

516001

D of M	A.O.	C.G.	E.O.	D.S.M.E
				Registrar
Received	28 SEP 1983			E & H
Answered				
DEPT. OF MINES				
REF. No. 8897/83				

INDUSTRIAL AND MINING INVESTIGATIONS PTY LIMITED

Incorporated in the A.C.T.

Exploration Licence 4/61

West Coast, Tasmania

QUARTERLY RESUMÉ

25.5.83 to 22.8.83

1. SUMMARY

No field work was undertaken during this quarter and all field staff were demobilised.

During the quarter under review activities were concentrated on

- Preparing for the 1983/84 field programme.
- Completing and filing the 1982/83 field season report.
- Logging boreholes MC 27 and 28 and the preparation and despatch of core cut therefrom to the CSIRO for geostatistical analysis.
- Commencement of a review of previous exploration data relating to the area covered by the licence.
- Further metallurgical research by the CSIRO.

2. MAIN CREEK MAGNESITE

In paragraph 43, page 16 of the company's report entitled "Report on Field Investigations within EL 4/61, West Coast Tasmania, Summer Field Season 1982 - 83 by C.H.C. Shannon and L. Vanzino" dated August 1983, it was advised that in relation to boreholes MC 27 and MC 28 that "detailed logging has been completed but was done after 24.5.83 and therefore will be included in the next quarterly report."

Detailed logs of MC 27 and MC 28 are annexed hereto as Appendix 1 and Appendix 2 respectively.

3. CSIRO METTALURGICAL RESEARCH

Progress Report No. 10: October 1982 - June 1983 received from the CSIRO during the quarter under review and is annexed hereto as Appendix 3.

4. CSIRO GEOSTATISTICAL ANALYSIS

During the quarter under review, cores from boreholes MC 27 and MC 28 were split in half using a diamond saw. A total of 213 samples weighing approximately 1 kg. each were then cut from one half of the core and sent to Dr. Malcolm Frost of the Department of Mineral Chemistry in Melbourne.

The sampling technique employed in relation to BQ diameter core was that from every intersection of magnesite in the split core greater than 65 cm. in length, a 65 cm. interval from that intersection of split core was cut and bagged. The bagged sample obtained weighed approximately 1 kg. The sampling technique employed in relation to NQ diameter core was that from every intersection of magnesite in the split core greater than 40 cm. in length, a 40 cm. interval from that intersection of split core was cut and bagged. The bagged sample obtained weighed approximately 1 kg.

These samples will be analysed by the CSIRO for magnesite, dolomite and silicates so that a geostatistical analysis can be made of the deposits tonnage and grade.

5. REPORTING

A report entitled "Report on Field Investigations within EL 4/61, West Coast Tasmania, Summer Field Season 1982 - 83 by C.H.C. Shannon and L. Vanzino" was filed with the Department of Mines on 23rd August 1983.

APPENDIX 1



DRILL CORE DESCRIPTION DRILL HOLE MC 27

LOCATION 4465 0018, RL 170m DRILLED FOR I.M.I. PTY LIMITED DRILLED BY OVERLAND DRILLING DATE 18.3.83
6.4.83

FROM	TO	INTERVAL	RECOVERY		GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
			M	%		
0	33.0	33	None	core drilling	Weathered greenschist chips, water loss near base of interval associated with red drilling mud interpreted as leached magnesite relics (clay/ferric oxides).	
3.30	33.15	0.15	0.15	100	Altered dolerite, dark greenish grey munsell colour code 5G 4/1, equigranular, no cleavage. Pyrite 2% magnetite 5%. Feldspar altered to green mineral. Interpreted as a dyke post dating memorphism. Cavings present.	
33.15	37.85	4.70	4.70	100	Magnesite rock, fine grained, very pale grey N8 to yellowish grey, 5Y 8/1, with weathered contact zone at 33.15 - 33.16, moderate orange pink 5YR 8/4, with white protruding magnesite vein. Remainder has blotches of darker material to medium grey N5 with gradational boundaries associated with greater pyrite content up to 2%. Blotches comprise 20% of the whole. Pyrite also occurs along fracture planes which expand to a network of annealed crack veins with associated detached vughs.	
37.85	41.00	2.15	2.15	100	Pyritic magnesite rich talc schist. 2 phases present. a) moderate brown 5YR 4/4, with quartz segregations	

210003

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
					and b) brownish grey with disseminated magnesite, pyrite 2-5% in both metamorphic layering with segregation of magnesite in both white magnesite veins near base, rare coarse magnesite concentration like segregations to 3 cm. Contorted core schistosity angle C.S.A. 45° to 60° in less contorted sections.	
41.00	42.80	1.80	2.80	100	Magnesite rock, medium light grey to N6 to yellowish grey 5Y 8/1 crack veins with olive grey magnesite 2%, tension veins 1% with white carbonate, pyrite 1-2%, otherwise very like 33.15 - 37.85 interval.	
42.8	43.8	1.00	0.9	90	Magnesite rock, pale yellowish orange 10YR 8/6 to yellowish grey 5Y 8/1 with crack veins. Core broken yellow stain on joints, minor leach voids 43.5 - 43.6 interpreted as effect of leaching near open joints.	
43.8	46.9	3.1	3.1	100	Magnesite rock, yellowish grey 5YR 8/1 fine grained rare (1%) sub-spherical patches recrystallised to pale olive grey, 6Y 8/1. Net of annealed crack veins and vughs with light olive grey coarse magnesite 5%, accessory pyrite, tension veins with yellowish white magnesite, 5Y 9/1.	

516006

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
46.9	47.1	0.2	0.2	100	Large tension vein, yellowish white magnesite, with very coarse, greater than 1 cm. white dolomite core.	
47.1	48.7	1.6	1.6	100	Magnesite rock, yellowish grey 5YR 8/1 fine grained rare very light grey blobs, fine grained, accessory pyrite in hairline fracture, annealed crack veins to 5 - 10%, tension veins with yellowish white magnesite, 5Y 9/1/	
48.7	48.85	0.15	0.15	100	Recrystallised magnesite rock, medium grained, partly replaced/veined with yellowish white coarse magnesite.	
48.35	53.55	4.7	4.7	100	Magnesite rock with accessory pyrite, annealed crackle veins, tension veins and fine grained grey blobs, colours and grainsize as before.	
53.55	53.75	0.2	0.2	100	Magnesite rock, greyish orange associated with incipient oxidation of 0.5 c. carbonate vein, other textures as before.	
43.75	62.25	8.5	8.5	100	Magnesite rock, fine grained, pale yellowish grey, 5Y 9/1 with annealed crack veins, tension veins, etc. as before. Towards base crack veins darken to olive grey 5Y 4/1, and pyrite increases.	

515007

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
62.25	62.40	0.15	0.15	100	Magnesite rock fine grained, yellowish grey and medium grey. Dolomite - Magnesite rock, increasing in proportion towards base. Relatively rich in pyrite. The grey material appears to be pseudomorphing original coarse dolomite. The basal 3 cm. are riddled with a white dolomite gash vein.	
62.40	62.50	0.10	0.10	100	Talc schist, olive grey, 5Y 4/1, with ptymatic quartz vein and dolomite layers in schistosity planes, greyish orange patina developed on dolomite layers. CSA 50°.	
62.50	64.00	1.50	1.50	100	Dolomitic greenschist, dark greenish grey, 5G 4/1, with gash veins tension veins and metamorphic layering of dolomite (white) which acquires a patina of dark yellowish orange, 10YR 6/6. Dolomite layers up to 60% 62.5-62.7, at 63.5 ptymatic quartz and carbonate.	
64.00	64.25	0.25	0.25	100	Talc schist, light olive brown, 5Y 5/6 with magnesite along schistosity and in veins. CBA at 64.25 is 65°.	
64.25	64.50	0.25	0.25	100	Magnesite rock, pale yellowish orange, 10YR 8/6 seamed with light grey with blurred boundary - interpreted as recrystallized "annealed crack vein" material. Some later generation crack veins, some dolomite in grey material.	

S16008

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
64.50	57.05	2.55	2.5	100	Magnesite rock, yellowish grey, 5Y 8/1 seamed with light grey N7 in arears of annealed crack veins. Some tension veins with white dolomite interior and light olive grey magnesite margins. Also isolated vughs of light olive grey 5Y 6/1 magnesite. Dolomite and magnesite at 67.05 - 67.15, medium grey N5, 67.15-67.20 recrystallised dolomite, medium grain size. CBA at 67.20 80°.	
67.20	67.45				Dolomitic greenschist, dark greenish grey. 5G 4/1, gash veins and short lenses of dolomite along schistosity.	
67.45	68.15				Altered Dolerite, medium greenish grey, 5G 5/1, equigranular, some calcite in rock itself and in veins. greenschist 1 - 2 cm. at 67.58 and 67.62.	
68.15	68.35	0.20	0.20	100	Dolomitic greenschist, dark greenish grey, 5G 4/1. Minor veins and lenses of dolomite in schistosity planes.	
68.35	68.50				Magnesitic dolostone, very pale orange, 10YR 8/2 to greyish orange, 10YR 7/4 recrystallised, medium grained some magnesite from 68.40, coarse grained vein, mainly	

516009

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
					medium grey with light olive grey patina, aggregates of dolomite and magnesite, some white dolomite.	
68.50	68.45				Greenschist, light olive grey, 5Y 6/1 metamorphic segregation with light layers, feldspar rich and darker layers, chlorite rich. Possibly talc rich.	
68.95	70.25				Dolomitic greenschist, dark greenish grey 5G 4/1, dolomite white with dark yellowish orange 10 YR 6/6 patina, up to 60% in schistosity planes. CSA 60°.	
70.25	70.35				Talc schist, light olive grey 5Y 5/2.	
70.35	70.90	0.55	0.40	72.7%	Dolomitic magnesite rock, pale yellowish orange 10YR 8/6 medium grained, pale grey and coarse at 70.35 - 70.37. Core losses associated with leached quartz/carbonate vein at about 70.80, dolomite 20% at top, less than 5% at base.	
70.90	76.10	6.20	6.20	100%	Magnesite rock, very pale orange, 10YR 8/2 with light grey N7 annealed crackle veins and vughs, and very light grey patches associated with coarse light olive grey magnesite rims and white dolomite cores. At 72.7 0.5 cm. brownish grey talk schist 60°.	

516010

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
76.10	77.50			Magnesite rock, pale yellowish orange, 10YR 8/6 with net of medium grey pyritic magnesite with blurred boundaries, some dark yellowish orange, 10YR 6/6 oxidised crack veins, medium grained. Talc schist with quartz at 78.58 - 78.63, and 78.86 - 78.95.		
77.50	79.35			Dolomitic greenschist, cf 68.95 - 70.25 interval, quartz at 79.20, talc at top and bottom.		
79.35	80.18		100	Dolomitic magnesite rock, dark yellowish orange, 10YR 6/6 patina over white medium grained white veins and replacement bodies of coarse dolomite.		
80.18	80.25		100	Talc schist, dusky brown, 5YR 2/2 with pygmatic quartz veins and pyrite to 5%.		
80.25	80.38		100	Dolomitic greenschist, greyish orange, 10YR 7/5, owing to high proportion of carbonate in schistosity planes (80%).		
80.38	84.00	3.62	100	Amphibolite, dark greenish grey, 5G 4/1, medium grained, slightly foliated equigranular carbonate in gash veins and tension veins, mainly dolomite with dark yellowish		

516011

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
					orange patina but also rare light brown 5YR 5/6 patina on siderite and some white calcite.	
84.0	84.65	1.65	1.65	100	Pyritic dolomitic greenschist, light olive grey 5Y 6/1, sparse carbonate in schistosity planes with ptigmatic folding.	
85.65	86.65	1.00	1.00	100	Amphibolite, dark greenish grey, 5GY 4/1, rare carbonate gash veins, equigranular.	
86.65	88.20	1.55	1.55	100	Pyritic dolomite greenschist, cf 84.0-85.65. CBA 20°.	
88.20	88.80	0.60	0.60	100	Dolomite-magnesite rock, dark yellowish orange, 10YR 6/6 with very pale orange dolomite veins/replacement bodies with rough edges, concave irregular but sharp boundaries with greenschist. Greenschist inclusion at 88.60.	
88.80	93.20				Dolomitic greenschist, dark greenish grey, 5G 4/1 with dolomite in schistosity planes with dark yellowish orange 10YR 6/6 patina and minor tension veins.	
93.20	93.35	0.15	0.15	100	Magnesite rock, dark yellowish orange, 10YR 6/6, coarse grained, with tension veins with white dolomite centres	

516012

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
					at 93.20, leached, with vein quartz etching out.	
93.35	94.60				Dolomitic greenschist, light olive grey, 5Y 6/1, dolomite disseminated as well as in schistosity plane layering. Bedding possibly present as layers up to 1 cm. with differing textures. Ptygmatic magnesite at 99.80 (5 cm.).	
94.60	97.80				Dolomitic greenschist, dark greenish grey, 5G 4/1 dolomite in schistosity planes to 20%, also in rare tension veins at 96.4 - 96.5, possible bedding parallel schistosity. CSA 25°.	
97.80	98.15				Magnesite rock, greyish orange to pale yellowish orange, 10YR 8/6 seamed with light olive grey coarse magnesite with white dolomite, quartz at 97.80. Sharp but irregular contacts with greenschist.	
98.15	100.05	1.90	1.9	100	Dolomitic greenschist, at 94.6 to 97.8.	
100.05	100.90	0.85	0.85	100	Magnesite rock, pale orange, 10YR 8/4 seamed with light olive grey 5Y 6/1 coarse carbonate veins, magnesite with some white dolomite. Blurred boundaries due to recrystallisation.	

516013

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
100.90	101.60			Dolomitic greenschist, at 94.6 - 97.8 but lighter with talc. 100.90 - 101-00 and with pytgmatic quartz 101.40 and 101.60.	
101.60	103.40			Magnesite rock, pale orange 10YR 8/4, seamed with light olive grey coarse carbonate, 5Y 6/1, mixed dolomite and magnesite, medium grained, blurred boundaries, tension veins with white magnesite.	
103.40	103.90			Dolomitic greenschist, greenish grey, 5GY 5/1, carbonate in schistocity planes. From 103.5 - 103.57, 'bed' with disseminated carbonate. CBA 65°.	
103.90	104.30			Magnesite rock, mainly displaced by white vein magnesite. Magnesite rock 10% pale yellowish orange 10YR 8/1, talc schist. 2% in stylolites, irregular sharp boundary with greenschist.	
104.30	104.70			Talc schist, light olive gtey, 5Y 6/1, trace pyrite minor carbonate in schistocity.	
104.70	107.10			Dolomitic greenschist, 60%, greenish grey, 5GY 5/1, interbedded with feldspathic greenschist, 40% light olive grey, 5Y 6/1. beds 1cm - 5 cm. usual, up to 20 cm at 106.2. CBA 40°.	

216014

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %		GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
107.10	108.60				Amphibolite, dark greenish grey, 5G 4/1 minor calcite veins.	
108.60	110.80	2.20	2.0		Dolomitic to feldspathic. Greenschist, dark greenish grey, 5G 4/1 to light olive grey, 5Y 6/1.	
110.80	111.20	0.40			Talc schist 50%, light olive grey, 5Y 5/1 with abundant ptygmatic quartz bodies, 50%.	
11.20	111.50	0.30	0.30	100	Magnesite rock, pale yellowish orange, 10YR 8/6, medium grained, tension veins, with dolomite cores.	
111.50	117.30	5.5	5.8	100	Magnesite rock, greyish yellow, 5Y 8/4 pale orange, 10 YR 8/4, medium grained seamed with light olive grey coarse magnesite with blurred boundaries. Also tension veins with dolomite cores. Darker material more abundant (to 20% at 114.50 - 115.90).	
117.30	120.1	3.1	3.1	100	Magnesite rock, greyish yellow, 5Y 8/4 fine grained with annealed crack veins, light olive grey. 5Y 6/1, some medium grained.	
120.10	121.40	0.30	0.20	66	Talc schist, light olive grey, 5Y 6/1.	

B16015

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %		GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
120.40	121.10	0.70	0.70		Greenschist, minor dolomite, dark greenish grey 5G 4/1, dolomite in veins and schistosity.	
121.10	125.70	4.60	4.6	100	Amphibolite, greyish olive green, 5GY 3/2, CSA 60°, CBA at base 45%.	
125.70	128.00	2.30	2.3	100	Pyritic talc schist, light olive grey 5Y 5/2.	
128.00	129.00	1.00	1.0	100	Pyritic talc magnesite schist, olive grey, 5Y 3/2, magnesite in ptymatic segregations and along schistosity plane to 20%. Basal CBA 30°.	
129.00	134.60	5.60	5.60	100	Magnesite rock, very pale grey to pale yellowish orange 10YR 8/6 with annealed crack veins, light olive grey, 5Y 6/1 to 10% of the rock, medium to fine grained, tension veins with coarse carbonates, magnesite with white dolomite cores. Basal CBA 65°, base moderate orange pink 5YR 8/4.	
134.60	134.65	0.05	0.05	100	Talc schist, olive grey, 5Y 4/1 with ptymatic quartz and magnesite in schistosity planes.	
134.65	135.15	0.50	0.50	100	Dolomitic greenschist, dark greenish grey, 5/1.	

516016

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
135.15	136.40	1.25	1.25 100	Amphibolite, dark greenish grey, 5GY 4/1, grading to olive grey, 5Y 4/1 below 136.10.		
136.40	136.55	0.15		Talc schist, with magnesite to 10%, olive grey, 5Y 4/1 to pale yellow brown 10YR 6/2 magnesite as ptigmatic blobs and in schistosity planes.		
136.55	138.20	41.65		Magnesite rock, yellowish grey, 5Y 8/1, medium grained seamed with annealed crack veins, light olive grey 5Y 6/1 to 10% with blurred boundaries, rare tension veins with coarse magnesite, 156.45 - 156.55 and 157.00 - 157.30 pale yellowish orange 10YR 8/6, also 171.70 - 167.40 light brown, 5YR 5/6, leached rock with relict spongy quartz and limonite stain light brown 5YR 5/6 coarsley crystalline areas with dolomite, 164.8 - 165.05, 166.00 - 166.30.		
178.20	178.50	0.30	0.30	Talc schist, mainly olive grey 5Y 3/2 with white talc porphyroblast, 178.20 - 178.25 well bedded, greyish brown 5YR 3/2, CBA 65°, 178.40 - 178.50, greyish brown fissile.		
178.50	179.20	0.20	0.50	Magnesite rock, greyish orange 10YR 7/4 with solution cavity, 178.80 - 179.00.		

510017

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
179.20	174.35	0.15	0.15		Magnesite rock, greyish yellow, 5Y 8/4.	
129.35	179.50	0.15	0.15		Magnesite rock, very light grey with 5% stylolite veins of pyrite.	
179.50	180.40	0.90	0.60		Magnesite rock, greyish orange, 10YR 7/4 with solution cavity, 179.6 - 179.9 from 179.55 to 179.60 spongy quartz, dark yellowish orange, 10YR 6/6 to moderate brown, 5YR 3/4.	
180.40	182.00				Magnesite rock, yellowish grey, 5Y 7/2 and pale yellowish orange, 10YR 8/4, medium grained, some annealed crack veins, and tension veins. At 181.10 - 181.20 recrystallised with dolomite?	
182.00	182.80				Magnesite rock, pale yellowish orange, 10YR 8/6 with annealed crack veins and relatively abundant tension veins, with dolomite cores and magnesite borders.	
182.80	185.30				Magnesite rock, greyish yellow, 5Y 7/5, seamed with yellowish grey to olive grey recrystallised areas, 10-20%, 184.85 - 185.15. Two very large carbonate veins, mostly white dolomite.	

B16018

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
185.30	186.00			Magnesite-dolomite rock, light olive grey to olive grey, coarsley crystallised magnesite/dolomite with 10% relict greyish yellow magnesite rock.	
186.00	186.55			Magnesite rock, pale yellowish orange, 10YR 8/1, to light olive grey, 5Y 6/1, medium grained, with coarse carbonate.	
186.55	186.95			Magnesite-dolomite rock, cf 185.30 - 186.00.	
186.95	189.92			Magnesite rock, greyish yellow, 5Y 8/4, medium grained, seamed with medium light grey N6, annealed crackle veins, 5%, tension veins, (2 carbonates), and minor areas of coarsley crystallised dolomite magnesite rock.	
189.92	190.25			Talc schist, dark yellowish brown, 10YR 4/2, pyritic with white talc?, porphyroblasts, and ptigmatic quartz veins 189.92 - 189.98 with magnesite to 60%.	
190.25	190.30			Amphibolite, pale brown, 5YR 5/2 (with talc) grading to amphibolite dark greenish grey, 5GY 4/1 with porphyroblasts magnesite.	

216019

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
190.40	190.55			Greenschist and talc schist, dark greenish grey 5GY 4/1, and light brown, 5YR 5/2, ptymatic quartz veins, magnesite, 1cm. at base.	
				Amphibolite, greenish black, 5GY 2/1, with porphyroblasts magnesite.	
190.55	193.15			Amphibolite, dark greenish grey 5GY 4/1 minor carbonate veins.	
193.15	193.50			Greenschist, medium bluish grey, 5B 5/1, with minor quartz and carbonate.	
193.50	195.60			Amphibolite, dark greenish grey, with calcite and dolomite veins at 194.7 and 194.9, greenschist beds, 2 cm. CSA 25°, minor quartz.	
195.60	196.60			Greenschist, medium bluish grey, some carbonate in schistocity planes and veins, minor ptymatic quartz.	
190.60	203.1			Amphibolite, dark greenish grey, 5G 4/1, equigranular but schistose at boundaries, calcite veins.	
203.1	211.00			Greenschist, dark greenish grey, 5G 4/1, dolomitic	

210020

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
				with up to 10% dolomite in schistosity planes, calcite in gash veins and in minor dolomite/calcite veins. Accessory pyrite throughout, minor quartz veins, chlorite rich.		
211.00	211.60			Amphibolite, dark greenish grey, 5G 4/1, equigranular to slightly schistose.		
221.60	219.90			Greenschist, greenish grey, 5G 6/1 with minor calcite veins.		
219.90	228.10		100	Amphibolite, dark greenish grey, 5G 4/1, with calcite veins, mainly equigranular, but minor schistose with some calcite segregating in schistosity planes, 221.20 - 221.40, 223.30, 223.55, 223.70 - 223.80.		
228.10	236.80		100	Calcitic amphibolite, medium bluish grey, 5B 5/1, fine grained foliated but non fissile grades into equigranular amphibolite, calcite as porphyroblasts and lenticles in schistosity and in veins at 236.00. Large vein with dolomite and calcite. CSA 50°.		
236.80	237.35	0.55	0.35	Dolomitic greenschist, dolomite schistosity planes		

21002

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
				at 236.90 dark green mineral, probably chlorite, but possibly talc.	
237.35	237.50			Quartz with chlorite stylolites and dolomite - calcite veins.	
237.50	237.90			Talc rock, white, coarse grained, CSA 0-20°, basal, CBA 0-20°.	
237.90	238.50	0.60	0.50	Greenschist - talc schist, with ptigmatic quartz, dark greenish grey to light olive grey.	
238.50	238.90			Dolomite, very light grey N8, coarsley crystalline, seamed with light olive grey 5Y 5/1, annealed crackle veins with magnesite dolomite, some magnesite rock (5% of whole) greyish yellow, 5Y 8/4.	
238.90	241.25			Magnesite rock, pale yellowish orange, 10YR 8/6 seamed with medium grey to light olive grey annealed crack veins and replacement areas (mainly dolomite and white tension veins magnesite).	
241.25	241.30			Talc schist, light olive grey, 5Y 6/1.	

516022

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
241.30	241.70			Dolomitic greenschist, light olive grey, 5Y 6/2.	
241.70	243.90			Pyritic amphibolite, fine grained, light olive grey, 5Y 5/2 with dolomitic green schist, dark greenish grey, 5GY 4/1, with prominent contorted layers of dolomite with schist with dark yellowish orange 10YR 6/6, patina. CBA 0°-10°, increasing to 30° near base. Basal CBA 30°.	
243.90	244.00			Greenschist, fine grained, dark greenish grey, 5G 4/1, with quartz/dolomite vein.	
244.00	247.30			Amphibolite fine grained, slightly foliated grading to dolomitic greenschist, dark greenish grey, 5G 4/1, dolomite rich, 245.50 - 245.80.	
247.30	260.50			Amphibolite, fine grained, medium yellowish grey, 5G 5/1, to medium bluish grey, 5B 5/1, with calcite gash veins, some pyrite.	
260.50	262.40			Greenschist, fissile, pyrite, greenish grey, 5G 5/1, white material in parting planes along schistosity.	
262.40	265.90			Amphibolite, dark greenish grey, 5G 4/1, medium	

516023

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
				grained, equigranular to slightly foliated, with calcite veins.	
265.70	266.70			Greenschist, fine grained greenish grey, 5G 5/1, ptygmatic quartz at base.	
266.70	267.20			Magnesite rock, medium grained, pale yellowish orange, 10YR 8/6 with coarse dolomite rock and white vein magnesite, Basal, CBA 10°.	
267.20	267.30			Greenschist, fusile, dark greenish grey.	
267.30	273.11			Amphibolite, dark greenish grey, 5G 4/1 with calcite veins, medium grained, equigranular to slightly schistose.	
273.10	273.70			Amphibolite, fine grained, medium bluish grey with calcite white vein.	
273.70	273.90	0.20	0.15	Talc schist, light olive grey, 5Y 5/2, with ptygmatic quartz.	
273.90	283.30			Magnesite rock, greyish yellow, 10YR 8/4 fine grained seamed with medium light grey, medium grained areas	

510024

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
				with blurred boundaries - (developed from crackle veins) containing dolomite, veins of very coarse carbonate-dolomite white, magnesite, pinkish grey, 5YR 8/1 274.40-274.50, 275.60 - 275.70, 276.10 - 276.80, 276.90 - 277.30, 277.60 - 277.70, 278.50 - 278.75, 279.10 - 274.70, at 280.40, 280.60, 281.00 - 281.10, 283.25 - 283.30, grey areas 70%, 282.3 - 282.4 elsewhere 5%.	
283.30	291.30			Magnesite rock, very light grey N8 seamed with medium to coarse grained medium light grey N6, dolomitic recrystallised crack veins with blurred boundaries, 287.25 - 287.45, rest coarse magnesite /dolomite veins, very large, 287.70 - 288.30.	
291.30	298.25			Magnesite rock, 10YR 8/4 greyish yellow, fine grained, seamed with medium-coarse grained recrystallised crackle veins to 20%, coarse dolomite, magnesite veins.	
298.25	298.70	0.45	0.35	Talc schist, greenish grey, 5GY 6/1, CSA 50°.	
298.70	800.10			Dolomitic greenschist, dark greenish grey, 5G 4/1, speckled with porphyroblastic dolomite 2.4 mm. up to	

B16025

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
					60° in bands 0.5-3.0 c.m. dolomite crystals develop pale yellowish orange, 10YR 8/6 patina. Minor carbonate veins.	
300.10	301.40	1.30	1.10		Greenschist, dark greenish grey, 5G 4/1, with minor pygmatic quartz.	
301.40	301.80	0.40	0.40		Dolomitic greenschist, cf 298.7 - 300.10.	
301.80	302.30	0.50	0.40		Greenschist, dark greenish grey 5G 4/1.	
302.30	303.40				Dolomitic greenschist, cf 298.7-300.1 bedding displaced by fault, 302.50 - 302.57 CBA 35°.	
303.40	305.80	2.40	2.10		Greenschist, medium greenish grey, 5G 5/1, with dolomitic greenschist, 304.20 - 305.10, minor carbonate veins.	
305.80	307.55	1.75	1.55		Talc schist, light olive grey, 5Y 5/2 to greyish olive 10Y 5/2.	
307.55	310.70	3.15	3.15		Magnesite rock, greyish yellow, 5Y 8/4, fine grained seamed with medium light grey N6, medium grained areas	

210026

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
					with blurred crack vein boundaries, including some dolomite. Approx. 40% interval.	
310.70	311.30	.60	.60		Amphibolite dark greenish grey, 5G 4/L, with porphyroblasts of dolomite to 2 mm and magnetite to 0.2 mm.	
311.30	313.00	1.70	1.70		Talc schist, light to olive grey, 5G 6/1, with minor fine grained dolomitic greenschist, 312.2 - 312.3.	
313.00	314.30	1.30	1.30		Magnesite rock, pale yellow, 5Y 8/2, with minor seams of medium light grey, N6.	
314.30	325.20	10.90	10.90	100	Magnesite rock, very light grey, N8, grading to pale yellow, 5Y 9/2, fine grained and seamed with medium grained, medium light grey, recrystallised crackle veins, with traces of dolomite.	
325.20	326.20	1.00	0.85	85	Dolomite magnesite rock, very light grey, medium to coarse dolomite rick areas, fine to medium grained greyish orange, 10YR 7/4 areas at 325.8 and 326.00. Core loss at base only.	

516027

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
326.20	331.40				Amphibolite, dark greenish grey, 5G 4/1, equigranular with calcite veins and porphyroblasts, also magnetite porphyroblasts, medium to coarse grained, also minor foliated fine grained amphibolite (or greenschist)	
					326.20 - 326.35 and 326.95 - 327.10. CSA 40°.	
331.40	336.40	5.00	4.80		Amphibolite, dark greenish grey, 5G 4/1, fine to medium grained with calcite and magnesite porphyroblasts, equigranular, with amphibolite, dark greenish grey, foliated, relatively low in calcite. 331.40 - 331.65, 332.10 - 332.20, 332.95 - 333.00, 333.15 - 333.20, 333.45 - 333.75, 334.15 - 334.40, 334.70 - 335.30, 335.50 - 335.55, 335.75 - 335.90, 336.00 - 336.65.	
336.40	337.00	0.60	0.40	66	Calcitic amphibolite, banded, with calcite in schistosity planes dark greenish grey 5G - 4/1.	
337.00	339.50	2.50	2.30		Amphibolite, dark greenish grey 5G - 4/1 slightly foliated with magnetite and minor calcite porphyroblasts with calcitic amphibolite cf 336.40 - 337.00, 337.15, 337.40 - 337.50, 337.90 - 338.00 (with pygmatic quartz) and equigranular amphibolite 337.00 - 337.15, 337.17 - 337.40.	

510028

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %		GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
339.50	341.30	1.80	1.65		Sandstone dark greenish grey 5G - 4/1 leach voids with fine grained amphibolite with magnetite porphyroblasts.	
341.30	343.20	1.90	1.70		Calcitic greenschist, dark greenish grey 5G - 4/1 calcite segregated in schistosity planes, with pyritic chlorite phyllite with pygmatic granite and dolomite 341.80, 342.10 - 342.65	
343.20	343.70	0.50	0.50	100	Amphibolite, fine grained, equigranular, calcite veins, magnetite, dark greenish grey, 5G 4/1.	
343.70	345.70	2.00	2.0	100	Calcitic greenschist, cf 341.30 - 343.20. CBA 60°.	
345.70	347.50	1.80	1.20		Chlorite phyllite, with magnetite, calcite greenschist, dusky yellowish, brown, 10YR 2/2 and calcitic greenschist magnetite rich beds, 100% of 345.80 - 346.10, 345.20 - 346.35 (with trace chalcopryrite) 346.60 - 346.70.	

516029

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
347.50	348.95	1.45	1.45	Chlorite phyllite, with sandstone graded units to 2 cm. fusing (some doubts up hole). Thicker isolated units, medium light grey intervals of thin units, e.g. 348.00 - 348.10, 348.40 - 348.50, light brownish grey, 5YR 6/1, to brownish black 5YR 2/1. CBA 70°.		
384.95	351.40	3.45	2.65	Calcitic greenschist, with minor chlorite phyllite with pygmatic quartz, and minor magnetite-calcite greenschist.		
351.40	353.00	1.60	1.55	Pyritic greenschist, dark greenish grey, 5G 4/1, with fine grained magnetite amphibolite, pyrite in clots of fine grained pyrite up to 2 mm, amphibolite greenish grey 5G 6/1, with euhedral magnetite porphyroblasts and minor pyrite. 352.15 - 352.50, 352.65 - 353.00.		
353.00	353.35	0.35	0.35	Chlorite schist, brecciated, pyritic, greenish grey, 5G 5/1 with siltstone, dark reddish brown, 10R 3/4 at 253.12 and 253.20 - 253.22.		
353.35	358.10	4.75	4.65	Magnetite fine grained greenish grey, 5G 6/1, with 0.2 mm euhedral magnetite porphyroblasts, massive to slightly foliated with pyritic greenschist, medium greenish grey, 5G 5/1, with pyritic aggregates to 2 mm.		

516030

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR			DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M	%	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
					354.60-355.10, 357.115 - 357.25, and calcitic greenschist, 357.50 - 357.60.	
358.10	360.30	2.20	1,85		Calcitic greenschist grading to dolomitic greenschist, with carbonates segregated in schistosity planes, with pyritic greenschists, 358.15 - 358.35, 359.4 - 359.8, 359.90 - 359.95 and with fine grained magnetite amphibolite, 359.10 - 359.25, CSA 70°.	
360.30	361.85	1.55	1.30		Dolomitic greenschist, dolomite rich with some calcite dark greenish grey, 5GY 4/1, with dolomite breccia, with magnetite pyrite, magnesite, quartz, chlorite, with greyish orange, 10YR 7/4 patina, 360.30 - 360.37, 360.42 - 360.44, at 360.62, 360.78 - 360.80, 360.80 - 360.93, (start core loss at 361.30, 361.50 - 361.54, 361.75 - 361.80).	
361.85	362.90	1.15	1.15		Magnetite bearing dolomite breccia, greyish orange, 10YR 7/4 patina, with magnetite (chlorite, quartz and pyrite, large pyrite clots 361.88 - 361.91).	
362.90	362.92	0.02	0.02	100	Magnetite-dolomite-pyrite rock, dusky yellowish brown, 10YR 2/2, with dolomite greyish orange, 10YR 7/4, thin layers of each mineral.	

210031

APPENDIX 2

DRILL CORE DESCRIPTION DRILL HOLE

MC28

LOCATION 4677 9965 RL 200M.

DRILLED FOR I.M.I. PTY LTD.

DRILLED BY OVERLAND DRILLING

DATE

FROM	TO	INTERVAL	RECOVERY		GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
			M	%		
0	16.00	16.00			None core drilling	
16.00	26.20	10.20	1.70		Greenschist, weathered light olive grey, 5Y 5/2, core broken. CSA 25°.	
26.20	40.30				Quartz, white N9 coarsley crystalline, some leach voids with gritty sandy clay, light brown, 5YR 5/6. (.5 cm of this material is preserved, but it is probably representative of most of the lost core).	
40.30	41.10	0.80	0.80		Porous silt, semi consolidated, moderate brown 5YR 4/4 to 5YR 3/4, interpreted as illuvial replacement/leaching residue of magnesite rock.	
41.10	46.30	5.20	0.20		Quartz, abundant leach voids, interpreted as veins from leached magnesite rock.	
46.30	47.00	0.70	0.70		a) Sandy chert, brecciated, medium grey N5 to yellowish grey, 5Y 7/2 with traces of b) spongy quartz, dark yellowish orange, 10YR 5/5, interpreted as a).	
					Siliceous replacement of magnesite rock and b) partially replaced magnesite rock with subsequent leaching.	

516034

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
47.00	50.20	3.20	3.20		Finely laminated medium dark grey (N4) "chert?" with numerous 1-2 mm wide carbonate veinlets and remnant, ghost sand grains.	
50.20	50.80	0.60	0.40		Core loss, rubble retained consists of vein quartz and chlorite phyllite.	
50.80	51.30	0.50	0.40		Medium bluish grey (5B 5/1), chloritic phyllite, numerous leach voids suggesting carbonate filled fractures 10cm. core loss at 51.20.	
51.30	52.00	0.70	0.70		Magnesite rock, finely crystalline, very light grey, (N8) with a 20 cm. basal band of moderate yellowish brown (10Yr 5/4) talc.	
52.00	52.60	0.60	0.60		Extensive core loss, rubble retained - sponge quartz laminated chert and chlorite phyllite.	
52.60	60.20	7.60	7.60		Magnesite rock, consisting of large white (N9) "clots" of cryptocrystalline magnesite, set in a light grey (N8 to N7) matrix of finely crystalline, more "granular" magnesite, sporadic infilling of tension veins by coarse carbonate (i.e. 55.40 m.). From	

516035

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
					58.50 to 59.30 the finer, grey carbonate predominates however, the few magnesite "clasts" present have now become pale yellowish orange (10 YR 5/6) and the grainsize of these clasts is coarse.	
60.20	60.60	0.40	0.40		Olive grey (5Y 4/1) talcose, chloritic schist.	
60.60	66.45	5.85			Magnesite rock, cryptocrystalline pale yellowish orange (10 YR 8/6) magnesite "clasts" set in light grey (N8) fine to medium crystalline magnesite.	
66.45	66.70	0.25	0.25		Brownish grey (5YR 4/1) talc enclosing small pale yellowish orange magnesite "clasts". Pyrite present 1-2%.	
66.70	69.50	2.80	2.80		Magnesite rock - Ibid 60.6 to 66.4, towards the bottom of this interval the magnesite verges on a talc magnesite schist. A 5cm. band of talc/chlorite green-schist with quartz at 68.20 m.	
69.50	70.60	1.10	1.10		Chloritic talc rich phyllite, dark greenish grey (5GY 4/1) CBA 45°.	

510030

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE	
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS		ASSAY REFERENCE
70.60	84.40	13.80	13.80	Magnesite rock, yellowish orange "clasts" are no longer evident. This interval is composed of finely crystalline, white (N9) magnesite and the more "granular", very light grey magnesite in equal proportions.		
84.40	89.90	5.40	5.20	Magnesite rocks, absence of brilliant white magnesite and a return to pale yellowish orange (10YR 8/6) clasts within the light to medium light grey magnesite talcose in part (89.10 - 89.40).		
89.90	93.40	3.50	3.50	Dolomitic greenschist, dark greenish grey (5Y 4/). Metamorphic segregation of dolomite into the schistosity planes CSA 40°. Dolomitic gash and tension veins are present at varying angles to the schistosity. Pyrite is disseminated approx. 5%.		
93.40	97.00	3.60	3.60	A gradational boundary exists between the dolomitic greenschist and this interval of magnesite. From 93.40 to 96.40 a cosmopolitan assemblage of very pale grey (N8) to grayish orange (10YR 7/4) magnesite, with numerous blotches of pure white (N9) magnesite, forming 20% of this interval. Dark yellowish brown (10YR 4/2) talc bands are present, i.e. 94.10-94.50.		

216037

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
				The remainder of the interval is composed of fine to medium crystalline, medium grey (N5) magnesite with minor pyrite (Less than 1%).	
97.00	100.70			Dolomitic greenschist, dark greenish grey (5Y 9/1) with quartz segregations. Pyrite is found infilling small hairline fractures.	
100.70	103.00			Magnesite rock, light bluish grey (5B 7/1), finely crystalline magnesite, with very light grey (N8) magnesite blotches, which have weathered to pale yellowish orange (10 YR 8/6) at the base of this interval. At 102.30 there is a 10 cm. wide assemblage of quartz, magnesite or dolomite (?) with abundant pyrite present around the boundaries of these minerals.	
103.00	103.50			Dolomitic greenschist cf 89.90 - 93.40.	
103.50	109.7	6.20		Magnesite rock, light bluish grey (5B 7/1) to medium grey (N5) magnesite forming the "matrix" with larger clasts of pale yellowish orange magnesite. Tension veins have been infilled with light olive grey (5Y 6/1) coarse carbonate, and minor gash veins filled with pure white (N8) magnesite).	BQ CORE

510038

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
109.70	111.90	2.20		Dolomitic greenschist, dark greenish grey (5G 4/1) with a few 2 mm wide calcitic bands defining the schistosity.	
111.90	114.10	2.20		Magnesite rocks, finely to moderately crystalline, white (N8) to very pale grey (N8). Towards the base of this interval, the rock is composed of greyish orange "matrix" with pure white (N9) blotches and veinlets of magnesite.	
114.10	114.30			Core loss rubble retained composed of greyish orange magnesite (10 m 7/4) and a 3 cm band of talc rich white clay. Greenschist caving is present.	
114.30	114.70			Magnesite return to greyish orange and pure white magnesite.	
114.70	115.20			Dolomitic greenschist - cf 89.90 - 93.40.	
115.20	116.00			Extensive core loss. Core retained - magnesite rock, moderate yellowish brown (10YR 5/4) blotches sitting on a light bluish grey (5B 1/1) finely crystalline magnesite. - magnesite breccia, a small 10 cm. band	

510039

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
				composed of angular pieces of moderate yellowish brown magnesite, set in a matrix of recrystalline coarse carbonate (considered magnesite).	
116.00	120.30			Magnesite rock, consisting of large white (N9) "clasts" of cryptocrystalline magnesite set in a light grey (N8 to N7) matrix of finely crystalline "coarser" magnesite.	
120.30	133.3			Dark greenish grey (5G 4/1) to medium bluish grey (5B 5/1) dolomitic greenschist. Dolomite present as discrete vein as well as in the metamorphic layering. Pyrite is both dessimated and found along the schistosity planes from 123.00 - 123.6 fine to medium crystalline magnesite rock, light grey (N7) to pale yellowish orange (10YR 8/6)	
133.3	135.90			Magnesite rock, fine to medium crystalline dark to moderate yellowish brown (10 YR 5/4) with blotches of finely crystalline white (N9) magnesite, gash veins filled with white to clear, coarse carbonate are present.	
135.40	137.80			Dolomitic greenschist, Ibid 120.30-133.30 CBA 45°.	

510040

DRILL CORE DESCRIPTION DRILL HOLE

LOCATION		DRILLED FOR		DRILLED BY	DATE
FROM	TO	INTERVAL	RECOVERY M %	GEOLOGICAL DESCRIPTION & REMARKS	ASSAY REFERENCE
137.80	168.80			<p>Magnesite rock - composition varies rapidly between</p> <p>a) fine to medium, yellowish brown (10YR 5/4) with blotches of fine crystalline, white (N9) magnesite</p> <p>b) finely crystalline, pale yellowish orange (10YR 5/4) magnesite, set in a relatively "coarser" light bluish grey (5B 7/1) magnesite. Gash and tension veins infilled with coarse carbonate (magnesite). A 1.00 m. pyritic greenschist interval exists at 160.00 - 161.00.</p> <p>The remaining 6.7 m. of this interval includes a 6 m. cavity.</p>	
168.80	178.10			<p>Substantial core loss due to fracturing of core.</p> <p>Grayish green phyllite with leach voids along the foliation planes suggestive of dolomite. Notable absence of pyrite (very much less than 1%). Some magnesite cavings present.</p>	
178.10	178.40			<p>Magnesite rock, moderate to coarsely crystalline, light bluish grey magnesite.</p>	
				- END -	

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APPENDIX 3

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APPENDIX 3

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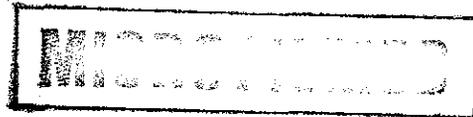
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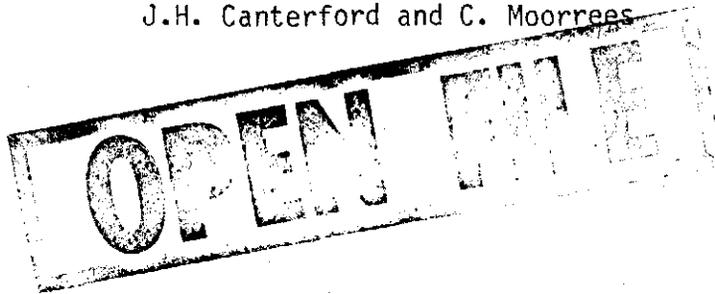
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PRODUCTION OF MAGNESIA FROM SAVAGE RIVER MAGNESITE

Progress Report No. 10: October 1982-June 1983

J.H. Canterford and C. Moorrees



July 1983

Mineral Chemistry Communication

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PRODUCTION OF MAGNESIA FROM SAVAGE RIVER MAGNESITE
PROGRESS REPORT NO. 10: OCTOBER 1982-JUNE 1983

SUMMARY

This report gives details of a range of tests designed to (i) establish reproducibility, and (ii) minimize iron dissolution. With respect to the former, it has been established that a good standard of reproducibility can be achieved so that data obtained in the present study can be used for cost estimation and pilot plant design purposes.

With respect to the minimization of iron dissolution tests, no conditions have been found that will give zero iron in the pregnant leach liquor. However, the iron concentration can be reduced to a low level by leaching at 45°C, less than 2% solids pulp density, and an extended leaching time (about 1-2 h). As a guide to the Fe_2O_3 content of the final magnesia product, a liquor containing 0.0006 g/l Fe per 1.0 g/l Mg will give a product containing 0.05% Fe_2O_3 . From the resultant liquors it is possible to recover at least part of the dissolved magnesium as a final product with a very low iron content (<0.02% Fe_2O_3).

On the basis of information received from magnesia producers it is evident that purity and hence market price is governed more by the B_2O_3 content and the CaO/SiO_2 ratio than by the Fe_2O_3 content. If the B_2O_3 content and the CaO/SiO_2 ratio of magnesia produced from Savage River magnesite can be kept below 0.005% and greater than 2.0, respectively, then it is probable that the iron content can be as high as 0.2% Fe_2O_3 . Analytical data obtained so far indicate that the above B_2O_3 content can be bettered.

INTRODUCTION

As outlined in our previous report [1], the CSIRO Division of Mineral Chemistry has been investigating many aspects of the production

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of high-purity magnesia from the Savage River magnesite deposit via the calcination/carbon dioxide leach process. During technical discussions with officers of Industrial and Mining Investigations Pty Ltd (IMI), it was made clear that development of the Savage River deposit would be on a Joint Venture basis. In order for IMI to enter into Joint Venture discussions with appropriate companies, IMI would need to be able to present data obtained on the laboratory scale that would satisfy potential partners with respect to reproducibility and product grade. For the latter, IMI, on the basis of discussions with the magnesia producers and potential customers, took the position that the product should contain less than 0.05% Fe_2O_3 . At IMI's request, proposed technical-scale studies and the generation of a reactivity index based upon the examination of other bulk samples were held over and efforts directed towards provision of reproducibility data and elucidation of leaching or calcination plus leaching conditions that gave a magnesia product containing less than 0.05% Fe_2O_3 . The results of this phase of our study are presented in this report.

REPRODUCIBILITY DATA

The feed for these tests was taken from a batch of bulk calcine prepared from drill core magnesite [2-4]. About 80% of the bulk calcine was produced in the rotary kiln [2], with the remaining 20% being produced on a batch basis in a laboratory muffle furnace [3]. All calcine was blended, screened and re-blended [3,4]. Because of difficulties experienced with the rotary kiln, it was considered that the bulk calcine was in fact under-calcined. This was confirmed by X-ray diffraction analysis of the final product, which showed the presence of undecomposed magnesite. Despite this, it was considered that the bulk calcine would be suitable for reproducibility tests.

For these tests, a drum of bulk calcine was coned and quartered, and split (by riffing) into 15 lots. Grab samples from 12 lots were used for leach tests, with a thirteenth grab sample used for chemical and mineralogical characterization. Two sets of leaching conditions were used:

Series I : 2% solids, 0.5 h slake, 45°C, 100 psig CO₂, 900 rpm

Series II: 2% solids, 0.5 h slake, 45°C, 100 psig CO₂, 1200 rpm

Samples of leach slurry for chemical analysis were recovered after 0.25, 0.5 and 1.0 h from the commencement of leaching. After collection of the 1.0 h samples, the carbon dioxide pressure was released and the remaining slurry collected. After liquid-solid separation by vacuum filtration (no washing), the mother liquors (~900 ml) were boiled for 1 h. The precipitates were collected by vacuum filtration, washed with 3 bed volumes of cold distilled water, air-dried at room temperature for 2 days and then at 105°C for 24 h. These products were then chemically analysed.

The results of the leaching tests are given in Table 1. Also included are the % Mg and % Fe extraction data for the 1 h samples, the data being based upon a calcine composition of 61.22% MgO and 3.85% Fe₂O₃. The following points are to be noted.

- Maximum magnesium extraction is achieved at 1200 rpm in less than 0.5 h, whereas at 900 rpm reaction is not complete after 1 h. This observation is consistent with previously reported kinetic data [5] and is related to the rate of transfer of carbon dioxide from the gaseous to the liquid phase, and the contact between dissolved carbon dioxide and the solid calcine particles.
- At the higher agitation rate, the iron concentration of the leachate decreases with increasing leaching time. As previously reported [6], this only occurs at low pulp densities and elevated leaching temperatures.
- Reproducibility of magnesium extraction is better for the Series II tests than for the Series I tests, consistent with the fact that the for latter dissolution of the magnesium oxide component of the calcine is not complete.
- For the Series II tests, the average magnesium extraction is $74.6 \pm 1.2\%$. This is consistent with previously reported data [3] on magnesium extraction as a function of calcine MgO content.
- Reproducibility of leach liquor iron concentrations is excellent for all twelve tests.

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In summary, although the feed and leaching conditions may not have been optimum, reproducibility with respect to magnesium and iron dissolution, at least on the batch-laboratory scale, can be readily achieved.*

Analytical data of the precipitates (intermediate products) derived from clarified leach liquors, and shown by X-ray diffraction analysis to be predominantly hydromagnesite, together with the calculated data for MgO produced by calcination of the precipitates, are given in Table 2. It can be seen that the final products all contain greater than 99% MgO and, with the exception of two samples, contain less than 0.1% Fe₂O₃. It is considered that the data presented in Tables 1 and 2 clearly indicate that reproducibility of an acceptable level, and products containing <0.1% Fe₂O₃ can be achieved using the calcination/carbon dioxide leach process.†

MINIMIZATION OF IRON DISSOLUTION

In order to meet IMI's requirements with respect to the maximum Fe₂O₃ content, the clarified leach liquor must contain no more than 0.0006 g/l iron per 1.0 g/l magnesium. An alternative measure is that the [Fe×100/Mg] concentration ratio should be less than 0.06. For convenience in the following discussion, the iron concentration data (rounded to the nearest 0.0001 g/l) below can be used to give an immediate first order indication of the final product (magnesia) Fe₂O₃ content.

*As has been indicated above, evidence was obtained for BC2 being under-calcined. It was decided that it would be advisable to carry out several reproducibility checks with a more reactive calcine. The latter was prepared by re-calcining BC2 for 3 h. Four sample of this calcine were leached under the following conditions: 2% solids, 0.5 h slake, 45.0°C, 100 psig CO₂ and 1200 rpm. The resultant leach liquors contained 8.10 ± 0.10 g/l magnesium and 0.009 ± 0.002 g/l iron, indicating good reproducibility of leaching behaviour of a more reactive calcine.

†This Fe₂O₃ content applies strictly only to the BC2 calcines. It will be demonstrated later in this report that more reactive calcines, producing higher magnesium concentrations in the leach liquor will have somewhat higher Fe₂O₃ contents.

Liquor Mg content (g/l)	Liquor Fe content (g/l) for product containing x% Fe ₂ O ₃			
	x = 0.01	x = 0.05	x = 0.10	x = 0.20
1.0	0.0001	0.0006	0.0012	0.0024
2.0	0.0002	0.0012	0.0024	0.0048
3.0	0.0004	0.0018	0.0036	0.0072
4.0	0.0005	0.0024	0.0048	0.0096
5.0	0.0006	0.0030	0.0060	0.0120
6.0	0.0007	0.0036	0.0072	0.0144
7.0	0.0008	0.0042	0.0084	0.0168
8.0	0.0010	0.0048	0.0096	0.0192
9.0	0.0011	0.0054	0.0104	0.0208
10.0	0.0012	0.0060	0.0120	0.0240

GROUP A TESTS

These tests were designed to establish iron levels in the intermediate precipitate and final magnesia products derived from clarified leach liquors produced from a series of calcines. The calcines themselves were derived from four different batches of magnesite ore, covering the widest possible ranges of magnesite to dolomite ratio in the feed, and degree of calcination. The details of the magnesite feeds are given in Table 3.

Each calcine was leached under 3 sets of conditions:

	A	B	C
Pulp density (% solids)	2.0	2.0	2.0
Temperature (°C)	40.0	45.0	45.0
Slake time (h)	0.5	0.5	0.5
CO ₂ pressure (psig)	100	100	100
Agitation (rpm)	1200	1200	900

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Each slurry was sampled 0.25, 0.50 and 1.00 h after the commencement of leaching. At the completion of each test (1 h leach), the carbon dioxide pressure was released, the slurry recovered and filtered immediately without washing. After clarification, each liquor was allowed to stand at room temperature for several days before being heated at $70 \pm 5^\circ\text{C}$ for 1 h to precipitate a mixture of nesquehonite and hydromagnesite. The precipitates were collected by vacuum filtration (no washing) and dried at 110°C for 1 h. These precipitates are termed the Series I intermediate precipitates. The mother liquors were then allowed to stand for 2 weeks and then boiled for 1 h. The precipitates were noticeably "whiter" than the first precipitates after drying at 110°C for 1 h - these are the Series II intermediate products. Samples of all Series I and Series II intermediate products were dissolved in dilute hydrochloric acid for determination of the MgO and Fe_2O_3 contents. About half of the remaining sample was retained for reference, the remainder being calcined at 1000°C in a muffle furnace to determine the weight loss on ignition. Samples of the final product, magnesia, were analysed for their MgO and Fe_2O_3 contents. Boron, calcium and silica contents of selected final products were also determined.

Details of the leaching tests are not presented here since they were consistent with previously reported observations. In summary, however, the following points were observed.

- Maximum magnesium dissolution had been achieved when using an agitation rate of 1200 rpm, whereas at 900 rpm reaction was still proceeding.
- If the magnesium concentration of the slurry was relatively low (≤ 4 g/l), the iron concentration increased and then remained constant throughout the 1 h leaching period. For a higher magnesium concentration, the iron concentration either passed through a maximum and then decreased, or decreased as leaching proceeded. Thus, although maximum magnesium dissolution could be achieved in a short time (< 0.5 h), it was advantageous to maintain the slurry under the prevailing conditions to reduce the iron concentration to a more acceptable level.

Analytical data for the leach liquors after 1 h, and for the Series I, Series II and composite intermediate (precipitate) and final (MgO) products are given in Tables 4-17. Also included are the actual weights

of MgO recovered, the percent MgO recovered,* and the percentage of the product that has a Fe₂O₃ content <0.05%.†

The following conclusions can be drawn from the data given in Tables 4-17.

- As expected, the magnesium and iron concentrations of the leach liquors vary considerably according to the composition of the original feed and the calcination conditions. As a general rule, the higher the magnesium concentration, the higher the iron concentration. The relationship between the magnesium and iron concentrations is discussed more fully later in this report. Under no conditions, however, was it possible to produce a leach liquor that contained no soluble iron.**
- Variation of leaching conditions had little effect on magnesium dissolution kinetics of calcines derived from high-dolomite ore (MAG1) or from calcines considered to be under-calcined (BM/600/3, BM/700/1). For the remaining calcines, use of a lower agitation rate led to a decrease in dissolution kinetics. This is consistent with the observations reported in the previous section on reproducibility.
- The bulk of the magnesium and iron is precipitated from clarified leach liquors as the Series I intermediate products. These products have lower magnesium and higher iron contents than do the corresponding Series II products. This is consistent with previously reported precipitation data [5].

*This is based upon the assumption that the intermediate product was precipitated from 900 ml clarified magnesium bicarbonate leach liquor.

†This percentage is based on the weights of Series I and/or Series II final products with Fe₂O₃ <0.05%. A different percentage could result if precipitation conditions were altered to give different weights of Series I and Series II intermediate products.

**With respect to runs 19 and 127 (equivalent to 153) reported previously [6,7], it is now concluded that the calcines and/or leaching conditions used were not responsible for the zero iron result. Rather, it is now concluded that analytical error led to the erroneous result.

- For all calcines and leaching conditions, the Series II final products all contain Fe_2O_3 contents in the range 0.007-0.022%, thus meeting IMI's target of a Fe_2O_3 content less than 0.05%. These Series II products constitute between about 10 and 45% of the total product. For calcines derived from high-dolomite ore (MAG1), the Series I products have Fe_2O_3 contents in the range 0.052-0.080% so that all but one of the composite final products have Fe_2O_3 contents less than 0.05%.
- As a general rule, there is good agreement between the measured Fe_2O_3 content in the final MgO product and that expected on the basis of the iron and magnesium contents of the clarified leach liquors - see p. 5 for approximate correlation data.
- By alteration of the precipitation conditions it may be possible to reduce the amount of magnesium precipitated as the high-iron Series I precipitate, thereby increasing the amount of product produced having a Fe_2O_3 content $<0.05\%$.
- Analysis of the filtrates from the Series II precipitations gave magnesium contents less than 0.05 g/l, indicating $>95\%$ precipitation of the magnesium content of the leach liquors. Consistent with this is the observation that the weight of MgO recovered from the original clarified leach liquor, assumed to be 900 ml, falls in the range 90-110%.*

GROUP B TESTS

It has previously been established that over calcination leads to a significant reduction in the rate of leaching [5,7] whereas an increase in leaching temperature results in an increase in magnesium dissolution kinetics [6]. More importantly, however, the actual amount of iron dissolved decreases with increasing leaching temperature. The following tests were designed to determine if iron dissolution could be minimized by a combination of a high calcination temperature and a high leaching temperature. The calcines used in these tests were prepared from the

*Because of a misunderstanding, actual filtrate volumes, although measured to fall in the range 850-960 ml, were not ascribed to a particular leach test.

bulk sample BC2 by re-calcination under specified conditions on a batch basis in a muffle furnace. Each calcine was characterized chemically and mineralogically, and with only one or two exceptions, were leached at 15.5 and 45.0°C at 2% solids, 0.5 h slake, 100 psig carbon dioxide, and 1200 rpm. The analytical data of the calcines and the leach results are given in Tables 18 and 19, respectively.

The data presented in Tables 18 and 19 confirm previously reported effects of calcination conditions and leaching temperature on magnesium and iron dissolution kinetics. More importantly, however, they show that advantage cannot be taken of the interaction of the variables to reduce the dissolved iron content of the leach liquor below the required maximum value.

GROUP C TESTS

It has previously [6] been clearly demonstrated that a reduction in the slurry pulp density leads to an appreciable reduction in the iron content of the leach liquor. In other words, the $[\text{Fe} \times 100 / \text{Mg}]$ concentration ratios decrease as the pulp density decreases. For example, using MAG3/700/3 at 35°C, the iron concentrations after a 1 h leach period for 4, 3 and 2% solids are 0.020, 0.011 and 0.008 g/l, respectively. The corresponding $[\text{Fe} \times 100 / \text{Mg}]$ concentration ratios are 0.212, 0.141 and 0.130, respectively.

As none of the Group B tests at 2% solids gave iron concentrations below the maximum acceptable level, it was decided to investigate how far the pulp density would have to be lowered in order to obtain this result. For these tests the BC2/700/5 calcine was chosen since this had an acceptable dissolution rate and an acceptable maximum magnesium dissolution yield. The results are summarized in Table 20. These show that for the particular calcine and set of leaching conditions, reduction of the pulp density to 1.6% solids will yield a leach liquor from which magnesium oxide of the desired purity can be produced. The commercial viability of operating at such a low pulp density will have to be established.

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GROUP D TESTS

At the suggestion of Mr F.R. Beggs of IMI, a series of tests was undertaken in which the impeller speed was varied. For these tests, the results of which are given in Table 21, three different calcines (all derived from BC2) were leached at 2% solids, 0.5 h slake, 30.0°C and 100 psig carbon dioxide. The results confirm previously reported observations [5] that at low agitation rates the ratio of magnesium dissolution is substantially reduced. In addition, the data indicate that it is not possible to markedly reduce the iron concentration of the leach liquor to a level that would produce a final product containing less than 0.05% Fe₂O₃.

GROUP E TESTS

In order to be confident that conditions under which iron dissolution was apparently "zero" had not been overlooked in the tests reported above, several additional leaches were carried out using different calcines, carbon dioxide pressures, pulp densities, agitation rates and temperatures. The results of these tests are given in Table 22.

The results presented are consistent with previously reported observations with respect to the effects of leaching variables on the magnesium and iron concentrations as a function of leaching time. The only previously unreported observation is that at high temperatures (45°C) and low carbon dioxide pressures (25-50 psig) the magnesium concentrations pass through a maximum, indicating precipitation of an insoluble basic magnesium carbonate.

GENERAL COMMENTS

All the above data indicate that there is a complex relationship between the iron and magnesium concentrations of the leach liquors and that no conditions (ore type, calcination conditions, leaching conditions) have been found that will give zero iron dissolution. As noted previously, it is now concluded that the results of Tests 19 and 127 (equal to 153) reported previously [6,7] are in error.

The relationship between iron and magnesium concentrations is dependent upon the leaching conditions but, as can be seen from Fig. 1, iron concentration increases as the magnesium concentration increases. This is consistent with

- previously reported results (see, for example, Fig. 2 in Ref. 3), and
- the observation that leaching fresh calcine with a magnesium-containing leachate results in increased iron dissolution (see Table 9 in Ref. 5).

Leaching temperature has the greatest effect on iron concentration, as is shown by the data in Fig. 2. The relationship between iron and magnesium concentration as a function of leaching conditions is complicated by the facts that under certain conditions the solubility of magnesium bicarbonate is exceeded, thereby giving artificially low magnesium concentrations, and that the iron concentration decreases with increasing leaching time. Whether the latter is due to an unusual equilibrium effect or to the metastable nature of the soluble iron species (presumably a ferric iron bicarbonate complex) is not clear at this stage. What is clear, however, is that to minimize iron dissolution there has to be a compromise between pulp density, leach time and temperature, agitation rate and carbon dioxide pressure. This compromise has been discussed previously [6] but is not as clear-cut as one would hope. For example, although an increase in leaching temperature decreases the time required to reach maximum magnesium dissolution, it will be advantageous to use a longer retention time to utilize the fact that under such conditions the iron concentration decreases with increasing leaching time.

The optimum conditions will of necessity be those that produce a pregnant leach liquor containing a low enough iron-to-magnesium concentration ratio to give a final product (magnesia) of the desired purity. As noted previously, for a maximum Fe_2O_3 content of 0.05%, the leach liquor must have a $[\text{Fe} \times 100 / \text{Mg}]$ concentration ratio of less than than 0.06. This is equivalent to a maximum iron concentration of 0.0006 g/l Fe per 1.0 g/l Mg. The only conditions found to yield such a liquor when using a magnesite-rich feed at an acceptable recovery rate (>70%) involve a lower pulp density and a higher leaching temperature than those used in the preliminary cost estimates calculated by Wright Engineers Pty Ltd [8].

REFRACTORY GRADE MAGNESIA - SOME GENERAL COMMENTS

As a result of verbal and written communications with a number of magnesia producers, the following points have been noted.

- Most producers market a range of products with differing levels of impurity contents in order to meet the requirements of the end users. Table 23 gives typical specifications of a number of products from a range of producers. As one would expect, the higher the purity, the higher the production costs and hence the higher the marked price. For a basic oxygen furnace (BOF), at least 3 grades of refractory brick are used, with the less pure bricks being placed in the less corrosive regions of the furnace.
- From a purity point of view, the critical components are boron, calcium and silica, expressed as B_2O_3 , CaO and SiO_2 respectively. These impurities affect such physical properties as thermal expansion, thermal conductivity and mean specific heat, which in turn affect the hot strength of the briquetted magnesia, and the degree of crystal development and crystal-to-crystal contact [9].
- The critical factors in determining the product grade are the MgO and B_2O_3 contents and the CaO/ SiO_2 ratio. Magnesia suitable for the most corrosive regions of a BOF furnace is required to have the following composition [10].

MgO	>98.5%
B_2O_3	0.01-0.03%
CaO/ SiO_2	2-3

The Fe_2O_3 content of this grade of magnesia is less critical, but will generally be less than 0.5%. BHP purchase low-iron magnesia from Japanese producers since that is what they produce at a competitive price.

In view of the above comments, it would seem that the exploitation of the Savage River magnesite deposit will involve the production of a number of grades of magnesia and that, provided the B_2O_3 content is below about 0.01% (100 ppm) and the CaO/ SiO_2 ratio is ≥ 2 , a good marketing position could be obtained, especially if the Fe_2O_3 content is held to less than say 0.2%. In other words, it would seem that reduction of the Fe_2O_3 content to less than 0.05% would not create any substantial advantage provided the B_2O_3 content was substantially less than competitors' products.

Because the boron content of the Savage River magnesite is known [11] to be low, typically 1-6 ppm B_2O_3 , it could be expected that magnesia produced by the calcination/carbon dioxide leach dioxide would also have very low boron contents. This has been confirmed by analysis of a number of intermediate and final products by AMDEL and the Analytical Services Section of the Division of Mineral Chemistry. The products were recovered from the reproducibility and Group A minimization of iron tests and were shown to contain 2-10 ppm B_2O_3 (0.0002-0.0010% B_2O_3).^{*} The same products also contained >98.5% MgO.

FUTURE WORK PROGRAMME

In the coming 6-month period, it is anticipated that the following will be undertaken.

- Preparation of a "state-of-the-art" review covering salient features of the calcination/carbon dioxide leach process, product specifications and recommended optimum processing conditions.
- Investigation of the 2-stage precipitation unit process in an attempt to recover more of the dissolved magnesium as the higher-purity second-stage product.
- Examination of the relationship between iron and magnesium concentration using synthetic mixtures, calcined Savage River magnesite, and calcined siderite-magnesite from Kambalda, W.A.
- Preparation of "demonstration" quantities of magnesium oxide with full analytical data (MgO, CaO, B_2O_3 , Al_2O_3 , Fe_2O_3 , SiO_2).
- Further testwork on minimization of iron dissolution.

^{*}The first sets of data received gave high (up to 100 ppm) and variable B_2O_3 contents and it was shown that this was caused by contamination during product calcination in a muffle furnace.

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Table 1. Leach test data - reproducibility.

Calcine: BC2 - 61.22% MgO, 3.85% Fe₂O₃

Leaching conditions: Series I - 2% solids, 0.5 h slake, 45°C, 100 psig CO₂, 900 rpm

Series II - 2% solids, 0.5 h slake, 45°C, 100 psig CO₂, 1200 rpm

Series	Leach time (h)	0.25		0.50		1.00			
		Composition (g/l)		Composition (g/l)		Extraction (%)			
		Test	Mg	Fe	Mg	Fe	Mg	Fe	Mg
I	RC1	1.73	0.002	2.73	0.002	4.94	0.004	66.9	0.74
	RC2	1.18	0.001	1.55	0.001	4.71	0.004	63.8	0.74
	RC3	1.65	0.001	1.55	0.002	4.80	0.005	65.0	0.93
	RC4	1.84	0.001	2.75	0.001	4.75	0.005	64.4	0.93
	RC5	1.85	0.001	2.63	0.002	5.35	0.004	72.5	0.74
	RC6	1.21	0.001	1.78	0.001	4.65	0.004	63.0	0.74
II	RC7	5.30	0.003	5.42	0.004	5.46	0.004	73.4	0.74
	RC8	5.43	0.005	5.57	0.004	5.56	0.004	75.3	0.74
	RC9	5.38	0.008	5.43	0.004	5.42	0.004	73.4	0.74
	RC10	5.51	0.007	5.52	0.004	5.42	0.004	74.8	0.74
	RC11	5.49	0.006	5.58	0.004	5.59	0.004	75.7	0.74
	RC12	5.49	0.004	5.52	0.004	5.52	0.004	74.8	0.74

Table 2. Analytical data (%) of intermediate precipitates and MgO products.

Test	Precipitate			MgO product	
	MgO	Fe ₂ O ₃	LOI*	MgO	Fe ₂ O ₃
RC1	41.03	0.034	58.93	99.90	0.083
RC2	41.40	0.030	58.54	99.85	0.072
RC3	40.72	0.029	59.04	99.41	0.071
RC4	41.08	0.043	58.65	99.35	0.104
RC5	41.50	0.033	58.46	99.90	0.079
RC6	40.62	0.032	59.33	99.98	0.079
RC7	40.87	0.042	59.07	99.85	0.103
RC8	41.34	0.041	58.60	99.86	0.099
RC9	41.74	0.040	58.16	99.76	0.096
RC10	41.92	0.041	57.96	99.71	0.098
RC11	41.68	0.040	59.15	99.27	0.098
RC12	40.55	0.040	59.15	99.27	0.098

*Weight loss on ignition at 1000°C.

Table 3. Details of magnesite ores and calcination conditions.

MAG 1	- High-dolomite ore, diamond drill core, calcined on a batch basis in a laboratory muffle furnace.
MAG 3	- High-magnesite ore, diamond drill core, calcined on a batch basis in a laboratory muffle furnace.
BC2/BC4	- High-magnesite ore, diamond drill core, 80% calcined on a continuous basis in a rotary kiln, 20% calcined on a batch basis in a laboratory muffle furnace, calcines bulked, blended, screened and re-blended.
BM	- High-magnesite ore recovered from the banks of Main Creek, calcined on a batch basis in a laboratory muffle furnace.

Table 4. Minimization of iron dissolution. Group A tests.

Calcine: MAG 1 - 25.04% MgO, 1.94% Fe₂O₃

Calcination conditions: 700°C/1 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		1.72	1.83	1.72
Fe (g/l)		0.001	0.001	0.001
[Fe×100/Mg]		0.058	0.055	0.058
Mg extraction (%)		57.0	60.6	57.3
Fe extraction (%)		0.37	0.37	0.37
<u>Intermediate product</u>				
Series I:	Wt (g)	4.21	3.83	3.41
	MgO (%)	35.89	36.75	39.71
	Fe ₂ O ₃ (%)	0.021	0.021	0.027
	LOI (%)	63.52	62.73	60.13
Series II:	Wt (g)	2.93	3.35	3.37
	MgO (%)	41.80	42.51	42.14
	Fe ₂ O ₃ (%)	0.006	0.003	0.003
	LOI (%)	58.07	57.43	57.83
Composite:	Wt (g)	7.14	7.18	6.78
	MgO (%)	33.38	39.28	40.86
	Fe ₂ O ₃ (%)	0.015	0.013	0.014
	LOI (%)	61.28	60.26	58.99
<u>Final product</u>				
Series I:	Wt (g)	1.53	1.43	1.36
	MgO (%)	98.7	98.6	99.3
	Fe ₂ O ₃ (%)	0.058	0.056	0.067
Series II:	Wt (g)	1.23	1.42	1.42
	MgO (%)	100.0	100.0	100.0
	Fe ₂ O ₃ (%)	0.014	0.007	0.007
Composite:	Wt (g)	2.76	2.85	2.78
	MgO (%)	99.3	99.3	99.6
	Fe ₂ O ₃ (%)	0.038	0.032	0.036
<u>MgO recovery</u>				
Series I	(g)	1.51	1.41	1.335
Series II	(g)	1.23	1.42	1.42
Composite	(g)	2.74	2.83	2.77
Product with <0.05% Fe ₂ O ₃ (%)		100.0	100.0	100.0
Total recovery (%) [*]		106.6	103.2	107.2

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 5. Minimization of iron dissolution. Group A tests.

Calcine: MAG 1 - 27.52% MgO, 1.99% Fe₂O₃

Calcination conditions: 700°C/3 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		2.39	2.47	2.42
Fe (g/l)		0.001	0.002	0.002
[Fe×100/Mg]		0.042	0.081	0.083
Mg extraction (%)		72.0	74.4	72.9
Fe extraction (%)		0.36	0.72	0.72
<u>Intermediate product</u>				
Series I:	Wt (g)	7.30	6.57	5.92
	MgO (%)	36.25	38.12	38.45
	Fe ₂ O ₃ (%)	0.023	0.022	0.020
	LOI (%)	63.38	61.78	61.37
Series II:	Wt (g)	2.97	3.30	3.38
	MgO (%)	42.00	42.18	43.24
	Fe ₂ O ₃ (%)	0.004	0.003	0.003
	LOI (%)	57.92	57.62	56.87
Composite:	Wt (g)	10.27	9.87	9.30
	MgO (%)	37.97	39.41	40.22
	Fe ₂ O ₃ (%)	0.018	0.016	0.014
	LOI (%)	61.80	60.39	59.73
<u>Final product</u>				
Series I:	Wt (g)	2.68	2.51	2.29
	MgO (%)	98.9	99.6	99.6
	Fe ₂ O ₃ (%)	0.060	0.058	0.052
Series II:	Wt (g)	1.25	1.40	1.46
	MgO (%)	100.0	99.3	100.0
	Fe ₂ O ₃ (%)	0.010	0.007	0.007
Composite:	Wt (g)	3.93	3.91	3.75
	MgO (%)	99.2	99.6	99.7
	Fe ₂ O ₃ (%)	0.044	0.040	0.034
<u>MgO recovery</u>				
Series I	(g)	2.65	2.50	2.28
Series II	(g)	1.25	1.39	1.46
Composite	(g)	3.90	3.89	3.74
Product with <0.05 Fe ₂ O ₃	(%)	100.0	100.0	100.0
Total recovery	(%)*	109.4	105.6	103.6

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 6. Minimization of iron dissolution. Group A tests.

Calcine: MAG 1 - 29.18% MgO, 2.14% Fe₂O₃

Calcination conditions: 850°C/1 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		2.39	2.47	2.50
Fe (g/l)		0.001	0.002	0.002
[Fe×100/Mg]		0.042	0.081	0.080
Mg extraction (%)		67.9	70.2	71.0
Fe extraction (%)		0.34	0.67	0.67
<u>Intermediate product</u>				
Series I:	Wt (g)	7.44	6.30	6.13
	MgO (%)	36.88	35.02	38.51
	Fe ₂ O ₃ (%)	0.023	0.023	0.031
	LOI (%)	62.68	65.12	61.41
Series II:	Wt (g)	2.48	3.98	3.65
	MgO (%)	42.21	42.84	42.90
	Fe ₂ O ₃ (%)	0.005	0.003	0.003
	LOI (%)	57.60	57.19	57.10
Composite:	Wt (g)	9.92	10.28	9.78
	MgO (%)	39.21	38.13	40.18
	Fe ₂ O ₃ (%)	0.019	0.015	0.021
	LOI (%)	61.41	62.05	59.80
<u>Final product</u>				
Series I:	Wt (g)	2.77	2.20	2.36
	MgO (%)	98.9	100.0	100.0
	Fe ₂ O ₃ (%)	0.061	0.066	0.080
Series II:	Wt (g)	1.05	1.71	1.57
	MgO (%)	100.0	100.0	100.0
	Fe ₂ O ₃ (%)	0.02	0.007	0.007
Composite:	Wt (g)	3.82	3.91	3.93
	MgO (%)	99.2	100.0	100.0
	Fe ₂ O ₃ (%)	0.048	0.040	0.051
<u>MgO recovery</u>				
Series I	(g)	2.74	2.21	2.36
Series II	(g)	1.05	1.71	1.57
Composite	(g)	3.79	3.92	3.93
Product with <0.05% Fe ₂ O ₃ (%)		100.0	100.0	39.9
Total recovery (%) [*]				

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 7. Minimization of iron dissolution. Group A tests.

Calcine: MAG 3 - 72.12% MgO, 4.36% Fe₂O₃

Calcination conditions: 700°C/2 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		6.85	7.02	4.38
Fe (g/l)		0.010	0.010	0.008
[Fe×100/Mg]		0.146	0.142	0.183
Mg extraction (%)		78.7	80.7	50.3
Fe extraction (%)		1.65	1.65	1.32
<u>Intermediate product</u>				
Series I:	Wt (g)	24.41	23.84	13.03
	MgO (%)	39.45	39.83	39.87
	Fe ₂ O ₃ (%)	0.084	0.064	0.048
	LOI (%)	60.20	60.04	60.13
Series II:	Wt (g)	3.00	3.90	3.84
	MgO (%)	43.01	42.08	42.14
	Fe ₂ O ₃ (%)	0.004	0.005	0.003
	LOI (%)	56.76	57.88	57.96
Composite:	Wt (g)	27.41	27.74	16.87
	MgO (%)	39.84	40.16	40.43
	Fe ₂ O ₃ (%)	0.075	0.056	0.038
	LOI (%)	59.82	59.74	59.58
<u>Final product</u>				
Series I:	Wt (g)	9.72	9.53	5.20
	MgO (%)	99.1	99.7	100.0
	Fe ₂ O ₃ (%)	0.211	0.160	0.120
Series II:	Wt (g)	1.30	1.64	1.62
	MgO (%)	99.2	100.0	100.0
	Fe ₂ O ₃ (%)	0.009	0.012	0.007
Composite:	Wt (g)	11.02	11.17	6.82
	MgO (%)	99.1	99.7	100.0
	Fe ₂ O ₃ (%)	0.187	0.138	0.093
<u>MgO recovery</u>				
Series I	(g)	9.63	9.50	5.20
Series II	(g)	1.29	1.64	1.62
Composite	(g)	10.92	11.14	6.82
Product with <0.05% Fe ₂ O ₃ (%)		11.8	14.7	23.8
Total recovery	(%)*	106.9	106.3	104.4

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 8. Minimization of iron dissolution. Group A tests.

Calcine: MAG 3 - 72.93% MgO, 4.36% Fe₂O₃

Calcination conditions: 700°C/10 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		6.56	6.59	3.73
Fe (g/l)		0.010	0.010	0.005
{Fe×100/Mg}		0.152	0.152	0.134
Mg extraction (%)		74.5	74.9	42.4
Fe extraction (%)		1.65	1.65	0.83
<u>Intermediate product</u>				
Series I:	Wt (g)	22.26	21.93	11.31
	MgO (%)	38.67	37.63	37.92
	Fe ₂ O ₃ (%)	0.094	0.078	0.049
	LOI (%)	60.63	62.65	62.07
Series II:	Wt (g)	2.80	4.29	3.93
	MgO (%)	42.31	42.53	42.25
	Fe ₂ O ₃ (%)	0.004	0.003	0.004
	LOI (%)	57.75	57.35	57.74
Composite:	Wt (g)	25.06	26.22	15.24
	MgO (%)	39.07	38.44	39.04
	Fe ₂ O ₃ (%)	0.084	0.066	0.037
	LOI (%)	60.31	61.78	60.95
<u>Final product</u>				
Series I:	Wt (g)	8.77	8.19	4.29
	MgO (%)	98.6	100.0	100.0
	Fe ₂ O ₃ (%)	0.239	0.208	0.129
Series II:	Wt (g)	1.18	1.83	1.66
	MgO (%)	100.0	99.5	100.0
	Fe ₂ O ₃ (%)	0.009	0.007	0.009
Composite:	Wt (g)	9.95	10.02	5.95
	MgO (%)	98.6	99.9	100.0
	Fe ₂ O ₃ (%)	0.211	0.171	0.096
<u>MgO recovery</u>				
Series I	(g)	8.61	8.25	4.29
Series II	(g)	1.18	1.82	1.66
Composite	(g)	9.79	10.07	5.95
Product with <0.05% Fe ₂ O ₃	(%)	13.5	18.3	27.9
Total recovery	(%)*	99.9	102.4	106.8

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

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Table 9. Minimization of Iron dissolution. Group A tests.

Calcine: MAG 3 - 73.28% MgO, 4.42% Fe₂O₃

Calcination conditions: 850°C/0.5 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		7.01	7.28	4.64
Fe (g/l)		0.011	0.010	0.007
[Fe×100/Mg]		0.157	0.137	0.151
Mg extraction (%)		79.3	82.4	52.5
Fe extraction (%)		1.79	1.63	1.14
<u>Intermediate product</u>				
Series I:	Wt (g)	23.64	22.85	13.22
	MgO (%)	38.99	37.22	37.83
	Fe ₂ O ₃ (%)	0.097	0.050	0.067
	LOI (%)	61.10	63.00	62.23
Series II:	Wt (g)	3.18	4.46	5.05
	MgO (%)	41.60	42.60	42.13
	Fe ₂ O ₃ (%)	0.003	0.003	0.006
	LOI (%)	58.49	57.26	57.93
Composite:	Wt (g)	26.82	27.31	18.27
	MgO (%)	38.48	38.08	38.31
	Fe ₂ O ₃ (%)	0.086	0.042	0.050
	LOI (%)	60.79	62.06	61.04
<u>Final product</u>				
Series I:	Wt (g)	8.99	8.48	4.86
	MgO (%)	99.9	99.9	99.9
	Fe ₂ O ₃ (%)	0.249	0.135	0.177
Series II:	Wt (g)	1.32	1.90	2.13
	MgO (%)	100.00	100.0	100.0
	Fe ₂ O ₃ (%)	0.007	0.007	0.014
Composite:	Wt (g)	10.31	10.38	6.99
	MgO (%)	99.9	99.9	99.9
	Fe ₂ O ₃ (%)	0.218	0.112	0.127
<u>MgO recovery</u>				
Series I	(g)	9.00	8.50	4.87
Series II	(g)	1.32	1.90	2.13
Composite	(g)	10.32	10.40	7.00
Product with <0.05% Fe ₂ O ₃	(%)	12.8	18.3	30.5
Total recovery	(%)*	98.6	95.0	101.1

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 10. Minimization of iron dissolution. Group A tests.

Calcine: BC2 - 61.20% MgO, 3.85% Fe₂O₃

Calcination conditions: Rotary kiln product

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		5.35	5.36	4.91
Fe (g/l)		0.005	0.006	0.004
[Fe×100/Mg]		0.093	0.112	0.081
Mg extraction (%)		72.5	72.6	66.5
Fe extraction (%)		0.94	0.99	0.66
<u>Intermediate product</u>				
Series I:	Wt (g)	17.21	15.59	14.32
	MgO (%)	36.53	35.98	37.05
	Fe ₂ O ₃ (%)	0.051	0.037	0.035
	LOI (%)	63.01	64.02	62.85
Series II:	Wt (g)	4.11	4.33	2.78
	MgO (%)	41.61	41.34	41.97
	Fe ₂ O ₃ (%)	0.004	0.003	0.006
	LOI (%)	58.31	58.51	57.96
Composite:	Wt (g)	21.32	19.22	17.10
	MgO (%)	37.52	37.15	37.85
	Fe ₂ O ₃ (%)	0.042	0.031	0.030
	LOI (%)	62.10	62.82	62.05
<u>Final product</u>				
Series I:	Wt (g)	6.37	5.61	5.32
	MgO (%)	98.8	100.0	99.7
	Fe ₂ O ₃ (%)	0.138	0.102	0.094
Series II:	Wt (g)	1.70	1.80	1.17
	MgO (%)	100.0	99.4	99.8
	Fe ₂ O ₃ (%)	0.010	0.007	0.014
Composite:	Wt (g)	8.08	7.41	6.49
	MgO (%)	99.0	99.9	99.7
	Fe ₂ O ₃ (%)	0.111	0.084	0.080
<u>MgO recovery</u>				
Series I	(g)	6.29	5.61	5.31
Series II	(g)	1.71	1.79	1.17
Composite	(g)	8.00	7.40	6.48
Product with <0.05% Fe ₂ O ₃	(%)	21.2	24.3	18.0
Total recovery	(%)*	100.1	92.7	88.5

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 11. Minimization of iron dissolution. Group A tests.

Calcine: BC4 - 62.22% MgO, 3.42% Fe₂O₃

Calcination conditions: Rotary kiln product

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		5.49	5.47	4.39
Fe (g/l)		0.005	0.006	0.004
[Fe×100]		0.091	0.110	0.091
Mg extraction (%)		73.2	72.9	60.6
Fe extraction (%)		1.05	1.26	0.63
<u>Intermediate product</u>				
Series I:	Wt (g)	18.53	18.78	14.18
	MgO (%)	36.80	37.03	40.00
	Fe ₂ O ₃ (%)	0.043	0.040	0.039
	LOI (%)	63.17	62.67	59.89
Series II:	Wt (g)	2.65	2.82	3.36
	MgO (%)	41.51	41.21	41.80
	Fe ₂ O ₃ (%)	0.009	0.003	0.005
	LOI (%)	58.40	58.49	58.19
Composite:	Wt (g)	21.18	21.60	17.54
	MgO (%)	37.39	37.41	40.31
	Fe ₂ O ₃ (%)	0.039	0.035	0.032
	LOI (%)	62.63	62.12	59.56
<u>Final product</u>				
Series I:	Wt (g)	6.83	6.97	5.69
	MgO (%)	99.9	99.3	99.6
	Fe ₂ O ₃ (%)	0.117	0.107	0.097
Series II:	Wt (g)	1.10	1.18	1.40
	MgO (%)	100.0	99.2	100.0
	Fe ₂ O ₃ (%)	0.022	0.007	0.012
Composite:	Wt (g)	7.92	8.15	7.09
	MgO (%)	99.9	99.2	99.7
	Fe ₂ O ₃ (%)	0.104	0.093	0.080
<u>MgO recovery</u>				
Series I	(g)	6.82	6.91	5.67
Series II	(g)	1.10	1.17	1.40
Composite	(g)	7.92	8.08	7.07
Product with <0.05% Fe ₂ O ₃ (%)		13.9	14.5	19.7
Total recovery (%) [*]		96.6	99.0	104.2

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

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Table 12. Minimization of iron dissolution. Group A tests.

Calcine: BM - 50.61% MgO, 3.50% Fe₂O₃

Calcination conditions: 600°C/3 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		2.05	2.11	2.08
Fe (g/l)		0.003	0.002	0.002
[Fe×100/Mg]		0.146	0.095	0.096
Mg extraction (%)		33.6	34.6	34.1
Fe extraction (%)		0.62	0.41	0.41
<u>Intermediate product</u>				
Series I:	Wt (g)	5.83	5.24	4.51
	MgO (%)	36.91	38.56	38.81
	Fe ₂ O ₃ (%)	0.026	0.029	0.033
	LOI (%)	63.07	61.02	61.23
Series II:	Wt (g)	2.14	3.02	3.53
	MgO (%)	41.94	41.80	41.79
	Fe ₂ O ₃ (%)	0.007	0.004	0.005
	LOI (%)	58.22	58.11	58.43
Composite:	Wt (g)	7.97	8.26	8.04
	MgO (%)	38.27	39.71	40.17
	Fe ₂ O ₃ (%)	0.021	0.020	0.021
	LOI (%)	61.77	59.98	60.00
<u>Final product</u>				
Series I:	Wt (g)	2.15	2.04	1.75
	MgO (%)	100.0	99.0	100.0
	Fe ₂ O ₃ (%)	0.070	0.074	0.085
Series II:	Wt (g)	0.90	1.26	1.48
	MgO (%)	100.0	100.0	100.0
	Fe ₂ O ₃ (%)	0.017	0.010	0.019
Composite:	Wt (g)	3.05	3.30	3.23
	MgO (%)	100.0	99.4	100.0
	Fe ₂ O ₃ (%)	0.054	0.050	0.055
<u>MgO recovery</u>				
Series I	(g)	2.15	2.02	1.75
Series II	(g)	0.90	1.26	1.48
Composite	(g)	3.05	3.28	3.23
Product with <0.05% Fe ₂ O ₃	(%)	29.5	100.0	45.8
Total recovery	(%)*	99.6	104.0	103.9

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 13. Minimization of iron dissolution. Group A tests.

Calcine: BM - 49.37% MgO, 3.18% Fe₂O₃

Calcination conditions: 700°C/1 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		2.05	2.14	2.16
Fe (g/l)		0.002	0.001	0.001
[Fe×100/Mg]		0.098	0.047	0.047
Mg extraction (%)		34.4	35.9	36.2
Fe extraction (%)		0.45	0.23	0.23
<u>Intermediate product</u>				
Series I:	Wt (g)	6.74	5.29	5.33
	MgO (%)	35.08	35.82	37.40
	Fe ₂ O ₃ (%)	0.030	0.017	0.024
	LOI (%)	64.60	64.14	62.62
Series II:	Wt (g)	2.39	3.73	3.43
	MgO (%)	42.51	41.40	41.65
	Fe ₂ O ₃ (%)	0.007	0.004	0.004
	LOI (%)	59.94	58.66	58.42
Composite:	Wt (g)	9.13	9.02	8.76
	MgO (%)	37.02	38.03	39.04
	Fe ₂ O ₃ (%)	0.024	0.012	0.016
	LOI (%)	62.86	61.87	60.98
<u>Final product</u>				
Series I:	Wt (g)	2.38	1.89	1.99
	MgO (%)	99.2	100.0	100.0
	Fe ₂ O ₃ * (%)	0.085	0.047	0.064
Series II:	Wt (g)	1.01	1.54	1.43
	MgO (%)	100.0	100.0	100.0
	Fe ₂ O ₃ (%)	0.016	0.010	0.010
Composite:	Wt (g)	3.39	3.43	3.42
	MgO (%)	100.0	100.0	100.0
	Fe ₂ O ₃ (%)	0.065	0.030	0.041
<u>MgO recovery</u>				
Series I	(g)	2.36	1.89	1.99
Series II	(g)	1.02	1.54	1.43
Composite	(g)	3.38	3.43	3.42
Product with <0.05% Fe ₂ O ₃ (%)		29.8	100.0	100.0
Total recovery (%)*		110.6	107.5	106.3

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

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Table 14. Minimization of iron dissolution. Group A tests.

Calcine: BM - 73.16% MgO, 3.31% Fe₂O₃

Calcination conditions: 700°C/3 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor: Mg (g/l)		6.49	6.65	5.23
Fe (g/l)		0.009	0.009	0.007
[Fe×100/Mg]		0.139	10.35	0.134
Mg extraction (%)		73.5	75.3	59.2
Fe extraction (%)		1.96	1.96	1.52
<u>Intermediate product</u>				
Series I:	Wt (g)	24.60	23.35	15.15
	MgO (%)	38.38	38.12	37.40
	Fe ₂ O ₃ (%)	0.104	0.057	0.043
	LOI (%)	61.21	61.76	62.72
Series II:	Wt (g)	3.32	4.13	3.55
	MgO (%)	41.51	41.60	41.80
	Fe ₂ O ₃ (%)	0.006	0.003	0.005
	LOI (%)	58.54	58.45	58.20
Composite:	Wt (g)	27.92	27.48	18.70
	MgO (%)	38.75	38.65	38.24
	Fe ₂ O ₃ (%)	0.092	0.049	0.036
	LOI (%)	60.89	61.26	61.86
<u>Final product</u>				
Series I:	Wt (g)	9.54	8.93	5.65
	MgO (%)	99.0	99.7	99.6
	Fe ₂ O ₃ (%)	0.268	0.149	0.115
Series II:	Wt (g)	1.38	1.72	1.48
	MgO (%)	100.0	100.0	100.0
	Fe ₂ O ₃ (%)	0.014	0.007	0.012
Composite:	Wt (g)	10.92	10.65	7.13
	MgO (%)	99.1	99.7	99.7
	Fe ₂ O ₃ (%)	0.236	0.126	
<u>MgO recovery</u>				
Series I	(g)	9.44	8.90	5.67
Series II	(g)	1.38	1.72	1.48
Composite	(g)	10.82	10.62	7.15
Product with <0.05% Fe ₂ O ₃	(%)	12.6	16.2	20.8
Total recovery	(%)*	110.0	107.1	91.3

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 15. Minimization of iron dissolution. Group A tests.

Calcine: 64.57 % MgO, 2.92% Fe₂O₃

Calcination conditions: 800°C/1 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor:	Mg (g/l)	5.20	5.06	4.65
	Fe (g/l)	0.007	0.007	0.007
	[Fe×100/Mg]	0.135	0.139	0.151
	Mg extraction (%)	66.8	65.0	59.7
	Fe extraction (%)	1.72	1.72	1.72
<u>Intermediate product</u>				
Series I:	Wt (g)	19.18	17.13	14.15
	MgO (%)	35.84	40.68	39.92
	Fe ₂ O ₃ (%)	0.052	0.048	0.042
	LOI (%)	63.95	59.42	60.01
Series II:	Wt (g)	3.46	3.29	3.24
	MgO (%)	42.05	41.93	41.11
	Fe ₂ O ₃ (%)	0.006	0.003	0.004
	LOI (%)	58.00	57.93	58.79
Composite:	Wt (g)	22.64	20.42	17.39
	MgO (%)	36.75	40.89	40.14
	Fe ₂ O ₃ (%)	0.045	0.041	0.035
	LOI (%)	63.04	59.18	59.78
<u>Final product</u>				
Series I:	Wt (g)	6.91	6.95	5.66
	MgO (%)	99.4	100.0	99.8
	Fe ₂ O ₃ (%)	0.144	0.118	0.105
Series II:	Wt (g)	1.45	1.38	1.33
	MgO (%)	100.0	100.0	100.0
	Fe ₂ O ₃ (%)	0.014	0.007	0.010
Composite:	Wt (g)	8.36	8.33	6.99
	MgO (%)	99.5	100.0	99.8
	Fe ₂ O ₃ (%)	0.121	0.100	0.087
<u>MgO recovery</u>				
Series I	(g)	6.87	6.97	5.65
Series II	(g)	1.45	1.38	1.33
Composite	(g)	8.32	8.35	6.98
Product with <0.05% Fe ₂ O ₃	(%)	17.3	16.6	19.0
Total recovery	(%)*	106.9	110.5	100.6

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 16. Minimization of iron dissolution. Group A tests.

Calcine: BM - 80.08% MgO, 3.64% Fe₂O₃

Calcination conditions: 800°C/3 h in muffle furnace

		40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
<u>Leaching conditions</u>				
Leach liquor:	Mg (g/l)	8.20	8.18	7.53
	Fe (g/l)	0.010	0.010	0.008
	[Fe×100/Mg]	0.122	0.122	0.106
	Mg extraction (%)	85.0	84.7	78.0
	Fe extraction (%)	1.98	1.98	1.58
<u>Intermediate product</u>				
Series I:	Wt (g)	31.03	27.39	17.57
	MgO (%)	38.97	40.15	37.63
	Fe ₂ O ₃ (%)	0.078	0.079	0.054
	LOI (%)	60.76	59.62	62.27
Series II:	Wt (g)	3.13	3.60	2.69
	MgO (%)	41.82	42.04	42.00
	Fe ₂ O ₃ (%)	0.004	0.003	0.004
	LOI (%)	58.05	57.76	57.81
Composite:	Wt (g)	34.16	30.99	20.26
	MgO (%)	39.23	40.37	38.20
	Fe ₂ O ₃ (%)	0.072	0.070	0.047
	LOI (%)			
<u>Final product</u>				
Series I:	Wt (g)	12.17	11.06	6.63
	MgO (%)	99.3	99.5	99.7
	Fe ₂ O ₃ (%)	0.199	0.195	0.143
Series II:	Wt (g)	1.31	1.52	1.14
	MgO (%)	100.0	99.3	99.1
	Fe ₂ O ₃ (%)	0.009	0.007	0.009
Composite:	Wt (g)	13.48	12.58	7.77
	MgO (%)	99.4	99.4	99.6
	Fe ₂ O ₃ (%)	0.181	0.172	0.123
<u>MgO recovery</u>				
Series I	(g)	12.09	11.00	6.61
Series II	(g)	1.31	1.51	1.13
Composite	(g)	13.40	12.51	7.74
Product with <0.05% Fe ₂ O ₃	(%)	9.72	12.1	14.7
Total recovery	(%)*	109.0	102.3	69.3

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 17. Summary of product (magnesia) analytical data (%).

Feed	Calcination conditions (°C/h)	Leaching conditions (°C/rpm)	Series I		Series II		Composite	
			MgO	Fe ₂ O ₃	MgO	Fe ₂ O ₃	MgO	Fe ₂ O ₃
MAG1	700/1	40.0/1200	98.7	0.058	100.0	0.014	99.3	0.038
		45.0/1200	98.6	0.056	100.0	0.007	99.3	0.032
		45.0/900	99.3	0.067	100.0	0.007	99.6	0.036
MAG1	700/3	40.0/1200	98.9	0.060	100.0	0.010	99.2	0.044
		45.0/1200	99.6	0.058	99.3	0.007	99.6	0.040
		45.0/900	99.6	0.052	100.0	0.007	99.7	0.034
MAG1	850/1	40.0/1200	98.9	0.061	100.0	0.012	99.2	0.048
		45.0/1200	100.0	0.066	100.0	0.007	100.0	0.040
		45.0/900	100.0	0.080	100.0	0.007	100.0	0.051
MAG3	700/2	40.0/1200	99.1	0.211	99.2	0.009	99.1	0.187
		45.0/1200	99.7	0.160	100.0	0.012	99.7	0.138
		45.0/900	100.0	0.120	100.0	0.007	100.0	0.096
MAG3	700/10	40.0/1200	98.6	0.239	100.0	0.009	98.6	0.211
		45.0/1200	100.0	0.208	99.5	0.007	99.9	0.171
		45.0/900	100.0	0.129	100.0	0.009	100.0	0.096
MAG3	850/0.5	40.0/1200	99.9	0.249	100.0	0.007	99.9	0.218
		45.0/1200	99.9	0.135	100.0	0.007	99.9	0.218
		45.0/900	99.9	0.177	100.0	0.014	99.9	0.127
BC2	Rotary kiln	40.0/1200	98.8	0.138	100.0	0.010	99.0	0.111
		45.0/1200	100.0	0.102	99.4	0.007	99.9	0.084
		45.0/900	99.7	0.094	99.8	0.014	99.7	0.080
BC4	Rotary kiln	40.0/1200	99.9	0.117	100.0	0.022	99.9	0.104
		45.0/1200	99.3	0.107	99.2	0.007	99.2	0.093
		45.0/900	99.6	0.097	100.0	0.012	99.7	0.080
BM	600/3	40.0/1200	100.0	0.070	100.0	0.017	100.0	0.054
		45.0/1200	99.0	0.074	100.0	0.010	99.4	0.050
		45.0/900	100.0	0.085	100.0	0.019	100.0	0.055
BM	700/1	40.0/1200	99.2	0.085	100.0	0.016	100.0	0.065
		45.0/1200	100.0	0.047	100.0	0.010	100.0	0.030
		45.0/900	100.0	0.064	100.0	0.010	100.0	0.041
BM	700/3	40.0/1200	99.0	0.268	100.0	0.014	99.1	0.236
		45.0/1200	99.7	0.149	100.0	0.007	99.7	0.126
		45.0/900	99.6	0.115	100.0	0.012	99.7	0.094
BM	800/1	40.0/1200	99.4	0.144	100.0	0.014	99.5	0.121
		45.0/1200	100.0	0.118	100.0	0.007	100.0	0.100
		45.0/900	99.8	0.105	100.0	0.010	99.8	0.087
BM	800/3	40.0/1200	99.3	0.199	100.0	0.009	99.4	0.181
		45.0/1200	99.5	0.195	99.3	0.007	99.4	0.172
		45.0/900	99.7	0.143	99.1	0.009	99.6	0.123

Table 18. Chemical composition of calcine used in Group B minimization of iron dissolution tests.

Calcine	Calcination conditions		Composition (%)			
	(°C)	(h)	MgO	CaO	Fe ₂ O ₃	Balance*
BC2	Original rotary kiln product		61.22	5.22	3.85	29.71
BC2/700/3	700	3	Not determined			
BC2/700/5	700	5	76.43	6.73	4.27	12.57
BC2/700/10	700	10	78.42	7.04	4.32	10.22
BC2/800/1	800	1	75.94	7.00	4.36	12.70
BC2/800/3	800	3	82.07	7.05	4.49	6.39
BC2/800/5	800	5	83.40	7.06	4.42	5.12
BC2/900/1	900	1	82.73	7.15	4.45	5.67
BC2/900/3	900	3	79.09	7.27	4.48	9.16
BC2/900/5	900	5	79.42	7.16	4.66	8.76
BC2/900/18	900	18	81.91	7.16	4.68	6.25
BC2/1000/1	1000	1	81.74	7.40	4.58	6.28
BC2/1000/3	1000	3	80.08	7.47	4.81	7.64
BC2/1000/5	1000	5	82.24	7.27	4.65	5.84

*Principally quartz and carbon dioxide.

Table 19. Minimization of iron dissolution. Group B Tests.

Leach time (h)	Leach temperature (°C)	0.25		0.50		1.00		1.50		2.50		Extraction (%)
		Composition (g/l)		Composition (g/l)		Composition (g/l)		Composition (g/l)		Composition (g/l)		
		Mg	Fe									
BC2	15.5	Not carried out										
BC2/700/3	15.5	Not carried out										
BC2/700/5	15.5	3.65	0.006	4.82	0.012	6.06	0.016	6.70	0.018	7.29	0.020	79.07
BC2/700/10	15.5	2.94	0.004	4.09	0.008	5.32	0.016	6.19	0.019	7.24	0.024	76.53
BC2/800/1	15.5	4.00	0.010	4.70	0.012	5.75	0.018	6.44	0.020	7.22	0.020	78.82
BC2/800/3	15.5	2.87	0.002	4.57	0.008	5.95	0.015	6.66	0.021	7.35	0.025	74.24
BC2/800/5	15.5	1.52	0.002	3.56	0.003	4.57	0.004	5.15	0.008	5.92	0.012	58.85
BC2/900/1	15.5	2.32	0.002	3.50	0.003	4.81	0.010	5.79	0.009	6.80	0.011	68.14
BC2/900/3	15.5	0.51	0.000	1.04	0.000	1.91	0.002	2.60	0.002	3.24	0.003	33.96
BC2/900/5	15.5	0.57	0.000	0.95	0.000	1.74	0.001	2.29	0.002	2.86	0.002	26.11
BC2/900/18	15.5	0.37	0.000	0.67	0.000	1.31	0.001	1.79	0.001	2.58	0.002	29.85
BC2/1000/1	15.5	1.00	0.001	1.60	0.001	2.31	0.001	2.88	0.002	3.80	0.002	38.54
BC2/1000/3	15.5	0.33	0.000	0.69	0.000	0.96	0.000	1.23	0.000	1.73	0.001	17.91
BC2/1000/5	15.5	0.21	0.000	0.40	0.000	0.72	0.000	1.01	0.000	1.39	0.000	14.01
BC2	45.0	5.49	0.004	5.52	0.004	5.52	0.000					
BC2/700/3	45.0	7.05	0.013	7.62	0.012	7.81	0.009	8.01	0.008			
BC2/700/5	45.0	7.30	0.013	7.31	0.013	7.34	0.008	7.32	0.008	7.33	0.007	79.50
BC2/700/10	45.0	7.20	0.012	7.27	0.009	7.29	0.008	7.24	0.008	7.19	0.008	76.00
BC2/800/1	45.0	6.89	0.017	7.50	0.014	7.48	0.011	7.50	0.009	7.50	0.009	81.88
BC2/800/3	45.0	7.12	0.012	7.63	0.012	7.62	0.008	7.61	0.008	7.61	0.008	76.87
BC2/800/5	45.0	6.67	0.012	7.55	0.012	7.65	0.010	7.67	0.009	7.69	0.009	76.44
BC2/900/1	45.0	7.23	0.007	7.53	0.007	7.56	0.007	7.63	0.007	7.73	0.007	77.45
BC2/900/3	45.0	5.91	0.003	6.67	0.007	7.24	0.013	7.81	0.012	7.91	0.010	82.91
BC2/900/5	45.0	3.52	0.001	6.73	0.002	7.29	0.008	7.83	0.009	7.85	0.012	81.94
BC2/900/18	45.0	3.43	0.000	4.95	0.002	6.10	0.010	6.67	0.012	7.12	0.013	72.06
BC2/1000/1	45.0	4.63	0.004	6.52	0.004	7.24	0.006	7.39	0.008	7.43	0.008	75.35
BC2/1000/3	45.0	1.47	0.001	2.86	0.001	4.55	0.004	5.05	0.007	5.26	0.012	54.45
BC2/1000/5	45.0	1.02	0.001	2.03	0.002	3.45	0.004	4.20	0.007	4.61	0.008	46.47

Table 20. Minimization of iron dissolution. Group C tests.

Calcine: BC2/700/5 - 76.43% MgO, 4.27% Fe₂O₃Leaching conditions: 0.5 h slake, 45.0°C, 100 psig CO₂,
1200 rpm, leached for 1.5 h

Pulp density (% solids)	Leach liquor			
	Mg (g/l)	Fe (g/l)	[Fe×100/Mg]	Mg extraction (%)
2.0	7.32	0.008	0.109	79.39
1.8	7.10	0.006	0.085	85.56
1.6	6.30	0.004	0.063	85.41
1.4	5.52	0.002	0.036	85.52
1.0	3.81	0.002	0.052	82.65

Table 21. Minimization of iron dissolution Group D tests.

Leaching conditions: 2.0% solids, 0.5 h slake, 30.0°C, 100 psig CO₂, 1200 rpm

Leach time (h)		0.5		1.0		1.5		2.0		Extraction (%)	
Calcine	Agitation (rpm)	Composition (g/l)		Composition (g/l)		Composition (g/l)		Composition (g/l)		[Fe×100/Mg]	Mg
		Mg	Fe	Mg	Fe	Mg	Fe	Mg	Fe		
BC2/700/5	810	0.95	0.000	0.76	0.000	4.38	0.004	6.86	0.010	74.40	0.146
	920	2.21	0.000	6.18	0.010	6.63	0.010	7.02	0.010	76.14	0.142
	1200	6.83	0.014	7.32	0.013	7.35	0.012	7.35	0.012	79.72	0.163
BC2/800/1	920	2.11	0.000	6.52	0.008	6.96	0.012	7.39	0.012	80.68	0.162
	1200	6.31	0.014	7.41	0.014	7.40	0.014	7.42	0.008	81.00	0.108
BC2/900/1	920	1.52	0.000	4.00	0.002	5.71	0.006	7.05	0.008	70.64	0.113
	1200	5.99	0.007	7.49	0.012	7.58	0.010	7.59	0.009	76.05	0.119

Table 22. Minimization of iron dissolution. Group E tests.

Calcine	Pulp density (% solids)	CO ₂ pressure (psig)	Agitation (rpm)	Temperature (°C)	0.25 h		0.5 h		1.0 h		2.0 h	
					Mg (g/l)	Fe (g/l)						
BC2/800/1	2	25	1200	45.0	3.36	0.005	4.11	0.004	4.21	0.003	4.10	0.002
	2	50	1200	45.0	6.32	0.016	7.42	0.018	6.74	0.008	5.68	0.004
	2	100	1200	45.0	6.89	0.017	7.50	0.014	7.48	0.011	7.49	0.010
BC2/700/2	2	100	1200	30.0			7.24	0.017	7.59	0.017	7.60	0.012
	2	100	1200	45.0			7.65	0.020	7.66	0.015	7.63	0.010
BC2/700/5	1.5	100	900	30.0			3.79	0.008	5.31	0.004	5.50	0.002
BC2/700/5	2	100	900	45.0			4.42	0.002	7.16	0.005	7.25	0.005

Table 23. Specifications of commercial refractory-grade magnesia.*

Producer	Product	Composition (%)							
		MgO	CaO	B ₂ O ₃	Al ₂ O ₃	Cr ₂ O ₃	Fe ₂ O ₃	SiO ₂	CaO/SiO ₂
Fimisco	SCALIMAG MFS	95.5	2.60	n.s.	0.05	n.s.	0.70	1.30	2.00
	SCALIMAG MF1	94.0	3.10	n.s.	0.10	n.s.	0.80	2.00	1.55
	SCALIMAG MF4	91.0	3.60	n.s.	0.20	n.s.	1.20	3.50	1.03
	SCALIMAG MFG	94.0	2.20	n.s.	0.10	n.s.	0.80	2.80	0.79
	SCALIMAG MFW	91.0	2.50	n.s.	0.20	n.s.	1.30	5.00	0.50
	SCALIMAG MFS	95.5	2.60	n.s.	0.05	n.s.	0.70	1.40	1.86
	SCALIMAG 503	93.5	3.30	n.s.	0.10	n.s.	0.90	2.20	1.50
	SCALIMAG MCF-6	83.0	2.30	n.s.	3.30	6.00	3.40	1.80	1.28
	SCALIMAG TBS	95.5	2.40	n.s.	0.05	n.s.	0.70	1.20	2.00
Dead Sea Periclase	CHD	99.2	0.55	0.001	0.03	0.07	0.10	0.05	11.0
Van Mannekus	CC	92.67	1.30	n.s.	0.77	n.s.	0.93	3.86	0.34
	CF	91.33	2.31	n.s.	0.81	n.s.	1.38	3.57	0.65
Billiton	NEDMAG 99.445	98.50	0.60	0.020	0.13	n.s.	0.45	0.17	3.53
Martin Marietta	Mag Chem 10-200	98.40	0.85	n.s.	0.17	n.s.	0.20	0.37	3.15
Steetley	BRITMAG 212PT	94.00	2.20	0.175	0.50	n.s.	1.40	1.00	2.20
	BRITMAG 215PT	92.00	1.80	0.175	0.50	n.s.	5.00	0.90	2.00
	BRITMAG 112P	96.50	0.95	0.175	0.50	n.s.	1.40	0.90	1.06
	BRITMAG 5CP	87.00	0.90	0.175	2.35	4.20	3.85	0.90	1.00
	BRITMAG 3/P-LB	96.70	2.25	0.035	0.20	n.s.	0.10	0.70	3.21
UBE	UBE 99-S	99.10	0.50	0.030	0.05	n.s.	0.05	0.20	2.50
	UBE 98	98.05	0.90	0.100	0.07	n.s.	0.07	0.90	1.00
	UBE GREEN	98.25	0.90	0.475	0.07	0.20	0.07	0.30	3.00
	UBE 90F	91.50	1.50	n.s.	0.35	n.s.	4.00	1.75	0.86

*Average composition when range given; n.s. = not specified.

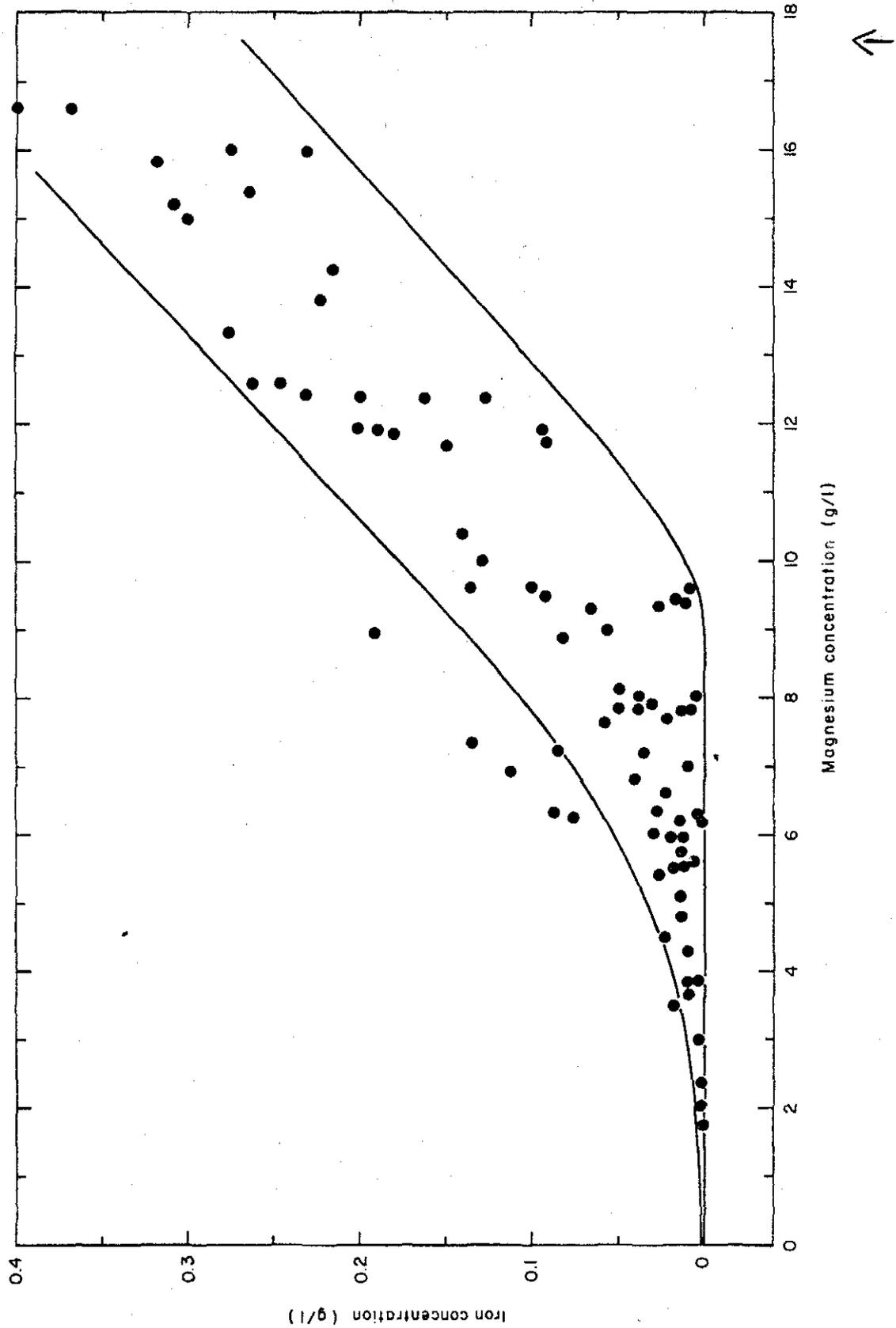


Fig. 1. Leach liquor composition: iron concentration as a function of magnesium concentration. Data taken from Reference 6.

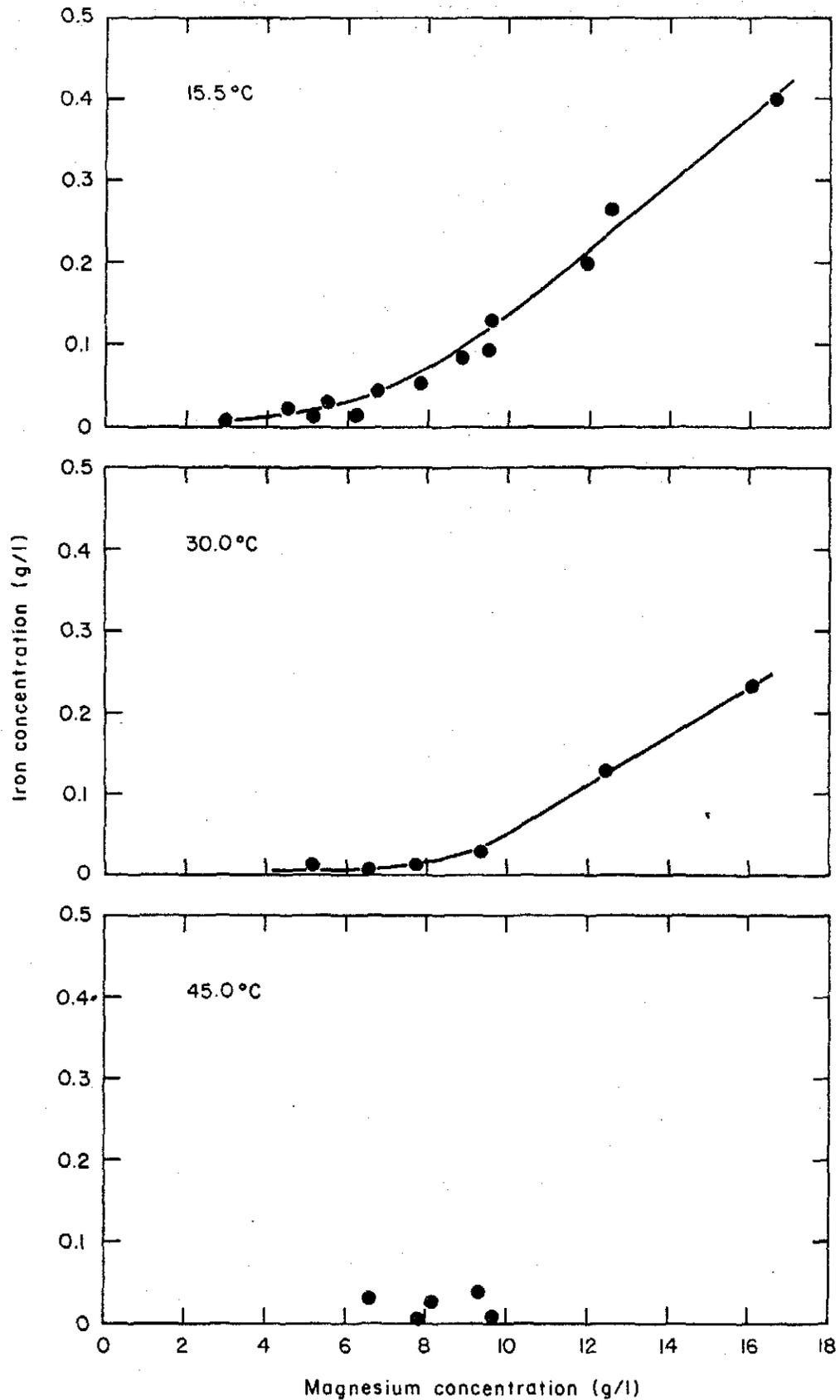


Fig. 2. Iron concentration as a function of magnesium concentration for different leaching conditions. Data for conditions under which iron concentration decreases with increasing leaching time and under which magnesium bicarbonate solubility is exceeded are not included. Data taken from Reference 6.