---	86.5735	2.22	100.00	---	2.0417	10.88	100.00	---	8.7775

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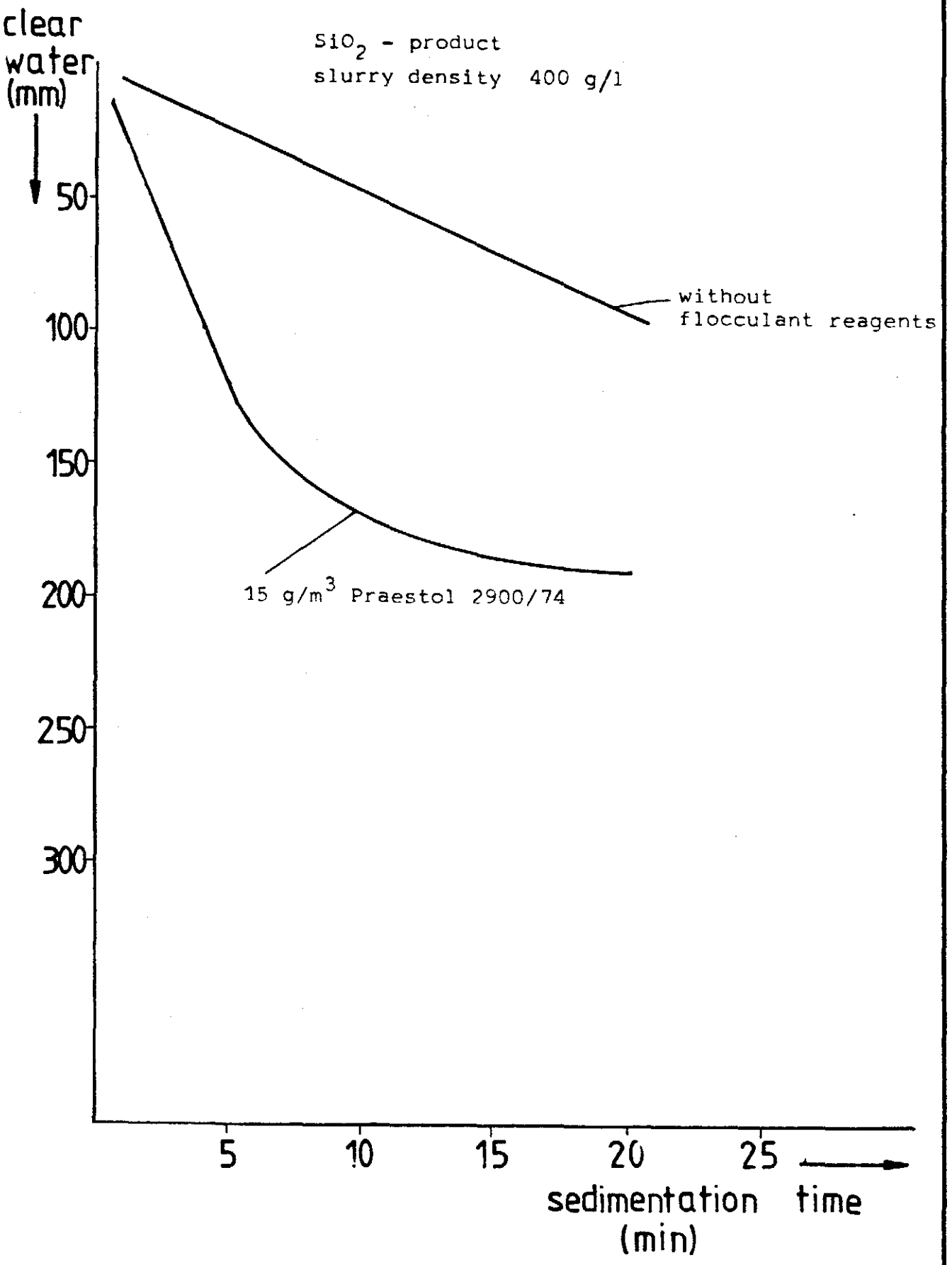
Settling curve SiO_2 - product

988035

enclosure 19



Hb 370/1

KHD HUMBOLDT WEDAG AG

Forschungs- und Versuchsanstalt

Bericht über

REPORT

on

process-engineering tests
carried out with magnesite
for Conzinc Riotinto Australia Ltd. (CRA),
Melbourne/Australia
P.-No. 9-2121-5-6089
A.-No. 9-8125-9-5011

KHD HUMBOLDT WEDAG AG

Köln-Porz, August 06, 1985
IH-YM 2 Wi/He - phone ext. 658
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Supplement to

R E P O R T

on

process-engineering tests
carried out with magnesite
for Conzinc Riotinto Australia Ltd. (CRA),
Melbourne/Australia
P.-No. 9-2121-5-6089
A.-No. 9-8125-9-5011

1. Summary

The tests carried out for producing a larger quantity of magnesite concentrate have shown that the particle size distribution of the flotation feed is of considerable importance. Regarding the MgO-recovery, the results achieved by the laboratory flotation tests, during which the size of the samples was reduced by means of rod grinding, could not be achieved with the ground product of the ball mill. This is probably attributable to the higher fines portion in the product discharged from the ball mill as against the product discharged from the rod mill.

During a multiple-batch test, a magnesite product of an MgO-content of approx. 97 % and an SiO_2-content of 0.58 % (related to burnt magnesite) was produced by way of three-stage flotation at a concentrate recovery of 57.6 %.

TN 0103 0431/04
(HW 3002/4)
50000 3.85 O

2. Size reduction

2.1 Preliminary size reduction

For production of the required quantity of concentrate and implementation of the multiple-batch test, approx. 150 kg of raw magnesite were crushed to a fineness of 100 % less than 5.6 mm by way of a jaw crusher with intermediately arranged sieve. The product had the following particle size distribution:

product jaw crusher / feed - ball mill

grain size mm			portions in % by weight	cumulative portions in % by weight
	+	4	21.3	21.3
4	-	2.8	21.9	43.2
2.8	-	2	12.4	55.6
2	-	1	15.8	71.4
1	-	0.5	8.4	79.8
0.5	-	0.315	3.0	82.8
0.315	-	0.18	2.8	85.6
0.18	-	0.125	1.7	87.3
	-	0.125	12.7	100.0

2.2 Grinding

A discontinuously operating ball mill of 600 mm diameter with obliquely arranged grinding vessel with a contents of 50 l was applied for fine grinding.

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(HW 3002/4)
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The grinding vessel made of wear-resistant cast steel is arranged as rotation ellipsoid at an inclination of 30^{o}. The operating speed equals $n = 50\ min^{-1}$. The drive has a capacity of 1.1 kW. The ball charge was selected as follows:

ball diameter mm	mass kg
40	40
30	36
25	13
≤ 20	11

During all grinding tests the solids/water-mass ratio equalled 1 and the feed quantity / batch approx. amounted to 20 kg of magnesite. Grinding was done batchwise in closed-circuit operation - mill - sieve - mill. After each grinding operation the total ground material was subjected to wet classification by means of a vibratory screen (make Sweco), which was covered by a 0.142 mm-screen deck. The residues retained, mixed with raw magnesite (together approx. 20 kg) served as feed material for next batch grinding. A circulating load of approx. 30 % resulted for each batch at a grinding period of 10 minutes. The particle size distribution of the combined ground product after six batches including chemical analyses of the fractions can be taken from enclosure 1. During a second closed-circuit grinding the grinding period was shortened to 6 minutes/batch, which resulted in an increase of the circulating load to more than 100 %.

However, the sizing characteristic obtained essentially corresponds to that for the first grinding operation.
In case of the two grinding operations carried out in the ball mill, the particle size distribution of the feed material for the laboratory flotation tests could not be exactly reached.
Rod grinding combined with intermediate sieving in the laboratory mill was more heedful (see enclosure 2), i.e. it produced less quantities of superfine material.

3. Flotation

The results of the laboratory flotation tests could be applied to the tests for production of the concentrate quantity only to a limited degree. On the one hand the quantity of reagents had to be adjusted due to the higher hardness of the water (approx. 15° German hardness instead of 10° German hardness). Proportioning of the calcite- and dolomite depressing agent EKOFACT DD 95 had to be reduced considerably and addition of the magnesite collector RESANOL A had to be increased, at least during the tests without medium-size material.

On the other hand, the flotation periods and the mode of operation had to be modified due to the varying mode of grinding (grinding in a ball mill instead of grinding in a rod mill). On the whole, SiO_2-flotation of the product discharged from the ball mill was less selective than that of the product discharged from the rod mill, which probably is attributable to the higher fines portion of less than approx. 0.01 mm in the ground product. The SiO_2-froth always contained a not insignificant portion of magnesite. Since the required purity in the MgO-concentrate for this material in a two-stage flotation process without secondary cleaning can be achieved only if the quartz during SiO_2-flotation is recovered at approx. 95 % in the froth product, a higher loss of magnesite will occur in this processing stage at lower selectivity.
For partly making good for this loss of recovery, it was required to accept a lower SiO_2-recovery during SiO_2-flotation and to subject the froth of magnesite flotation to secondary cleaning (see enclosure 3).

3.1 Multiple-batch test

A multiple-batch test was carried out after a series of preliminary tests for matching the proportioning rate of reagents to the changed conditions. To that end, a Humboldt-cell of a capacity of 18 l with double wobble agitator was applied. 6 kg of ground raw magnesite of a fineness of 86 % less than 0.090 mm were fed per batch.

The reagents below were applied for SiO_2-flotation:

EKOFACT DD 95	75 g/t of ore
RESANOL 450	150 g/t of ore in three batches (80 g/t at the beginning, 2 x 35 g/t during flotation)

The conditioning period for EKOFACT DD 95 equalled two minutes and five minutes for RESANOL 450 (1st addition). The overall duration of flotation equalled 8 - 10 minutes.

Prior to subsequent MgO-flotation, soda waterglass at a proportioning rate of 400 g/t of ore was admitted for deadening the quartz. The collecting-/effervescing reagent combination RESANOL A was admitted after a conditioning period of approx. 1 minute. MgO-flotation was started after a short period of conditioning. RESANOL A was added twice.
During the preliminary tests carried out with the water of greater hardness and during the first runs of the multiple-batch test, the required proportioning rate for RESANOL A amounted to 800 - 1000 g/t of ore.

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As from batch 10 of the multiple-batch test up to the end of flotation, the consumption could be reduced to 500 g/t of ore due to recycling of the medium-size.
Compared to the laboratory tests, addition of EKOFACT DD 95 had to be strongly reduced, since the magnesite recovery was substantially lowered upon higher proportioning rates.

Contrary to the laboratory tests, provision was made for a secondary cleaning stage for flotation of magnesite. The magnesite froth was collected, mixed with soda waterglass (300 g/t of raw ore, resp. approx. 450 g/t of magnesite froth) and subjected to secondary flotation after a short conditioning period. The cleaned froth was the final magnesite concentrate and the residues retained in the cell (approx. 10 % by weight related to raw ore and 15 - 20 % by weight related to the magnesite concentrate, respectively) were added to the next batch after completion of SiO_2-flotation (see enclosure 3).
The products obtained from flotation of the last batch were dried, weighed and chemical analyses were made. The product distribution is listed on next page.

Product	% by weight	loss on ignition %	MgO-content %	SiO_2-content %	CaO-content %	Fe_2O_3-content %
SiO_2-product	32.04	42.00	39.00	16.41	0.86	0.72
MgO-concentrate	57.64	51.41	47.17	0.28	0.3	0.51
tailings	10.32	48.12	40.52	3.71	10.31	1.38
feed (calc.)	100	-	43.87	5.80	1.00	0.67
(found)		48.54	43.81	5.60	1.14	0.51
medium-size (circulating load)	10.60	50.64	45.36	0.93	1.83	0.82
sum	110.60					

By variation of the admitting rate of depressing agent, the ratio of the CaO/SiO_2-contents can probably be raised to more than 2.

3.2 Secondary cleaning of the SiO_2-product

An SiO_2-product of one cycle of the multiple-batch test was subjected to secondary cleaning. After a flotation period of 3 minutes for the froth product without addition of reagents, RESANOL 450 (60 g/t) was added and SiO_2-flotation was discontinued after additional 3 minutes. Following this, attempts were made to win a froth product of low SiO_2-content by means of soda waterglass as depressing reagent and RESANOL A as collecting/effervescing reagent. The product distribution shown below reveals that this objective could not be reached.

Product	% by weight	SiO_2-content %
froth 1	45	25.7
froth 2	46) 55	2.3) 7.75
residues	9)	35.6)
SiO_2-product	100	15.8

3.3 Production of concentrate

A total of 57 kg of final concentrate was produced from the magnesite products of the multiple-batch test as well as from the previous tests carried out with the 18 l-Humboldt-flotation cell. The chemical composition of this concentrate calculated on the basis of the analyses for the different products is as follows:

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	non-ignited	ignited
MgO-content (%):	46.91	96.54
CaO-content (%):	0.40	0.81
SiO_2-content(%):	0.27	0.55
Fe_2O_3-content (%):	0.5	1.03

The tests were carried out by us to the best of our knowledge and ability. A liability, in particular for the process engineering results of machines, plant sections or plants delivered by us, can be undertaken by us only if this has been agreed upon in writing.

KHD Humboldt Wedag AG

Dr. Imhof Dr. Bleckmann

B A L A N C E

enclosure : 1
date: 25.05.1985
A. - Nr.: 9-8125-9-5011

client: CRA Ltd. / Australia
material: magnesit discharge of the ball mill
1st grinding
procedure: Grain size distribution with
chemical analysis

grain size mm			weight %	weight add.%	MgO grade %	MgO recovery %	MgO recovery add.%	MgO content %	CaO grade %	CaO recovery %	CaO recovery add.%	CaO content %	SiO2 grade %	SiO2 recovery %	SiO2 recovery add.%	SiO2 content %
+	.090		23.13	23.13	42.68	22.59	22.59	9.8719	1.33	28.25	28.25	.3076	8.03	35.04	35.04	1.8573
.090 -	.063		13.43	36.56	43.02	13.22	35.81	5.7776	1.15	14.18	42.44	.1544	6.20	15.71	50.75	.8327
.063 -	.040		12.21	48.77	43.59	12.18	47.99	5.3223	1.05	11.77	54.21	.1282	5.49	12.65	63.39	.6703
.040 -	.032		6.28	55.05	44.57	6.40	54.39	2.7990	1.08	6.23	60.44	.0678	4.46	5.28	68.68	.2801
.032 -	.020		14.59	69.64	43.77	14.61	69.01	6.3860	1.10	14.74	75.18	.1605	4.97	13.68	82.36	.7251
.020 -	.000		30.36	100.00	44.61	30.99	100.00	13.5436	.89	24.82	100.00	.2702	3.08	17.64	100.00	.9351
feed:			100.00	---	43.81	100.00	---	43.7004	1.14	100.00	---	1.0888	5.60	100.00	---	5.3006

045

9880047

988048

046

Körnungsnetz / Grading graph
Diagramme granulométrique

enclosure: 2
Datum / Date: 15.07.85

Stoff / Material / Produit: MAGNESITE
Firma / Customer / Client: CRA Australia
Maschine / Machine / Appareil: ROD MILL / BALL MILL

1 □——— discharge of rod mill
feed of laboratory flotation tests

2 ○——— discharge of ball mill
1st grinding

3 X- - - - discharge of ball mill
2nd grinding
feed of locked tests

Körnung d in µm (mm) / Grain size d in µm (mm) / Dimension des grains d en µm (mm)

Rückstand R in %
Residue R in %
Refus R en %

988049

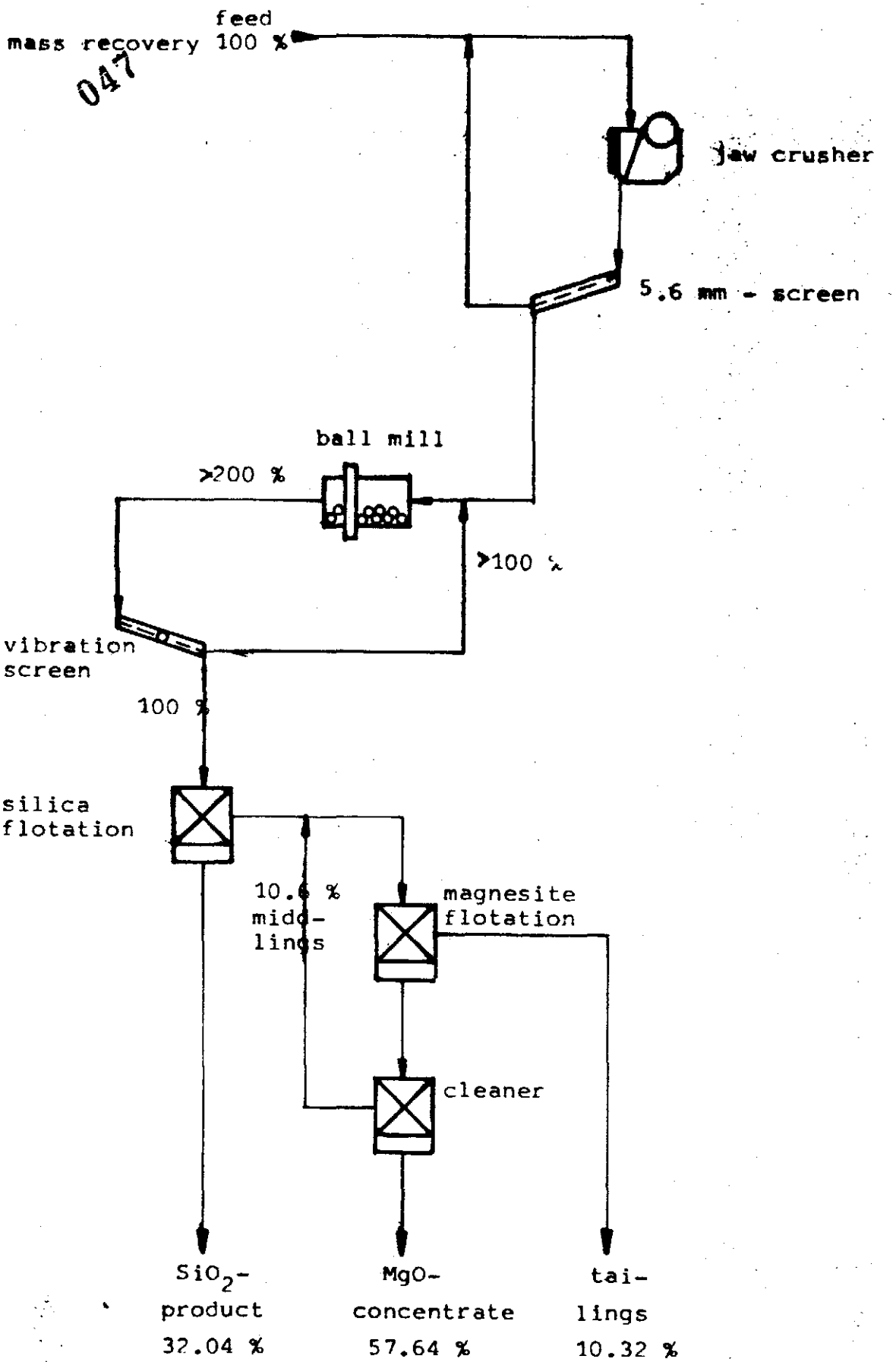
HUMBOLDT WEDAG

MAGNESITE

Flow - sheet locked test

enclosure 3

22.7.85



KHD HUMBOLDT WEDAG AG

Forschungs- und Versuchsanstalt

Bericht über

process-engineering tests carried
out with magnesite
for Conzinc Riotinto Australia Ltd. (CRA),
Melbourne/Australia
P.-No. 9-2121-5-0089
A.-No. 9-8125-9-5011

KHD HUMBOLDT WEDAG AG

Cologne, August 23, 1985
IH-YM 2, Wirkus/EH, 658

2nd supplement to

Report

on

process-engineering tests carried out
with magnesite
for Conzinc Riotinto Australia Ltd. (CRA),
Melbourne/Australia
P.-No. 9-2121-5-0089
A.-No. 9-8125-9-5011

Microprobe and scanning electron microscopy (SEM) investigation

Microprobe and SEM investigation of a raw magnesite sample was carried out to look in a more detailed way at the texture of the minerals which were identified by means of optical microscopy. (Compare with Report dated July 25, 1985, chapter 4.15 Mineralogie testing).

For that examination the sample has been used the microphotographs no. 3 and no. 7 (thin sections) of which have been shown in the Report dated July 25, 1985.

...

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In general the SEM investigation can confirm the paragenesis which has been found by optical microscopy. Furthermore, a sulfide mineral, pyrite, was found as idiomorphic grains at the rims of magnesite and as inclusions in magnesite, dolomite and quartz. But must of the pyrite is changed into goethit. This corresponds to the observation, that there are alteration products of quartz, magnesite and goethite as a result of weathering process.

Fig. 1 a shows an aggregate of secondary quartz which is xenomorphic surrounded by well defined grains of magnesite.
The secondary quartz itsself has inclusions of magnesite which are probably remains of a solution process.
The magnesite in solution may have precipitated as small veins and then this type of magnesite is a cementate between the different grains.

X-ray element distributions (fig.: 1b-d) of the area, which is to be seen in fig. 1 a were made to give an improved representation of quartz and magnesite.
The C-Ka distribution (fig.: 1d) shows enrichments of carbon in the cracks and between the grain bounduries resulting from preparation of the samples.

Table 1 gives some typical analyses of the carbonates magnesite, dolomite and calcite which were carried out by careful electron microprobe analysis using the energy dispersive system.

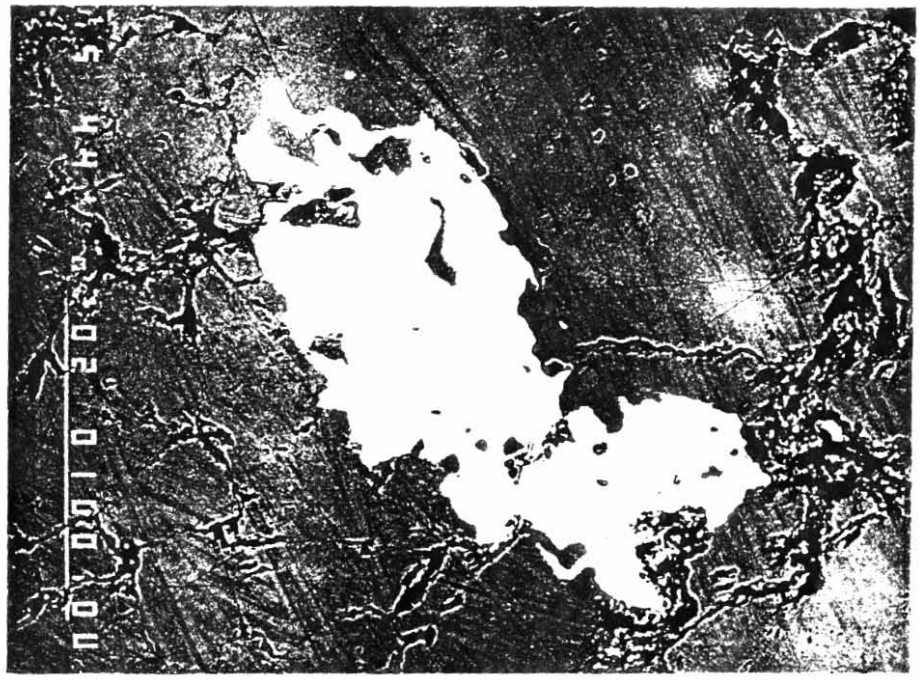
The tests were carried out by us to the best of our knowledge and ability. A liability, in particular for the process engineering results of machines, plant sections or plants delivered by us, can be undertaken by us only if this has been aggreed upon in writing.

KHD Humboldt Wedag AG

- Dr. Kellerwessel - - Dr. Bleckmann -

Enclosures

-FIG. 1a-

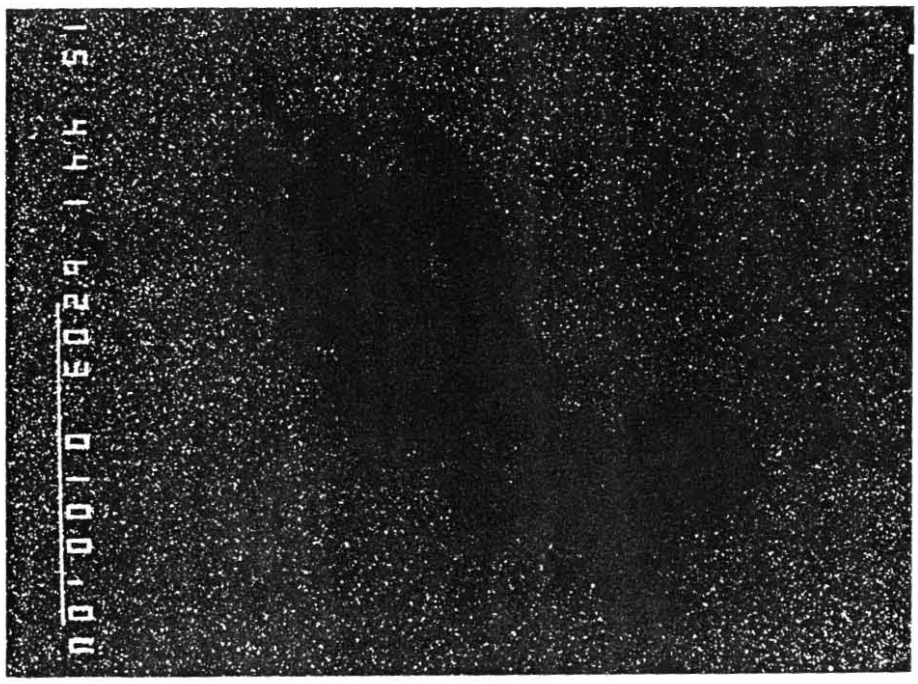


COMPO IMAGE

100 µm

XENOMORPHIC QUARTZ (CENTER) SURROUNDED BY MAGNESITE (GREY)

-FIG. 1B-



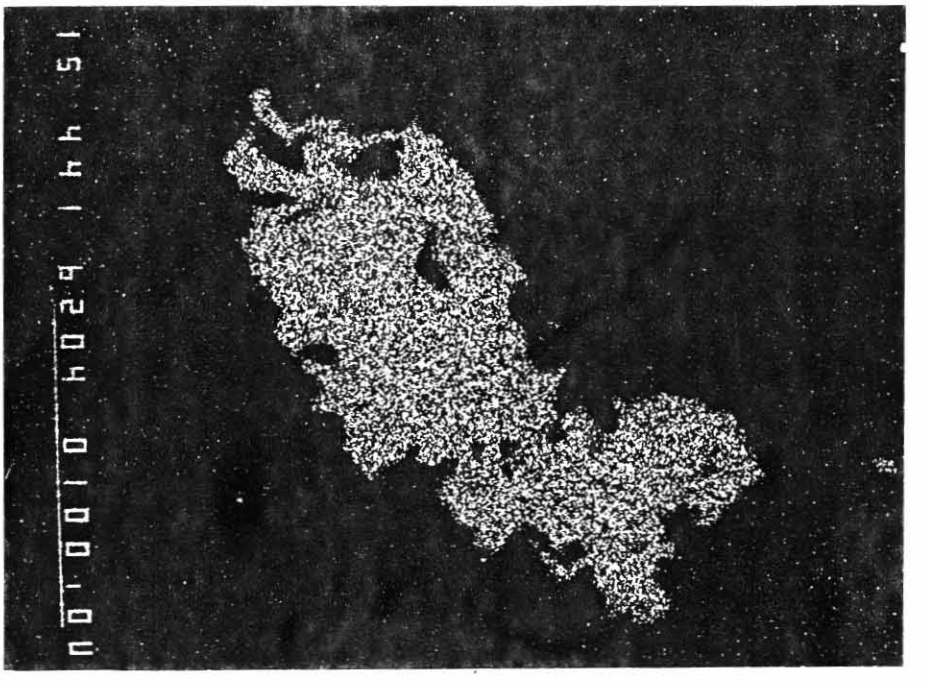
100 µm

MG Kα - DISTRIBUTION OF AREA GIVEN IN FIG. 1a

5 cm

052

-FIG. 1c-



Si Kα-DISTRIBUTION OF AREA GIVEN IN FIG. 1a

-FIG. 1d-

C Kα-DISTRIBUTION OF AREA GIVEN IN FIG. 1a

5 cm

HUMBOLDT WEDAG

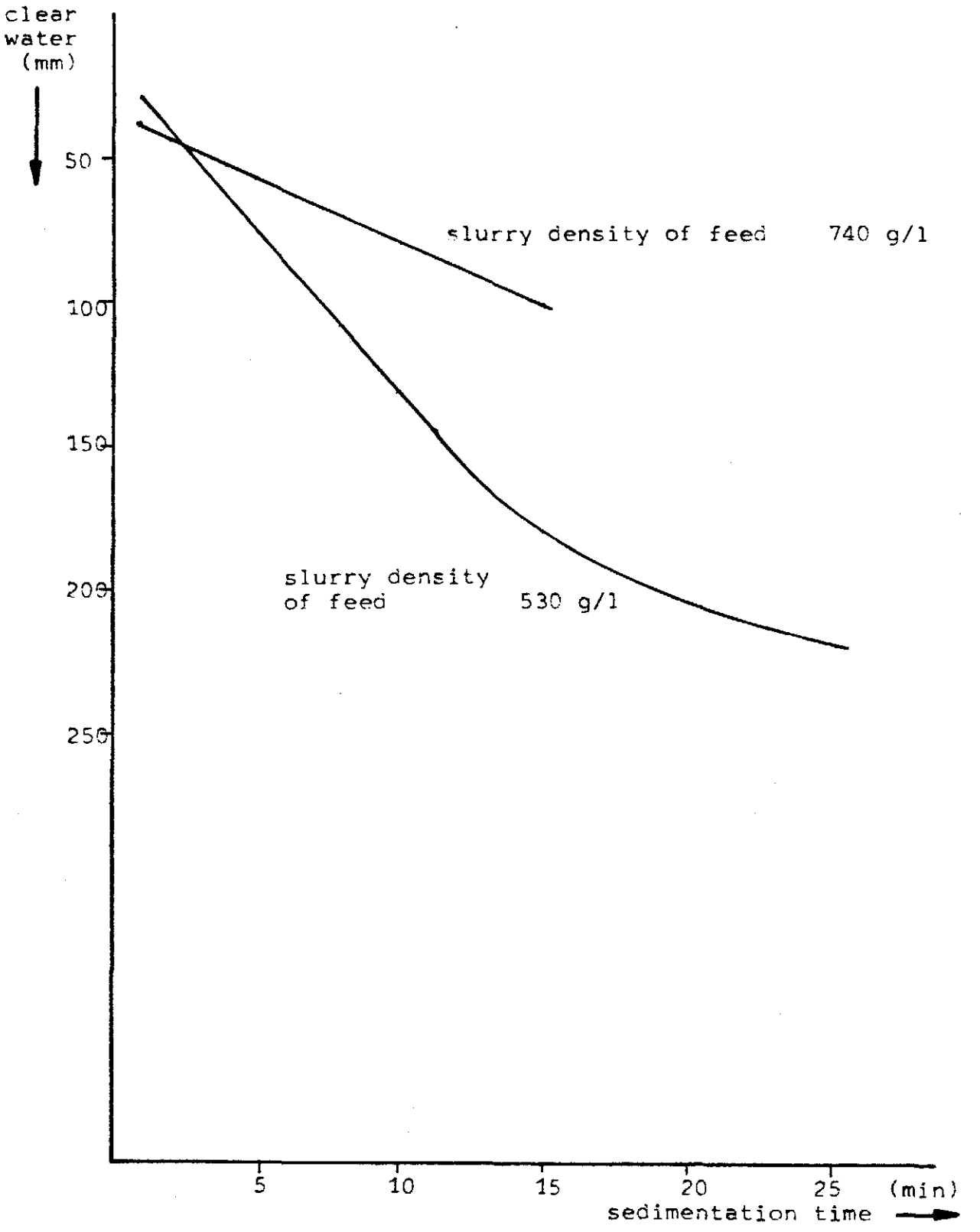
SETTLING CURVE

MgO - concentrate

enclosure 20

988055

053



Hb 370/1

HUMBOLDT WEDAG

SETTLING CURVE
tailings

enclosure 21

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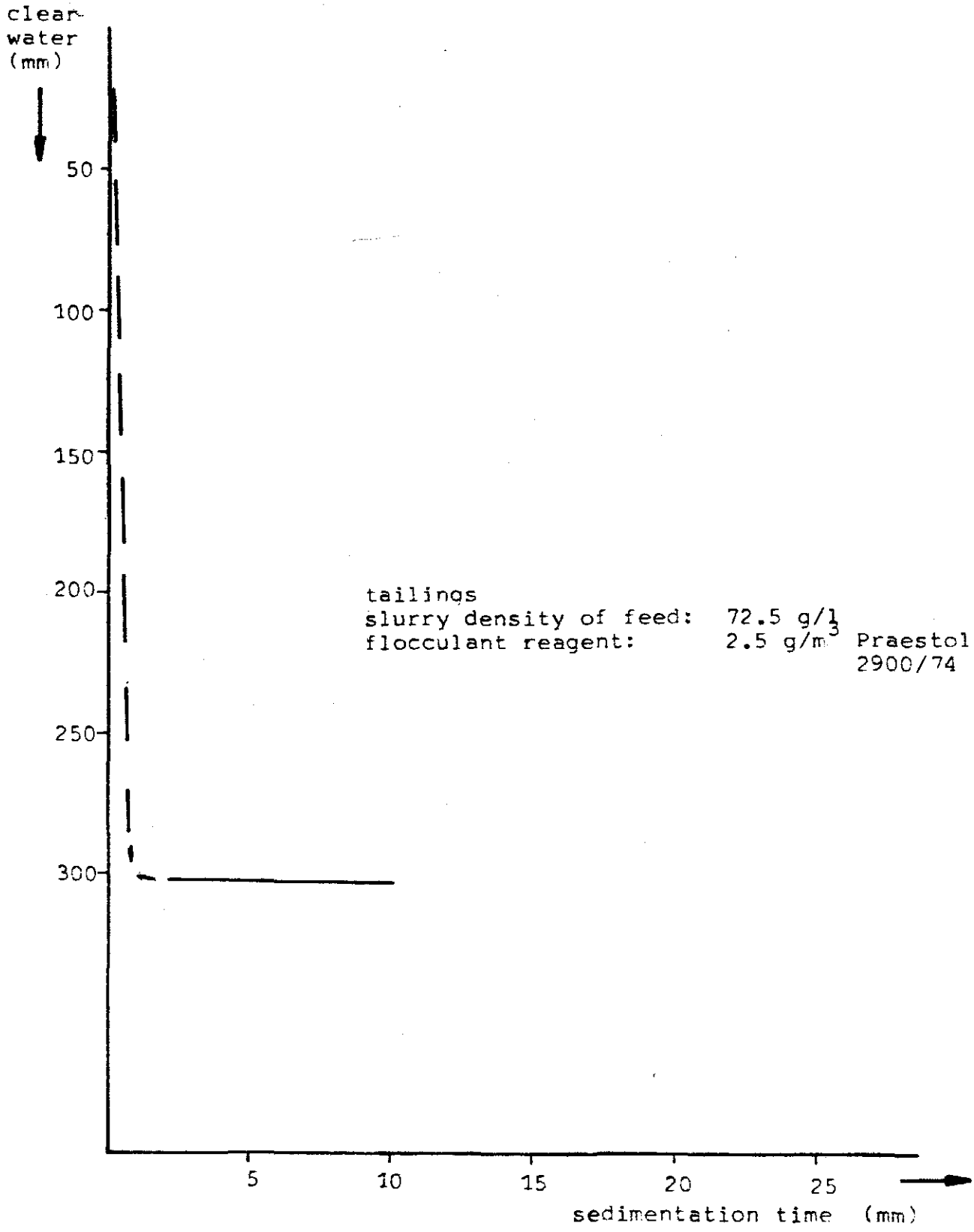
054



Hb 370/1

enclosure 22

055

List of filtration tests

MgO-concentrate

test no.	slurry density	suction time	drying time	height	filtration cake weight		moisture	calc. capacity (dry)
					wet	dry		
	g/l	sec	sec	mm	g	g	%	kg/(h · m²)
4	553	40	40	16	316	284	10,1	1022
5	553	40	80	20	328	304	7,3	730
6	553	40	60	20	320	294	8,1	852
11	1400	20	60	36	667	598	10,3	2153
12	1400	20	40	35	680	606	10,9	2909
13	1400	20	80	34,5	664	602	9,2	1746

9805-1

Table 1:

mineral	MgO-grade %	SiO_2-grade %	CaO-grade %	MnO-grade %	Fe_2O_3-grade %	sum %
magnesite	47,54	0,18	-	0,26	0,52	48,50
magnesite	45,94	0,20	-	0,30	1,95	48,39
dolomite	22,36	0,22	30,02	-	0,41	53,01
calcite	-	-	54,92	0,38	0,44	55,78

057

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KHD HUMBOLDT WEDAG AG

KHD Humboldt Wedag AG · Postfach 10 27 29 · D-4630 Bochum 1

CRA Limited
Attn. Mr. J.L. Dunbar
Executive Officer Minerals
GPO Box 384 D

Melbourne 3001

Australia

Im Namen und für Rechnung der
Klöckner-Humboldt-Deutz AG, Köln

Bochum, Herner Straße 299
Telefon: Bochum (0234) 539-1
Telegramme: humboldtwedag bochum
Telex [redacted]

Zahlungen bitte nur an:
Klöckner-Humboldt-Deutz AG,
Abt. KRF, Postfach 80 05 09, D-5000 Köln 80
Deutsche Bank AG, Köln
(BLZ 370 700 60) Konto-Nr. 117 1719
Dresdner Bank AG, Köln
(BLZ 370 800 40) Konto-Nr. 9 782 503
Commerzbank AG, Köln
(BLZ 370 400 44) Konto-Nr. 5002001

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen	☎ Durchwahl	Bochum
			539	

Unsere Zeichen: IH-MV1-Bender/SH
Telefon-Durchwahl: (0234) 539-514
Fax-Durchwahl: (0234) 539-218
Telex-Durchwahl: 8812-276
0274C

Bochum, 03.03.1986

Re.: Magnesite Testwork
Our nos. 9-2125-5-0016
9-2121-5-0089
9-8125-9-5011
9-8125-9-5018

Dear Mr. Dunbar,

attached please find the report on the refractory testwork carried out by Messrs. RCE, Austria.

The report has been airmailed 2-fold under two separate covers.

The remaining samples have been airfreighted in the meantime.

Best regards

Yours faithfully

KHD Humboldt Wedag AG

Enclosures

i.V. Bender

TN 0103 0425/11
(HW 2300/11)
10 000 10. 84 O.

058

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T E S T R E P O R T

Refractory tests with magnesite
flotation concentrate carried out

for

KHD HUMBOLDT WEDAG AG
ABT. IH-MV1, BOCHUM/FRG

prepared by

REFRACTORIES CONSULTING &
ENGINEERING AG
RADENTHEIN/AUSTRIA

Radenthein, 1986/02/25
VERSO2/Kn/Kü Nr. 056

059

988061

CONTENTS

060

988062

SUMMARY

Raw magnesite, originating from a deposit in NW-Tasmania was beneficiated in KHD's test facilities to flotation concentrate with + 97 % MgO content. RCE was requested to carry out refractory tests in a 3-step program which was mutually agreed upon after detailed discussions between KHD and RCE. Tests covered under step 1 aimed to determine optimum conditions for producing maximum sinter densities and to produce sufficient MgO sinter from the remaining sample quantity for subsequent refractory tests of step 2.

The tests carried out according scope of tests defined under step 1 gave completely unsatisfactory results with sinter densities at 1850 °C of max. 2,69 g/cm³. The rate of calcintation showed no influence on the final sinter density (BSD) and the compactibility of the caustic MgO produced at 800 °C (= highest reactivity), 850 °C, 900 °C and 950 °C was equally poor for all samples.

At this stage KHD agreed with RCE to extend the scope of sintering tests in order to cover the complete range of technological possiblities for achieving high sinter densities.

This included single step sintering of raw concentrate in original and finely ground modification up to 2-stage calcining/ sintering of original and finely ground MgO produced at an optimum temperature of 800 °C for calcination and 1850 °C for sintering. Fine grinding of caustic MgO increased the sinter density along with an increased fineness. The best sinter density of 3,15 g/cm³ was achieved with a fineness of the caustic MgO of 98 % minus 32 micron, a figure which was still far away from the target of + 3,30 g/cm³.

MgO Periclase 3.67 - 3.90 sinter gravity.
$MgCO_3$ magnesite 3.0 - 3.12 "

061

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A certain chance to improve the sinter density further exists in ultra-fine grinding of the caustic MgO and by increasing the sintering temperature. But from a technical and economical point of view it is hardly to imagine that an industrial scale operation will be feasable based on such a complex technology.

Considering above circumstances and facts and after consultations with the customer in Australia, KHD advised RCE to carry out no further tests and to prepare a formal test report.

Questions raised by CRA regarding the poor sintering properties of this sample in comparison with the samples from NW-Tasmania tested by RCE in 1974 have already been commented in a separate telex addressed to KHD on 1986/02/21.

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1.0.0 INTRODUCTION

Against official KHD-order no. 9-8125-9-5018-001/4029 dated 1985/10/02 RCE was requested to carry out laboratory scale refractory tests in a 3-step program:

- Refractory tests up to sinter product
- Refractory tests with pieces of bricks
- Basic information and plant data

For this purpose on 1985/09/25 RCE received a quantity of 56 kg magnesite flotation concentrate which was produced in KHD's test facilities.

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2.0.0 SCOPE OF TEST PROGRAM

2.1.0 REFRACTORY TESTS UP TO SINTER PRODUCT

- Calcination tests at 3 different temperatures
- Sintering tests and determination of sinter densities and best suited temperature
- Calcination of total concentrate sample at best suited temperature
- Sintering tests at different temperatures
- Determination of sinter density, water absorption, apparent porosity and primary crystal size
- Expertise and comparison of sinter with other marketable sinters of equivalent composition

2.2.0 REFRACTORY TESTS WITH PIECES PRODUCED FROM SINTER

- Pressing of sinter produced under item 2.1
- Determination of brick density, apparent porosity and other relevant parameters after firing
- Determination of refractoriness under load and temperature
- Expertise and comparison with well known products

2.3.0 INFORMATIONS AND PLANT DATA

Based on the results of testwork outlined under items 2.1 and 2.2 basic information and data will be given regarding operation costs of a production plant, process, parameters, retention time, costs for calcination, briquetting and sintering, etc.

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3.0.0 GENERAL INFORMATION

Already in 1974 RCE had carried out beneficiation and sintering tests with raw magnesite origination from NW-Tasmania (Lions River Deposit, Victory Deposit, Arthur River Main Outcrop). Based on these results it was obvious that a single step burning process, even after fine grinding of flotations concentrate to minus 40 micron, will not yield the required sinter density of plus 3,30 g/cm³. But this goal in 1974 was reached by applying a two step burning process including fine grinding of the pre-calcined material.

According to information received from KHD the test material obviously originated from the same area of magnesite mineralization in NW-Tasmania with basically similar mineralogical features.

For above reason, our general experience with similar types of magnesite and according to the latest trend in industrial scale sintering technology aiming at highest possible sinter densities, a single step sintering process was not envisaged to be feasable right from the beginning and the investigation programm was focused on a 2-step calcination/sintering process.

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4.0.0 COURSE OF TEST WORK

4.1.0 FLOTATION CONCENTRATE CHARACTERISTICS

The total quantity of flotation concentrate supplied by KHD was thoroughly mixed in order to assure an optimum homogenity for the subsequent tests.

4.1.1 CHEMICAL ANALYSIS

After homogenization the following chemical analysis of the flotation concentrate was determined by X-ray fluorescent analysis. According to general practice of our laboratories for reasons of accuracy MgO is calculated as difference to 100 %. All figures represent ignited conditions, therefore the value for "loss on ignition" (L.O.I.) is put into brackets.

SiO_2	0,40 %
Fe_2O_3	0,95 %
Al_2O_3	0,05 %
Mn_3O_4	0,16 %
Cr_2O_3	0,01 %
CaO	1,12 %
MgO (Diff.)	97,31 %
L.O.I.	(51,45 %)
CaO/SiO_2 ratio	2,80

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4.1.2 GRAIN SIZE DISTRIBUTION

Determination of grain size, also in case of caustic calcined material, was carried out by use of a CILAS-Lasergranolumeter.

Grain size (micron)	Grain size distribution (Vol.-%)
192	-
128	5,6
96	10,7
64	36,2
48	49,7
32	70,8
24	81,2
16	7,9
12	91,8
8	94,0
6	95,6
4	96,7
3	97,4
2	97,7
1,5	98,3
1	98,5

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4.2.0 CALCINATION TESTS

Calcining of flotation concentrate was carried out batch-wise in a laboratory muffle furnace with charges of 1 kilogram each. Retention time of the samples at specific calcining temperatures was 30 minutes.
In order to cover the whole range of possibly applicable calcining temperatures for achieving of maximum sinter densities the tests were extended to 4 calcining temperatures instead of 3 originally planned, namely 800 °C, 850 °C, 900 °C and 950 °C.
For each sample of caustic calcined MgO produced at above temperatures the "loss on ignition" (L.O.I.) was determined which is the usually applied figure for defining the rate of calcination.
In addition the specific surface in (m^2/g) according to BET-method was determined which describes the reactivity of the caustic calcined MgO. A highly reactiv MgO, equivalent to a high specific surface is one parameter for achieving favourable compacting properties respectively good green densities of the briquetted caustic MgO which normally also influences the final sinter density in a positive way.
In addition the grain size distribution of the calcined samples was determined by CILAS-granolumeter. The results are enclosed under table 2-5.
The results from the calcining tests for test samples no. 1 - 4 are summarized under item 4.4.0 (sintering tests).

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4.3.0 COMPACTING TESTS

The caustic calcined MgO samples produced at 800 °C, 850 °C, 900 °C and 950 °C were compacted in cyclindrical moulds by means of a piston press applying a standard pressure of 150 N/mm². The size of the compacted MgO cylinders was 50 mm in diameter and 30 mm in height. Despite ~~of~~ the differing rate of calcination respectively reactivity the green density (RD) of the samples was unexpectedly low and more or less the same, ranging from 1,39 g/cm³ to 1,45 g/cm³. Comparable MgO qualities show green densities in the range of 1,90 g/cm³ to 2,20 g/cm³.

The test results for samples no 1 - 4 are summarized under item 4.4.0 (sintering tests).

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4.4.0 SINTERING TESTS

Sintering of the test samples was carried out in a high temperature chamber type laboratory kiln at different temperatures, namely 1750 °C and 1850 °C. Heating up requires approximately 8 hours and the sample is placed into the kiln at roughly 500 °C. Retention at a specified temperature ist 4 hours. The sinter bulk specific density or BSD for samples no. 1 - 4 sintered, at 1750 °C, was practically the same and completely unsatisfactory.
Even an increase of the sintering temperature to 1850 °C did not change the results apart from a neglible increase by 0,04 g/cm³ to a maximum of 2,69 g/cm:

Sample no.	Calcined MgO				Sintered MgO	
	Calc. temp. (°C)	L.O.I. (%)	BET (m^2/g)	Raw density RD (g/cm^3)	BSD (g/cm^3) 1750 °C	1850 °C
1	800	0,34	39,344	1,45	2,65	2,69
2	850	0,14	17,445	1,39	2,63	2,69
3	900	0,08	11,848	1,43	2,56	2,62
4	950	0,06	4,656	1,41	2,65	2,69

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4.5.0 EXTENSION OF TEST PROGRAM

The unexpected negative results of course did not allow to carry out the tests according to original schedule. In order to continue with refractory tests outlined under step 2 of the program a sinter density of 3,30 g/cm³ was considered as a minimum.
At this stage KHD was informed about the negative results and RCE suggested to carry out additional tests which might lead to a satisfactory sinter density and should cover the complete range of possibilities from single step firing of raw flotation concentrate to 2-step firing including fine grinding of material. This proposal was accepted by KHD.

4.5.1 SCOPE OF ADDITIONAL TEST WORK

For calcination of magnesite the optimum temperature of 800 °C, determined during initial test work, was maintained. Incidently this is the same calcining temperature applied in RCE's 1974 tests with magnesite from NW-Tasmania.

Sample no. 5

Original flotation concentrate (grain size analysis table no. 1) as supplied by KHD was mixed with 20 % caustic MgO produced at a calcining temperature of 800 °C. After addition of 3 % Kieserite ($MgSO_4$) solution with a concentration of 28 ° Bè the mixture was compacted to cylindrical shape sizing 50 mm in diameter and 30 mm in height. Pressure applied was 150 N/mm².
Green density (RD) of the compacted material was 2,15 g/cm³, sinter density after firing at 1850 °C 2,38 g/cm³ only.

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This traditional technology in principle is identical with present large scale production in Radenthein (Radex) and many other major refractory producers operating on the basis of natural magnesite.

Sample no. 6

Original flotation concentrate was ground to 100 % minus 48 micron in a laboratory rod mill (grain size analysis table 6). After mixing with 20 % caustic MgO (calcining temperature 800 °C) and addition of 3 % Kieserite solution at 28 ° Be the sample was compacted as described above and sintered at 1850 °C. Compared with sample no. 5 fine grinding raised the sinter density from 2,38 g/cm³ to 2,82 g/cm³ only.

Sample no. 7

Caustic MgO produced at 800 °C calcination temperature was compacted without addition of any binder to standard size cylinders as above. No grinding of the concentrate or caustic calcined MgO took place (cross-check to sample no. 1). The green density of 1,39 g/cm³ and sinter density of 2,67 g/cm³ were practically identical with sample no. 1 proving that tests were carried out correctly.

Sample no. 8

Caustic MgO produced at 800 °C was ground to a fineness of 100 % minus 64 micron and subsequently compacted without addition of binder to standard size cylinders (grain size distribution table 7).
The green density could be raised to 1,60 g/cm³ and the sinter density to 3,03 g/cm³ which still was far below the target of + 3,30 g/cm³.

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Sample no. 9

Caustic MgO produced at 800 °C was ground to a fineness of 100 % minus 48 micron or approximately 98 % minus 32 micron (grain size distribution table 8). With above measures almost all natural magnesite types can be dead burned to satisfactory high sinter densities. Unfortunately not so in this specific case. The green density remained at the same level as for sample no. 8. Though the sinter density increased further to 3,15 g/cm³ this figure was still disappointingly low. Diagram 1 illustrates and compares the grain size distribution characteristic of the various samples.

4.5.2 SUMMARY OF RESULTS FROM ADDITIONAL TESTS

Sample no.	Sample preparation	RD (g/cm³)	BSD at 1850 °C (g/cm³)
5	Orig.flot.conc. +20% caustic MgO +3% Kieserite solution	2,15	2,38
6	Ground flot.conc. +20% caustic MgO +3% $MgSO_4$	2,15	2,82
7	Caustic MgO in original grain size, 800 °C	1,39	2,67
8	Caustic MgO (800 °C) ground to 100% -64 micron	1,60	3,03
9	Caustic MgO (800 °C) ground to 100% -48 micron	1,58	3,15

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4.5.2 CONCLUSIONS FROM ADDITIONAL TEST RESULTS

RCE informed KHD about the negative results and hinted out on the principal possibility and chance that a sufficient high sinter density might be a achieved by super fine grinding of caustic MgO aimings at a maximum content of minus 10 micron particles in combination with an increase in sinter temperature to 1950 °C. Basing an industrial production on such a technology can hardly be justified commercialy with respect to investment and operating costs.
Under these circumstances RCE proposed to cancel further tests planned according original schedule.
After consultation with the Australian customer KHD confirmed that RCE should terminate further tests.
Further RCE was requested to air-freight the remaining sample of approx. 40 kg original KHD-concentrate and the small sinter samples from the various test to CRA Exploration Pty. Ltd/Australia which meanwhile has been effected.

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ENCLOSURES

Table 1: Grain size distribution
Original flotation concentrate

Table 2: Grain size distribution
caustic MgO, 800 °C

Table 3: Grain size distribution
caustic MgO, 850 °C

Table 4: Grain size distribution
caustic MgO, 900 °C

Table 5: Grain size distribution
caustic MgO, 950 °C

Table 6: Grain size distribution
Raw flotation concentrate
ground to minus 48 micron

Table 7: Grain size distribution
caustic MgO, 800 °C
ground to 100 % minus
48 micron

Table 8: Grain size distribution
caustic MgO, 800 °C
ground to 48 % minus
32 micron

Diagram 1: Graphical comparison of
grain size distribution of
various samples

Diagram 2: Temperature profile of high
temperature laboratory
sintering tests

988077

075 # Körnungsanalyse Nr. 208

Datum 1985 10 16

Flotationskonzentrat Tasmanien original	Cilas Lasergranulometer

Kornfraktion (µm)	Siebrückstand		Bemerkung
	Fraktions- %	ΣFrakt. - %	
+200			
128 - 200	5,6	5,6	
96 - 128	5,1	10,7	
64 - 96	25,5	36,2	
48 - 64	13,5	49,7	
32 - 48	21,1	70,8	
24 - 32	10,4	81,2	
16 - 24	6,7	87,9	
12 - 16	3,9	91,8	
8 - 12	2,2	94,0	
6 - 8	1,6	95,6	
4 - 6	1,1	96,7	
3 - 4	0,7	97,4	
2 - 3	0,3	97,7	
1,5 - 2	0,6	98,3	
1 - 1,5	0,2	98,5	
-1	1,5	100,0	

GRANULOMETRE 715 E256
85-10-16
FA.7855.RM.KONZENTRAT
A

1	098,5 %
1,5	098,3 %
2	097,7 %
3	097,4 %
4	096,7 %
6	095,6 %
8	094,0 %
12	091,8 %
16	087,9 %
24	081,2 %
32	070,8 %
48	049,7 %
64	036,2 %
96	010,7 %
128	005,6 %
192	000,0 %

59% - PUNKT = 047.0

VOLUMENVERTEILUNG

988078

076 Körnungsanalyse Nr. 218

Datum 1985 11 15

Flotationskonzentrat Tasmanien Kauster 800°C	Cilas Lasergranulometer

Kornfraktion (µm)	Siebrückstand		Bemerkung
	Fraktions- %	ΣFrakt.- %	
+200			
128 - 200			
96 - 128	2,7	2,7	
64 - 96	18,4	21,1	
48 - 64	12,3	33,4	
32 - 48	27,0	60,4	
24 - 32	13,2	73,6	
16 - 24	10 4	84,0	
12 - 16	4,5	88,5	
8 - 12	3,5	92,0	
6 - 8	2,2	94,2	
4 - 6	1,6	95,8	
3 - 4	1,0	96,8	
2 - 3	0,7	97,5	
15 - 2	0,6	98,1	
1 - 15	0,3	98,4	
-1	1,6	100,0	

GRANULOMETRE 715 E266
85-11-15
FR-7855-888.C-1
#

1	898,4 %
1,5	898,1 %
2	897,5 %
3	896,8 %
4	895,8 %
6	894,2 %
8	892,0 %
12	888,5 %
16	884,0 %
24	873,6 %
32	868,4 %
48	833,4 %
64	821,1 %
96	802,7 %
128	800,0 %
192	800,0 %

50% - PUNKT = 839,2

VOLUMENVERTEILUNG

988079

077

Körnungsanalyse Nr. 220

Datum 1985 11 15

Flotationskonzentrat Tasmanien Kauster 850°C	Cilas Lasergranulometer

Kornfraktion (µm)	Siebrückstand		Bemerkung
	Fraktions- %	ΣFrakt. - %	
+200			
128 - 200			
96 - 128	3,0	3,0	
64 - 96	16,9	19,9	
48 - 64	13,0	32,9	
32 - 48	26,9	59,8	
24 - 32	13,7	73,5	
16 - 24	10,5	84,0	
12 - 16	5,1	89,1	
8 - 12	3,3	92,4	
6 - 8	2,1	94,5	
4 - 6	1,8	96,3	
3 - 4	0,9	97,2	
2 - 3	0,6	97,8	
15 - 2	0,4	98,2	
1 - 15	0,2	98,4	
-1	1,6	100,0	

GRANULOMETRE 715 E266
95-11-15
FA-7855-850.C-1
A

1	098,4 %
1,5	098,2 %
2	097,8 %
3	097,2 %
4	096,3 %
6	094,5 %
8	092,4 %
12	089,1 %
16	084,0 %
24	073,5 %
32	059,8 %
48	032,9 %
64	019,9 %
96	003,0 %
129	000,0 %
192	000,0 %

50% - PUNKT = 037,9

VOLUMENVERTEILUNG

078

Table 4

988080

Körnungsanalyse Nr. 222

Datum 1985 11 15

Flotationskonzentrat Tasmanien Kauster 900°C	Cilas Lasergranulometer

Kornfraktion (µm)	Siebrückstand		Bemerkung
	Fraktions- %	ΣFrakt. - %	
+200			
128 - 200			
96 - 128	2,1	2,1	
64 - 96	17,5	19,6	
48 - 64	12,2	31,8	
32 - 48	27,7	59,5	
24 - 32	13,7	73,2	
16 - 24	11,2	84,4	
12 - 16	5,0	89,4	
8 - 12	3,6	93,0	
6 - 8	2,0	95,0	
4 - 6	1,7	96,7	
3 - 4	0,9	97,6	
2 - 3	0,4	98,0	
15 - 2	0,3	98,3	
1 - 15	0,2	98,5	
- 1	1,5	100,0	

GRANULOMETRE 715 E266
95-11-15
FA-7855-900.C-1
A

1	098,5 %
1,5	098,3 %
2	098,0 %
3	097,6 %
4	096,7 %
6	095,0 %
8	093,0 %
12	089,4 %
16	084,4 %
24	073,2 %
32	059,5 %
48	031,8 %
64	019,6 %
96	002,1 %
128	000,0 %
192	000,0 %

59% - PUNKT = 037,5

VOLUMENVERTEILUNG

988081

079

Körnungsanalyse Nr. 224

Datum 1985 11 15

Flotationskonzentrat Tasmanien Kauster 950°C	Cilas Lasergranulometer

Kornfraktion (µm)	Siebrückstand		Bemerkung
	Fraktions- %	ΣFrakt. - %	
+200			
128 - 200			
96 - 128	2,6	2,6	
64 - 96	18,2	20,8	
48 - 64	12,3	33,1	
32 - 48	27,1	60,2	
24 - 32	13,7	73,9	
16 - 24	11,4	85,3	
12 - 16	5,2	90,5	
8 - 12	3,6	94,1	
6 - 8	1,8	95,9	
4 - 6	1,5	97,4	
3 - 4	0,8	98,2	
2 - 3	0,3	98,5	
1,5 - 2	0,1	98,6	
1 - 1,5	0,1	98,7	
-1	1,3	100,0	

GRANULOMETRE 715 E266
95-11-15
FA-7055-950.C-1
R

1	098,7 %
1,5	098,6 %
2	098,5 %
3	098,2 %
4	097,4 %
6	095,9 %
8	094,1 %
12	090,5 %
16	085,3 %
24	073,9 %
32	060,2 %
48	033,1 %
64	020,8 %
96	002,6 %
128	000,0 %
192	000,0 %

50% - PUNKT = 039.1

VOLUMENVERTEILUNG

988082

Körnungsanalyse Nr. 226

Datum 1985 11 26

Flotationskonzentrat Tasmanien gemahlen <48µm	Cilas Lasergranulometer

Kornfraktion (µm)	Siebrückstand		Bemerkung
	Fraktions- %	ΣFrakt. - %	
+200			
128 - 200			
96 - 128			
64 - 96	–	–	
48 - 64	0,1	0,1	
32 - 48	8,3	8,4	
24 - 32	9,5	17,9	
16 - 24	17,3	35,2	
12 - 16	10,0	45,2	
8 - 12	10,3	55,5	
6 - 8	6,9	62,4	
4 - 6	7,9	70,3	
3 - 4	5,1	75,4	
2 - 3	6,6	82,0	
1,5 - 2	6,4	88,4	
1 - 1,5	2,8	91,2	
-1	8,8	100,0	

GRANULOMETRE 715 E255

FR-7855 Konz. vor d. 0,5 kg 1 Std. gem. Stabmühle

1	091,2 %
1,5	088,4 %
2	082,0 %
3	075,4 %
4	070,3 %
6	062,4 %
8	055,5 %
12	045,2 %
16	035,2 %
24	017,9 %
32	008,4 %
48	000,1 %
64	000,1 %
96	000,0 %
128	000,0 %
192	000,0 %

50% - PUNKT = 010,2

VOLUMENVERTEILUNG

Körnungsanalyse Nr. 227

Datum 1985 11 26

Flotationskonzentrat Tasmanien Kauster 800°C gemahlen < 48µm	Cilas Lasergranulometer

Kornfraktion (µm)	Siebrückstand		Bemerkung
	Fraktions- %	ΣFrakt. - %	
+200			
128 - 200			
96 - 128			
64 - 96			
48 - 64	0,6	0,6	
32 - 48	6,6	7,2	
24 - 32	7,7	14,9	
16 - 24	16,5	31,4	
12 - 16	11,7	43,1	
8 - 12	14,0	57,1	
6 - 8	8,7	65,8	
4 - 6	8,3	74,1	
3 - 4	4,3	78,4	
2 - 3	5,6	84,0	
15 - 2	6,4	90,4	
1 - 15	2,6	93,0	
-1	7,0	100,0	

GRANULOMETRE 715 E266
95-11-26
FA-7055-30MI.-800.C
A

1	093,8 %
1,5	090,4 %
2	084,0 %
3	078,4 %
4	074,1 %
6	065,8 %
8	057,1 %
12	043,1 %
16	031,4 %
24	014,9 %
32	007,2 %
48	000,6 %
64	000,6 %
96	000,0 %
128	000,0 %
192	000,0 %

50% - PUNKT = 019,9

VOLUMENVERTEILUNG

Körnungsanalyse Nr. 228

Datum 1985 11 26

Flotationskonzentrat
Tasmanien

Kauster 800°C
gemahlen < 32µm

Cilas
Lasergranulometer

Kornfraktion (µm)	Siebrückstand		Bemerkung
	Fraktions- %	ΣFrakt. - %	
+200			
128 - 200			
96 - 128			
64 - 96			
48 - 64			
32 - 48	1,8	1,8	
24 - 32	4,5	6,3	
16 - 24	11,7	18,0	
12 - 16	11,7	29,7	
8 - 12	13,8	43,5	
6 - 8	10,3	53,8	
4 - 6	9,9	63,7	
3 - 4	5,9	69,6	
2 - 3	7,7	77,3	
15 - 2	9,5	86,8	
1 - 15	3,7	90,5	
- 1	9,5	100,0	

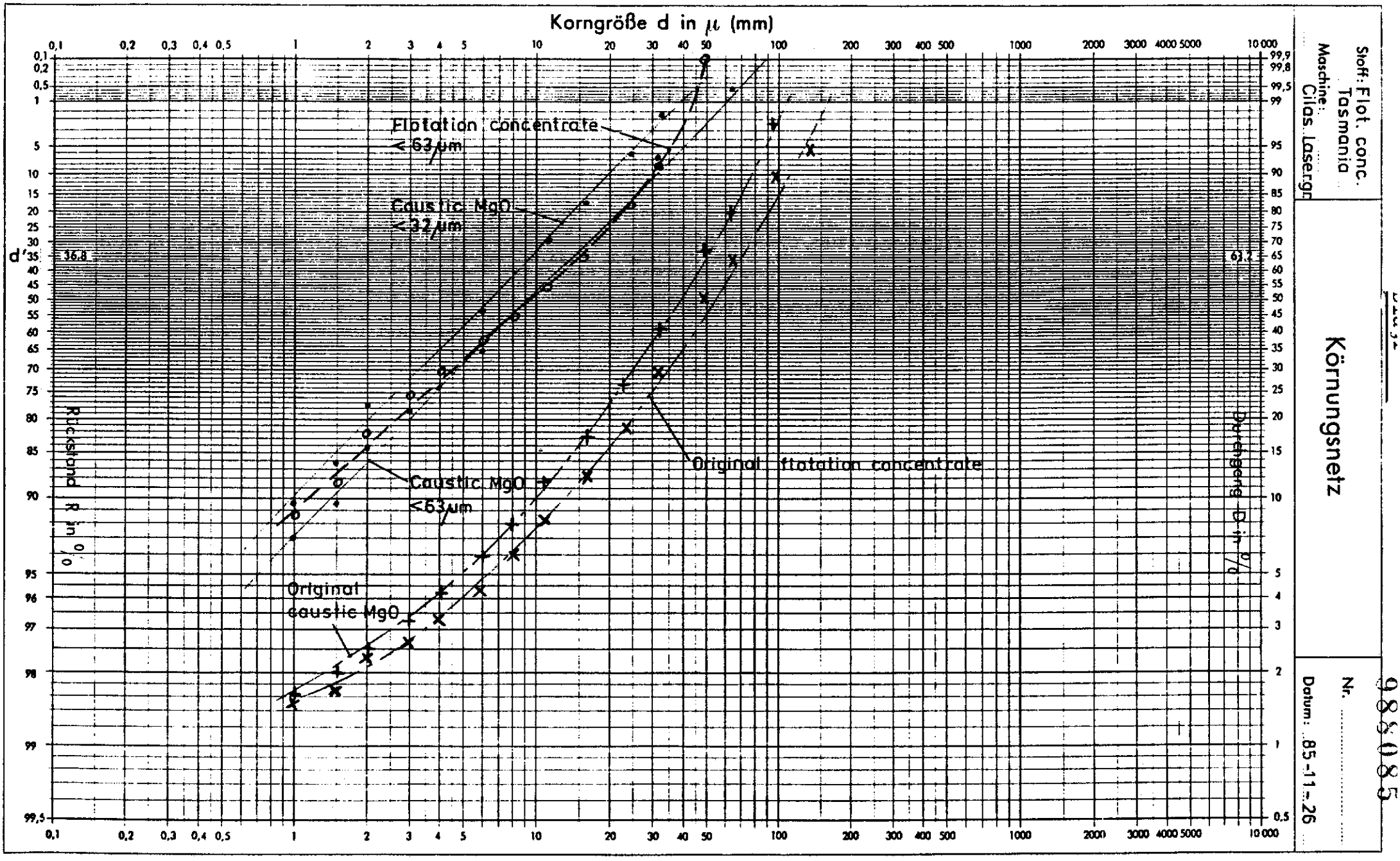
GRANULOMETRE 715 E266
95-11-26
FA-7855-800.C-15TD.SEM.
R

1	098,5 %
1,5	086,8 %
2	077,3 %
3	069,6 %
4	063,7 %
6	053,8 %
8	043,5 %
12	029,7 %
16	018,0 %
24	006,3 %
32	001,8 %
48	000,0 %
64	000,0 %
96	000,0 %
128	000,0 %
192	000,0 %

50% - PUNKT = 006,7

VOLUMENVERTEILUNG

083



Stoff: Flot. conc. Tasmania

Maschine: Cilas Lasergr...

Körnungsnetz

Nr. .....

Datum: 85-11-26

9885085

Temperature profile of high temperature laboratory kiln for sintering of magnesite

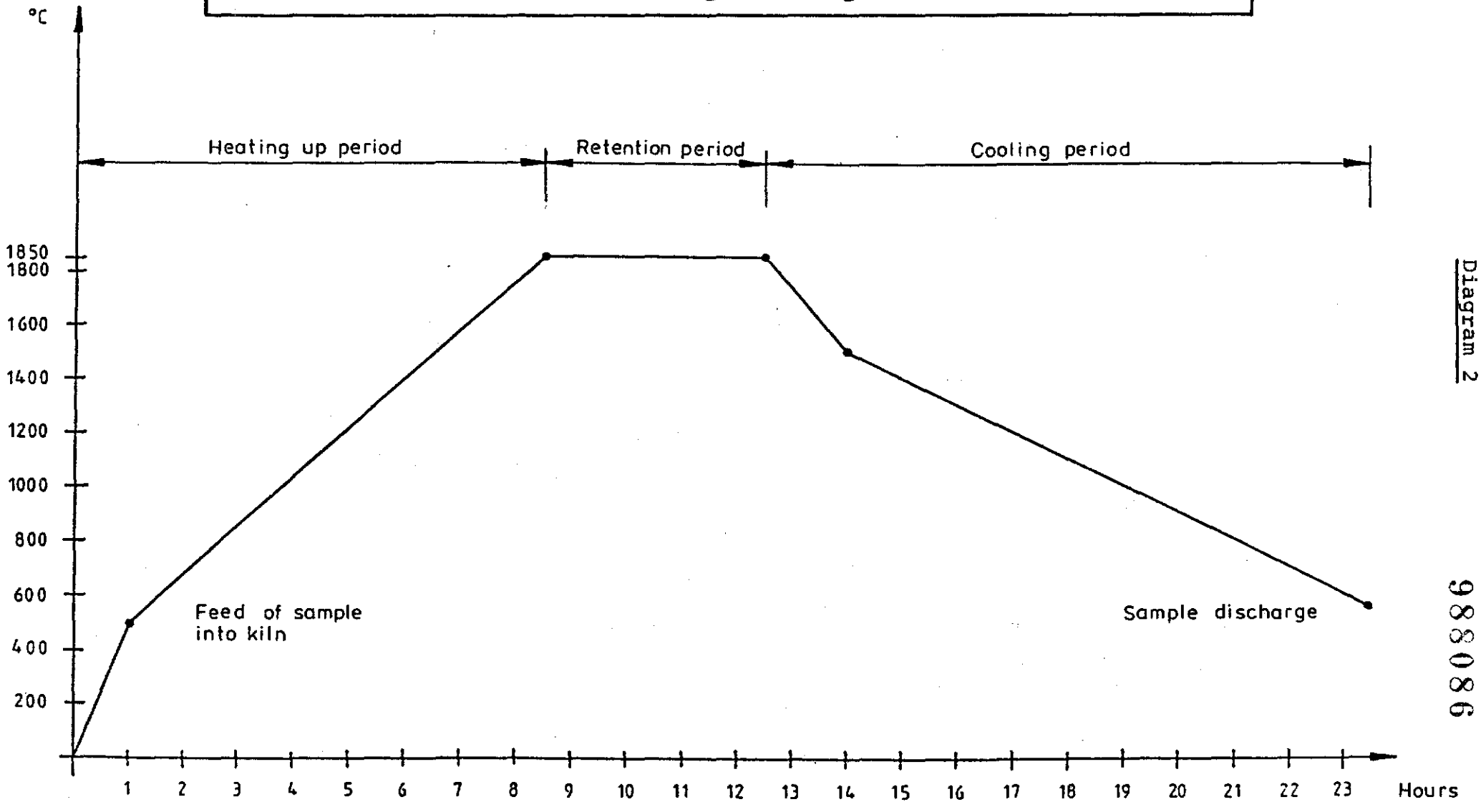


Diagram 2